Working Paper Series no. 24

Socioeconomics and Policy

Early adoption of modern groundnut varieties in West Africa

J Ndjeunga, BR Ntare, F Waliyar, CA Echekwu, O Kodio, I Kapran, AT Diallo, A Amadou, HY Bissala and A Da Sylva

International Crops Research Institute for the Semi-Arid Tropics

Citation: Ndjeunga J, Ntare BR, Waliyar F, Echekwu CA, Kodio O, Kapran I, Diallo AT, Amadou A, Bissala HY and Da Sylva A. 2008. Early adoption of modern groundnut varieties in West Africa. Working Paper Series no. 24. Sahelian Center, BP 12404 Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics. 62 pp.

Titles in the Working Paper Series aim to disseminate information and stimulate feedback from the scientific community. A large number of similar and informal publications, derived from ICRISAT's socioeconomics and policy research activities are also being distributed under various titles: Impact Series, Policy Briefs, Progress Reports, Discussion Papers and Occasional Papers.

Abstract

This study investigates the early adoption of modern groundnut varieties in the pilot sites of the Groundnut Seed Project (GSP) in Mali, Niger and Nigeria following government and donors' investment. Seventeen varieties were disseminated in the pilot sites of the three countries. Uptake has increased significantly during the last three years partially as a result of project intervention.

The proportion of area planted with modern varieties has increased by 22% in Nigeria, 12% in Mali and 10% in Niger in the pilot sites since 2003. Farmers using modern varieties have derived significant yield gains of 24%, 43% and 31% over the local varieties in Mali, Niger and Nigeria respectively. The modern varieties had significantly lower per unit cost of production estimated to 9.8%, 11% and 11% in Mali, Niger and Nigeria respectively. The net income derived by adopters is 66% higher than non-adopters in Mali, 73% in Niger and 111% in Nigeria. Relative to household types, income gains are estimated to be less than 20% compared to poor households in Mali, while it is more than 50% in Nigeria.

Results from the Logit models indicate that the major determinants of adoption in the three countries include the participation of farmers to on-farm trials, the build up of social capital through the empowerment of farmers' associations and small-scale farmers at producing and marketing seed. Constraints to adoption remain the poor access and availability of seed of modern varieties, pest and disease pressure in at least two out of three countries. Tobit results indicate that intensification of modern varieties is dependent essentially on seed availability, social capital, exposure to the varieties through farmers' participatory variety trials.

Early adoption of modern groundnut varieties in West Africa

J Ndjeunga, BR Ntare, F Waliyar, CA Echekwu, O Kodio, I Kapran, AT Diallo, A Amadou, HY Bissala and A Da Sylva

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

Patancheru 502 324, Andhra Pradesh, India

2008

About the authors

J Ndjeunga International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 12404, Niamey, Niger.

BR Ntare International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali.

F Waliyar International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh 502 324, India.

CA Echekwu Institute for Agricultural Research (IAR), Samaru, PMB 1044, Zaria Nigeria.

O Kodio Institut d'Economie Rurale (IER), CRRA, Kayes, Mali.

I Kapran Institut National de Recherche Agricole du Niger (INRAN), BP 429, Niamey, Niger.

AT Diallo International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali.

A Amadou International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 12404, Niamey, Niger.

HY Bissala International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 12404, Niamey, Niger.

A Da Sylva Institut Senegalais de Recherche Agricole (ISRA), CRRA Bambey, BP 53 Bambey, Senegal.

Contents

Introduction

Groundnut production, marketing and trade are still major sources of employment, income and foreign exchange in many West African countries. Until the mid-1970s, groundnut contributed between 15% (Senegal) and 40% (The Gambia) of gross domestic production in West African countries. With the exception of Nigeria and Sudan, groundnut exports provided between 40% to 90% of export revenues of West African countries during the 1960s and the early 1970s (Kinteh and Badiane 1990).

Groundnut production in West Africa averaged about 4.832 million t in shells in 1997-2001. This represents about 60% of Africa's production and about 15% of world production (Table 1). Since 1961, production has been stagnant with an annual growth rate of 0.38%. Groundnut yield in West Africa is low with yields estimated to 981 kg/ha below the world average of 1386 kg/ha. This represents about one-third of the yield in China estimated to 2922 kg/ha in 1997-2001. Nigeria and Senegal are the largest producers accounting together for about 45% of total African production. Mali, Niger and Burkina Faso are also groundnut producers.

West Africa lost its world production share, which dropped from 23.2% in 1961-65 to 15.6% in 1999-01. However, groundnut remains the most important source of vegetable oils and fats in the sub region. The development of other competing sources of oils is becoming important. Soybean *(Glycine max)* production grew by an annual rate of 11.61% during 1984-2001 to reach an average of 440600 t annually in 1997-2001. Similarly, sesame *(Sesamum indicum)* production grew by 5.2% since 1984. Sesame is also a potential oil seed crop that could serve as second crop in a sequential cropping system (as in some mono-modal rainfall regions). Its versatility in the local diet renders it a promising oilseed crop. Cotton *(Gossypium* spp) seed production is increasing faster than groundnut. Groundnut and cotton must also compete for land and farm labor. Given the prospects in the fiber market, the relatively well developed product markets for cotton, and drought-tolerant character of the crop, cotton production is likely to be a competitive force to reckon with for the groundnut sector (Ndjeunga et al. 2003).

Groundnut oil prices have fluctuated widely over time with peak in 1981 and 1987. This variability is partially due to the thinnest of markets; and also to climatic conditions, policy shocks, or structural changes in these countries. Another factor is substitutability. Relative to substitutes such as soybean or palm oil, the price of groundnut oil is more than double. Similarly groundnut meal prices have fluctuated significantly for almost the same reasons. However, the relative price of meal is lower than that of substitutes, making it more competitive than soybean meal for example.

Groundnut production has suffered major setbacks from the groundnut rosette epidemics and foliar diseases, aflatoxin contamination and lack of sufficient and consistent supply of seed of improved varieties. This has significantly affected productivity and thus production and subsequently led West Africa to lose its share in the domestic, regional and international markets. To regain its competitiveness, groundnut yield would have to increase substantially, using yield enhancing technologies including varieties tolerant or resistant biotic and abiotic stresses.

The major constraints facing the development of the groundnut sector in West Africa are known to be, among others, the poor access and availability of high yielding groundnut varieties resistant to the rosette virus and foliar diseases. Since the 1990s, the International Crops Research Center for the Semi-Arid Tropics (ICRISAT) and partners – Institute for Agricultural Research (IAR), Institut d'Economie Rurale (IER) and Institut National de Recherche Agronomique du Niger (INRAN) – have developed or introduced a range of groundnut varieties with various attributes including different maturity groups

resistant to groundnut rosette disease, foliar diseases and other desirable agronomic traits. About 39 varieties have been selected from regional variety trials across a range of agro-ecological zones.

In 2003 and 2004, crop seasons were under Groundnut Seed Project (GSP), a larger program of more than 200 Farmer Participatory Variety Selection (FPVS) trials in Nigeria, Niger and Mali. Following the choice of varieties by farmers, ICRISAT and partners initiated and catalyzed the development of institutions and institutional arrangements that will deliver seed at low transaction costs to smallholder farmers. Research institutions were involved in the production of breeder and foundation seed using revolving fund schemes, a process that involved more than 30 farmers' associations and led to 20 small-scale farmers being trained in seed production and marketing. This resulted in the production of more than 33 tons of breeder seed and 107 tons of foundation seed. In addition, more than 130 tons of certified seed have been produced by community based organizations. This amount of seed could cover more than 100 000 ha of groundnut area. However, little is known on whether the modern varieties have spread beyond the FPVS participants and the pilot sites, whether the area cultivated to modern varieties has increased in the pilot sites, whether the number of households using modern varieties have increased, what the major drivers are in the uptake of modern varieties and the options of scaling up and out such technical and institutional interventions.

This study has three main objectives. The first was to assess the level of adoption of modern varieties and compare it with baseline information in the pilot sites. The second was to identify the determinants of uptake and intensity adoption of modern varieties, and the third is to propose options for scaling up and scaling out successful interventions.

The report is organized as follows: Section II presents a description of the study region, Section III presents the research and development process under the Groundnut Seed Project. Section IV presents the conceptual framework while Section V outlines the methodology. The results are presented in Section VI and Section VII concludes with options for scaling up and out successful interventions in developing seed supply systems in West Africa.

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

This study was undertaken in the GSP pilot sites in Nigeria, Niger and Mali. These countries are among the least developed in the world with low human development index (HDI). More than 60% of the population lives with less than US$1/day (Table 2). Agriculture employs more than 90% of the active population in Niger and Mali and 43% in Nigeria. The development of the agricultural sector remains a prerequisite for economic growth.

The pilot sites by region by country are presented in Table 3. The sites span a range of socioeconomic and demographic settings and are representative of agro-ecologies suitable for groundnut production.

Table 1. Evolution of African groundnut production in selected countries from 1961-2001: Area harvested, production and yield.

Aggregation	Production					Area		Yield	
	Average 1997-2001 ('000 t)	Average share of Africa 1997-2001 (%)	Average share of World 1997-2001 (%)	Annual growth rate 1984-2001 (%)	Annual growth rate 1961-2001 (%)	Average 1997-2001 ('000 ha)	Annual growth rate 1961-2001 (%)	Average 1997-2001 ('000 kg/ ha)	Annual growth rate 1961-2001 (%)
World	32,945	NA	100	3.30	2.01	23,772	0.56	1386	1.45
China	12,698	NA	38.54	6.2	5.86	4,927	2.72	2922	3.14
India	6.855	NA	0.02	0.46	1.18	7,287	0.20	943	0.98
Africa	8,018	100	24.34	4.87	0.53	9,154	0.33	875	0.20
Western Africa	4832	60.2	14.67	5.69	0.38	4,920	0.16	981	0.55
Gambia	113	1.4	0.34	0.23	-1.08	98	-0.40	1146	-0.68
Mali	141	1.8	0.43	2.91	0.22	146	-0.57	962	0.79
Niger	105	1.3	0.32	9.50	-3.66	254	-2.03	416	-1.63
Nigeria	2730	34.1	8.29	9.93	0.55	2571	-0.35	1063	0.90
Senegal	852	10.5	2.59	1.45	-0.65	871	-0.86	981	0.21
Benin	94	1.2	0.29	3.10	2.85	109	0.99	862	1.86
Ghana	193	2.4	0.59	1.17	3.72	188	3.53	1023	0.18
Liberia	4.2	0.0	0.01	1.87	1.94	7.0	2.10	600	-0.15
Mauritania	2.0	0.0	0.01	1.05	2.52	2.5	0.96	808	1.56
Guinea	180	2.3	0.55	7.65	2.26	180	1.04	1002	1.22
Guinea-Bissau	19	0.2	0.06	-1.73	-5.34	16	-5.95	1170	2.71
Burkina Faso	198	2.5	0.60	4.00	3.30	239	1.84	824	1.46
Cote d'Ivoire	145	1.8	0.44	1.99	5.19	151	3.59	962	1.60
Sierra Leone	26	0.3	0.08	2.42	0.70	30	1.68	868	-0.99
Togo	30	0.4	0.09	1.01	2.18	57	2.20	523	0.01

NA= not applicable

Source: FAOSTAT Database 2002.

Table 2. Socio-demographic and economic profile of Mali, Niger and Nigeria.

Indicator	Country/Region				
	Mali	Niger	Nigeria	LDCs[+]	SSA[++]
People					
Population (million)	11.7	11.8	135.6	703	702.6
Population growth (annual %)	2.4	2.9	2.1	2.2	2.1
Life expectancy rate (years) in 2002	40.9	46.2	45.3	50.7	45.8
Literacy (% more 15 years)	24.9[*]	17.1[*]	66.8[#]	53.8[*]	64.9[#]
Environment					
Surface area (million sq km)	1.2	1.3	0.924	20.8	24.3
Arable land ('000 sq km)	46.06	49.94	303.71	--	--
Economy					
Gross National Income per capita (current $US)	290	200	320	310	490
Gross Domestic Product (current $US billion)	4.3	2.7	50.2	232.1	417.3
Gross Domestic Product growth (annual %)	6.0	4.0	10.6	4.8	3.4
Value added in agriculture (% GDP)	36.3	40.0	37.4	32.3[2]	14.1
Agricultural labor in 1990 (% of labor force)	93	91	43	--	--
Technology and Infrastructure					
Percentage of paved roads of total area in 1999	12.1	7.9	30.9	13.3	12.9
Trade and finance					
Trade in goods as a share of GDP (%) in 2002	60.7	33.8	52	45.1	55.3
Aid per capita (current US$) in 2002	41.5	26.1	2.4	25.4	28.2
Poverty proxies					
Human Development Index (2003)	0.337	0.292	0.463	--	--
Population with less US$1 per day in 2004 (%)	72.8	61.4	70.2	--	--

[*] in 1999; [#]in 2002. LDC[+] = Least Developed Countries; SSA[++] = Sub-Saharan Africa.
Source: World Development Indicators Database August 2004.

Table 3. GSP pilot sites by country, region/state and villages.

Country	Region/State	Number of villages	Name of villages
Mali	Kolokani	8	Tioroubougou, Bambabougou, Somon, Gouakoulo, Seriwala, Soninkoro, Kanekebougou, Kolokani
	Diola	3	Wolome, Wobougou, Wakoro
	Kita	2	Sanoko, Senko
	Kayes	7	Same, Babala, Diakandape, Same Oulof, Dar Salam, Soutoucoule, Kayes center
	Katibougou	2	Winzinbougou, Mamaribougou
	Bancoumana	1	Gonzolo
Niger	Dosso	7	Sia, Karakara, Sambera, Sormo, Kigoudou Koara, Faska, Hankoura
	Maradi	3	Atchi da Koloto, Kourougoussao Kagera-Bargaja
	Zinder	2	Langiwa, Angoal-Gandji
Nigeria	Kano	7	Gezawa, Minjibir, Albasu, Daurawa, Sharadan, Gaya, Danbata
	Katsina	5	Zango, Daura Mashi, Dutsin ma, Kankiya, Makurda
	Jigawa	9	Kantoga, Jalomi, Masaya, Kangire, Dalarin Kwetta, Dalarin-lungu, Rangera, Gareri

Nigeria

The study was carried out in Jigawa, Katsina and Kano states where groundnut production accounts for more than 50% of total groundnut production. These states are located in+ the Sudan savanna and Sahel ecological zones where pearl millets, sorghum, cotton, groundnut, cowpea, vegetables, maize, cassava, sugarcane and beniseed are the main crops grown under rainfed and irrigated conditions.

The three states occupy each between 20,400 sq km and 22,600 sq km with average 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, estimated to 276 people/sq km more than double that of Jigawa. Average household sizes range between 8 and 10 members with average income ranging between 3200 Naira ($25) in Jigawa to 4000 Naira ($30.7) in Kano. The major ethnic groups are Hausa and Fulani (Table 4).

Table 4. Bio-physical and socioeconomic characteristics of three states in the Sudan-savanna and Sahel zones of Nigeria.

	State		
Characteristic	Jigawa	Katsina	Kano
Climate			
Rainfall (mm)	635-890	600-700	816
Temperature (°C)	31-33	NA	26-33
Land area (sq km)	22 600	25938	20400
Arable land area (sq km)	1695	1726	1632
Cultivated area (sq km)	1627	1537	1626
Average farm size (ha)	1.9	2.7	1.6
Population			
Total ('000 inhabitants)	2830	3878	5632
Population density (per sq km)	125	162	276
Ethnic groups	Hausa, Fulani, Kanuri	Hausa, Fulani	Hausa, Fulani
Farm households			
Average household size (no of members)	8.0	9.7	8.2
Average household income (in Naira)	3500	3200	4000

Source: Adapted from Ogungbile et al. 1999. p. 11-12.

Niger

The pilot sites were located in south-west and eastern parts of the country, involving Dosso, Maradi and Zinder regions. These regions are representative of the different agro-ecological zones with different assets endowments and market orientation.

The region of Dosso, located in southwest Niger covers 33,844 sq km with a population density of 44 persons/sq km and population estimated to 1,504,684 inhabitants accounting for 14% of the total population of Niger (République du Niger 2005). The climate is the Sudano-Sahelian type, with annual rainfall ranging between 400 and 1200 mm. Soils are mainly sandy accounting for two-third of the region, with clayey soils in less than 10% of the region. There are hydromorphic soils located in the dallol and river valley, which are 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 lying areas and dallol. Major crop associations include millet-cowpea, followed by millet-sorghum-cowpea, millet-sorghum and millet-cowpea-sesame. The size of production units ranges between 7.3 ha in the Gaya area to 19.7 ha in the Loga area.

Maradi in the center of Niger covers about 41,796 sq km, ie, about 3% of Niger. About 72% of this area is suitable for agriculture, 24% to grazing land for livestock and the remaining 4% is forestland. The climate is the Sahelian type in the north, Sudano-Sahelian in the center and Sudanian in the south with rainfall ranging from 200 to 700 mm. The region of Maradi is the most densely populated with population density estimated to about 54 persons/sq km. In 2001, the population was estimated to 2,235,748 inhabitants accounting for 20% of Niger population in 2001. Haoussa, Peulh and Touareg are the main ethnic groups, representing 83%, 10% and 6% respectively. Maradi is among the highest production zone in Niger accounting for 18% of millet, 20% of sorghum, 21% of cowpea and 38% of groundnut. Farmers are exposed and are using modern technologies due to numerous interventions by the rural development projects and non-governmental organizations (NGOs) during the last 30 years. More than 50% of households are equipped with animal traction. Millet-cowpea-fallow is the major production system. Millet and sorghum remain the major cereal crops. Groundnut, cowpea, sesame and cowpea are the major cash crops. The importance of vegetable crops is growing rapidly.

Zinder in eastern Niger covers 155,778 sq km with a population estimated to 2,080,250 inhabitants accounting for 19% of the total population. Population density is estimated to 19 persons/sq km, whereas in almost all the regions, population growth has been decreasing. It fell from 3.71% to 3.05% in 1977-88 and 1988-01 in Dosso and from 3.29% to 3.03% in Zinder during the same periods. In the region of Maradi it has slightly increased from 3.66% in 1977-88 to 3.73% in 1988-01 (Republique du Niger 2005). This is the least endowed area with respect to resources.

Mali

Groundnut production in Mali is concentrated in the west, south and parts of the center, covering the regions of Kayes, Koulikoro, Sikasso and Segou. These account for 97% of the area and 98% of groundnut production in Mali. Average rainfall ranges from 400 and 800 mm per year.

The survey was carried out in the regions of Koulikoro and Kayes, and specifically in the districts of Kolokani, Diola, Mande, Kita and Kayes. The region of Kayes is the most important groundnut producing region, accounting for 33% of area and 35% of groundnut production in the country. This is followed by the region of Koulikoro which accounts for 21% of groundnut area and 24% of groundnut production.

Kolokani is one of the largest groundnut-producing areas in the region of Koulikoro. It has a history of experiencing repeated droughts, at least during 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).

A survey of groundnut producers in Mali in 1997/98 showed that family size ranges from 16 to 28 persons of which half is considered as active population. Cereal crops account for 62% of the total cropped area in Kolokani, followed by Bougouni with 45% and Kita with 20% of total cropped area. Cotton and groundnut are the main cash crops grown with the proportion of groundnut cultivated area estimated to 17% in Bougouni, 38% in Kita and 37% in Kolokani (CPS-IER 1998). Average area cultivated per household is estimated to 5.8 ha in Kolokani, 2.9 ha in Kita and 2.1 ha in Bougouni.

Groundnut is cultivated as a sole crop or associated with cereals such as pearl millet or sorghum or other crops such as ‘dah’. However, there are differences by region. While in Bougouni, groundnut is

* ICG 7878, ICG (FDRS) 4, ICG (FDRS) 10, Mossitiga, Demba, Niouma (ICGS (E) 34), ICGV 92093, ICGV 92088, ICGV 92082 and ICGV 91225

cultivated as mixed crop in 48% of the groundnut-cropped area, groundnut is cultivated almost as sole crop in 92% of the total groundnut-cropped area. Yields are higher in Kita (1249 kg/ha) against 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. About 32% 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 fertilizers.

Section III. The Groundnut Seed Project: Dissemination and institutional processes

The Groundnut Seed Project (GSP) started in April 2003 and evolved through two phases. During the first phase, from 2003/04 to 2004/05, farmer participatory variety selection (FPVS) trials were carried out in pilot sites to evaluate variety performance under farmers' own crop management and expose farmers to new varieties. On-farm trial participants were selected among volunteers in Nigeria and Niger and were purposely selected in Mali among the best farmers whose management was already known. This is because, in Mali, the pilot sites were basically the social laboratory of ICRISAT and IER where all technologies had been tested with many farmers since 1997 under the Groundnut Germplasm Project (GGP).

Mali

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. Apart from other constraints, foliar diseases were targeted as the major biological constraint limiting groundnut productivity and were estimated to be responsible for more than 60% of yield losses. ICRISAT has developed a range of varieties tolerant or resistant to many foliar diseases. Since 1998, ICRISAT initiated a large on-farm testing program with partners in the research and development continuum in order to test the performance of these varieties in the real conditions and provide opportunities to farmers to select their preferred varieties. Nine groundnut varieties* resistant to foliar diseases and with early-to medium-maturity were identified. Selected farmers were given 1 kg seed of each of the varieties. This quantity was sufficient to plant a plot of 10 m ×10 m along with the traditional variety. Field monitoring and evaluation were conducted by ICRISAT and IER scientists, and a range of development partners including NGOs such as Winrock International and ADAF GALLE (a local organization), and rural development projects such as the Office de la Haute Vallee du Niger (OHVN) and la Compagnie Malienne du Developpement Textiles (CMDT).

Every year, data on yields and farmers' rapid assessment of their preferences were collected. In 2000, ICRISAT initiated a small-scale seed production scheme with four farmers in the villages of Bambabougou, Kanekebougou, Tioribougou and Komokorobougou in the region of Kolokani. These farmers produced about 3.6 tons of seed of the variety ICG 7878, Mossitiga and Demba Niouma. Seed was marketed using small-scale pack seed (Ndjeunga et al. 2003).

Since 2003, GSP continued to promote a range of seed multiplication and delivery schemes in other regions of Mali. Four farmer associations and 10 individual farmers were selected and tasked with seed multiplication and distribution. More than 40 tons of seed were produced by farmers and marketed through seed demand from NGOs, or individual farmers through village markets and seed exchange between farmers.

Nigeria

Since 1990, ICRISAT and IAR developed, tested or adapted 44 groundnut varieties. These varieties were tested in multi-location trials in partnership with Agricultural Development Projects (ADPs) and Sasakawa Global 2000 in many states including Kaduna, Kano, Jigawa and Katsina. The specific locations for on-farm testing included Samaru (1996-97, 1998-99) in the state of Kaduna, Bagauda (1997-98), Minjibir (1996-98), Shika (1998-99), Kano (1998-99) in the state of Kano, Katsina (1998-99) in the state of Katsina and Maiduguri (1998-99) in Borno State*. Following the on-farm testing program, three groundnut varieties (UGA 2 (SAMNUT 21), M 572.80I (SAMNUT 22) and ICGV-IS-96894 (SAMNUT 23) were formally released in 2001.

In 2003, GSP promoted a range of high yielding groundnut varieties resistant to groundnut rosette disease (GRD) with market and farmer preferred traits through participatory variety selection (PVS), seed multiplication and delivery systems. Four states were targeted including Kaduna, Kano, Katsina and Jigawa. On-farm trials with farmers' management were conducted under the supervision of Agricultural Development Programs, the state agricultural extension services. Once farmers had selected the preferred varieties, the next task was to increase access to seed of selected 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 companies outlets.

Niger

In the 2000 crop season, farmers from Bengou village in Gaya district visited the INRAN research station where ICRISAT had established a large nursery of groundnut germplasm for characterization. Fascinated by the diversity of varieties, farmers were eager to test some of them on their farms. They chose the varieties based on their observations, information given by ICRISAT technicians, and their know-how. Each of the seventy farmers was given 1kg of seed of the selected variety after harvest. Overall 52 varieties# were selected by these farmers who came from the villages of Bengou, Koita Tegui and Kouara Zeno. The varieties were grown in a 2-hectare field provided by the village chief. ICRISAT technicians trained the farmers in how to sow in lines and the basics of good crop husbandry. Farmers themselves carried out all field operations such as land preparation, planting, weeding and harvesting. The Programme d'Appui au Développement Local de Gaya (PADEL), a Swiss-funded development project, assisted in the organization of three field days: 45 days after planting to show plant vigor, at harvest, and the third one during oil extraction. More than 150 women and men attended each of the field days. A total of 20 varieties was selected based on productivity .

---

* Varieties tested were ICGV IS 96894 (SAMNUT 23), ICGV IS 96900, ICGV IS 96901, ICGV IS 96859, ICGV IS 96909, ICGV IS 96871, ICGV IS 96898, ICIAR 18 AR, ICIAR 7B, ICIAR 18 AT, ICIAR 19 BT, ICIAR 9 AT, ICIAR 12 AR, ICIAR 10 B, ICGV IS 96826, ICGV IS 96801, ICGV IS 96848, ICGV IS 96808, ICGV IS 96804, ICGV IS 96805, ICGV IS 96855, ICGV IS 96802, ICGV IS 96845, ICGV IS 96827, ICGV IS 96840, ICGV IS 96809, ICGV IS 96828, ICGV IS 96835, ICGV IS 96810, ICGV IS 96841, ICGV IS 96847, ICGV IS 96825, ICGV IS 96824, ICGV IS 96816, KH 241 D, RRB, 55-437, ICGV IS 96891, ICIAR 6AT, ICGV 96891, UGA 2 (SAMNUT 21), UGA 4, M572.80I (SAMNUT 22) and Fleur 11.

55-437, 796, FLEUR 11, ICG 10105, ICG 10187, ICG 10203,ICG 10399, ICG 10425, ICG 10485, ICG 10511, ICG 10514, ICG 10529, ICG 11028, ICG 12020, ICG 12115, ICG 12139, ICG 12965, ICG 1305, ICG 1476, ICG 2373, ICG 3151, ICG 3190, ICG 3783, ICG 5193, ICG 544, ICG 564, ICG 6080, ICG 6102, ICG 6118, ICG 6428, ICG 6575, ICG 6592, ICG 6743, ICG 6747, ICG 7257, ICG 7371, ICG 7758, ICG 7759, ICG 7920, ICG 7922, ICG 8055, ICG 8482, ICG 8534, ICG 8801, ICG 8811, ICG 8849, ICG 8852, ICG 8892, ICG 9199, ICG 9232, ICG 9346, ICG 9360, ICG 9380, ICG 9829, ICG 9829, ICGV 86047, ICGV 86124

Women with at least 20 years of experience in groundnut oil extraction conducted the assessment of the selected varieties for their oil and cake yields using traditional methods. From this assessment, five varieties (ICGV 86124, 55-437, ICG 9346, ICG 9199 and ICG 7299) were selected.

In 2001, PADEL initiated on-farm variety testing and dissemination in the region of Gaya, using the varieties selected above. Thirteen farmer trials from the villages of Mallan Kadi, Sabon-Birni, Makani, Guéza gado, Mallamawa, Gawassa, Garin Hamani, Goumandey and Rountoua Tanda participated in the trials. Two additional varieties (Fleur 11 and J 11) were added.

In 2002, eight individual farmers and five farmers' associations in the villages of Mallam Kadi, Sabon Birni, Makani, Guéza Gado, Mallamawa, Gawassa, Goumandeye, Kawara Gohé, Garin Hamani, Tanagaye, Toungan Darfou and Toungan Donfou were targeted to produce seed of farmer-selected varieties (J 11, Fleur 11, RRB, ICGV 96894 and ICGV 96891). In other villages in the region of Gaya also, viz, Tounga Darfo, Tanagueye, Guéza gado, Makkani and Rountoua Dolé, farmers' associations were targeted to produce seed of the selected varieties, ICGV-IS 96891, ICGV-IS 96894, JL 24, J 11, Fleur 11, and ICG 9199. Little follow-up was done on the where-abouts or use of those varieties by the farmers.

With the inception of the GSP in 2003/04, a mother and baby trial approach was implemented in three villages of western Niger to assess household preferences for plant and seed traits of five groundnut varieties based on a random utility based choice experiment. Preferences were estimated for five groundnut varieties. Median ranking of varieties showed that farmers preferred by order: RRB, 55-437, ICG 9346, Fleur 11 and ICGV 96894. Similarly pod yields followed the same patterns as the overall ranking of varieties. However, ICG 9346 yields significantly more haulm than others. Ordered probit results show that color (red), maturity (short cycle), pod yield and disease pressure (low) are the most important attributes by order of importance.

In 2004/05, using the same varieties and trial design, the on-farm trials were extended to other villages including Faska, Hankoura, Gobery, Fabidji, Sadeizi Kouara and Simari. Similar results were obtained. This was followed up by the production of seed of selected varieties by farmers' associations and individual farmers. More than 30 tons of improved seed was produced and marketed through small pack seed sales or by individual farmers in the village markets or farmer-to-farmer exchanges.

During the second phase of the GSP starting in 2005/06, the project focused on building institutions and institutional arrangements that would enhance access and increase seed availability of selected varieties in sufficient quantities and suitable quality to end-users. Breeder and foundation seed production and delivery schemes were experimented. While revolving fund schemes were established in Niger and Nigeria, production of breeder seed was ensured by the public sector in Senegal and the GSP project in Mali. Certified and quality declared seed (QDS) were produced by farmers' associations and small-scale farmers in pilot sites. Strategies to enhance delivery of seed include among others the sale of small-seed packs in pilot sites. The quantities of seed produced by seed class, year and country are summarized in Table 5.

Project activities were undertaken in partnership with NARES, NGOs and rural development projects. Certified and quality declared seed were produced using three major multiplication schemes: farmers' associations; small-scale seed producers, and rural development projects through contract growers.

Table 5. Seed produced ('000 kg) by country during four years (2003/04–2006/07).

		Seed class			
				Certified	
Country	Year	Breeder	Foundation	FA	SCSP
Mali	2003/04	1.7	12.0	1.440	3.762
	2004/04	1.7	8.8	3.059	13.330
	2005/06	1	20.0	4.489	12.869
	2006/07	1.1	10.0	4.365	33.437
Niger	2003/04	1.0	4.9		
	2004/05	-	5.5		
	2005/06	-	4.8		
	2006/07	-	-		
Nigeria	2003/04	2.0	5.7		
	2004/05	1.9	10.0		
	2005/06	0.4	3.8		
	2006/07	0.4	5.6		
Total		11.2	91.1		

FA: Farmer association, SCSP: Small-scale seed producers

Theory and conceptual framework

The conceptual framework for this study is based on diffusion theory using a sustainable livelihood framework. An important issue in discussing diffusion theory is that it is not one, well-defined, unified and comprehensive theory. Rather, a large number of theories, from a wide variety of disciplines, each focusing on a different element of the innovation process combine to create a meta-theory of diffusion. Four of the theories discussed by Rogers (1995) are among the most widely-used theories of diffusion. These are: Innovation Decision Process; Individual Innovativeness; Rate of Adoption; and Perceived Attributes. In this study, we will focus on the perceived attributes which fit best farmers' circumstances when selecting their preferred groundnut varieties.

The theory of perceived attributes states that potential adopters judge an innovation based on their perceptions in regard to five attributes of the innovation. These attributes are: Trialability; Observability; Relative Advantage; Complexity and Compatibility. The theory holds that an innovation will experience an increased rate of diffusion if potential adopters perceive that the innovation: 1) can be tried on a limited basis before adoption; 2) offers observable results; 3) has an advantage relative to other innovations (or maintains status quo); 4) is not overly complex; and 5) is compatible with existing practices and values. The Theory of Perceived Attributes has been used as the theoretical basis for several studies relevant to the field of instructional technology. Perceptions of compatibility, complexity, and relative advantage have been found to play a significant role in several diffusion studies. Wyner (1974) and Holloway (1977) each found relative advantage and compatibility to be significant perceptions among potential adopters of technology. Surry (1993) studied the perceptions of weather forecasters in regard to innovative computer based training and found relative advantage,

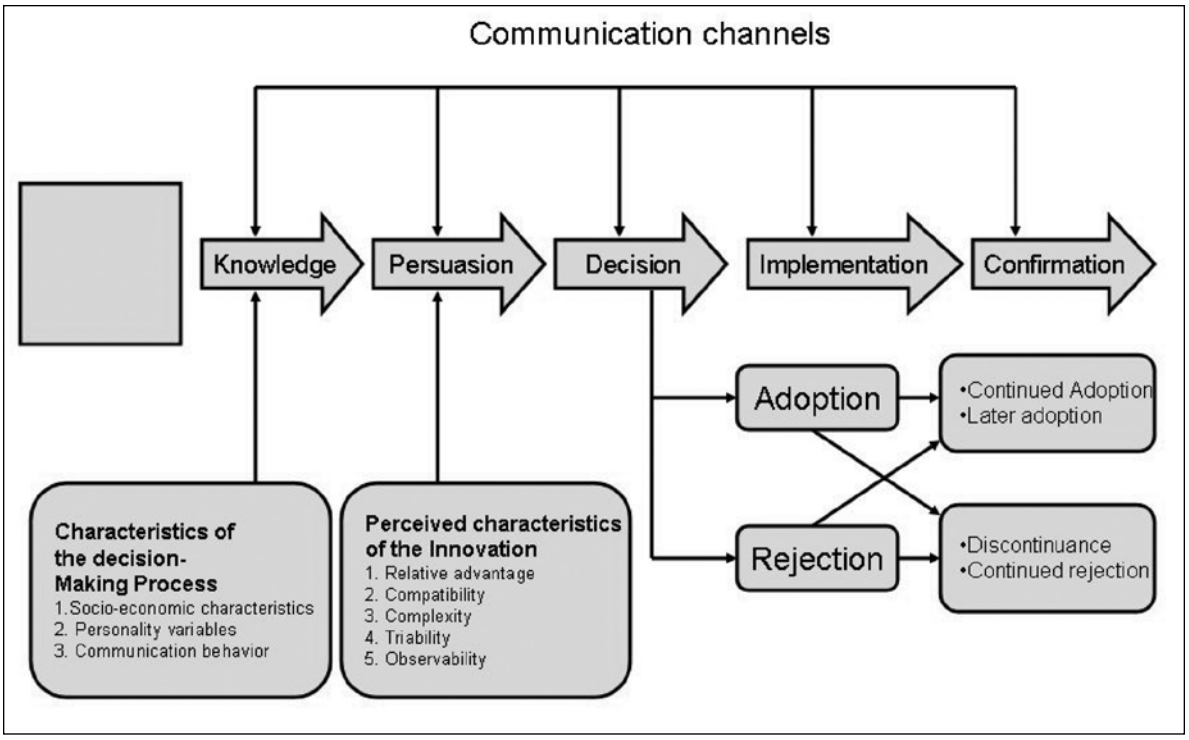

Figure 1. A model of stages in the innovation decision process. Source: Rogers & Shoemaker (1973)

complexity and compatibility were important adoption considerations. This study draws from a mixture of the theories of the Innovation Decision Process and the perceived attributes of the technology and will then attempt to address the following research questions and hypotheses.

The conceptual framework will be that of the Sustainable Livelihood Framework (SRL) presented in Figure 2. The framework brings together relevant concepts to allow poverty to be understood more holistically (Farrington et al. 1999). It draws on the improved understanding of poverty, but also on other streams of analysis in economic theory, development theory, anthropology and sociology relating to households, gender, governance and farming systems.

Where:

H represents **human capital**: the skills, knowledge, ability to labor and good health, which is important to the ability to pursue different livelihood strategies

P represents **physical capital**: the basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means that enable people to pursue livelihoods

S represents **social capital**: the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods

F represents **financial capital**: the financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) which provide them with different livelihood options

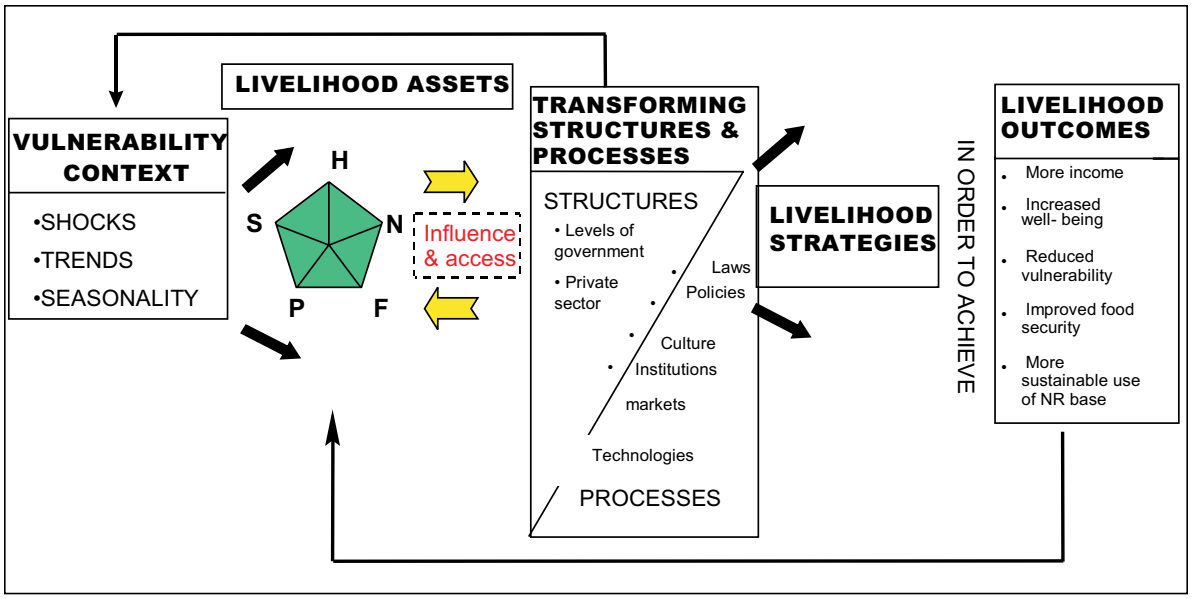

Figure 2. A modified version of DFID's Sustainable Livelihoods Framework.

N represents **natural capital**: the natural resource stocks from which resource flows useful for livelihoods are derived (eg, land, water, wildlife, biodiversity, environmental resources)

The framework encourages users to think about existing livelihood patterns as a basis for planning research and development activities. This entails analysis of various tools to better understand:

- the context in which (different groups of) people live, including the effects upon them of external trends (economic, technological, population growth etc.), shocks (whether natural or manmade) and seasonality;
- people's access to different types of assets (physical, human, financial, natural and social) and their ability to put these to productive use;
- the institutions, policies and organizations which shape their livelihoods; and
- the different strategies that they adopt in pursuit of their goals.

The value of a framework such as this is that it encourages users to take a broad and systematic view of the factors that cause poverty – whether these are shocks and adverse trends, poorly functioning institutions and policies, or a basic lack of assets – and to investigate the relations between them. It does not take a "sectoral" view of poverty, but tries to recognize the contributions made by different interconnected assets, processes and structures that people draw on to devise livelihood *strategies* in order to achieve an anticipated livelihood *outcome*. This does not imply that development activity itself should always be multi-sectoral. The need is to conceive of problems and solutions in a holistic way, but then to select target and manageable approaches for implementation.

Methodology

The study was carried out in pilot sites in Mali, Niger and Nigeria where GSP started its activities in 2003/04. These regions encompassed the Sahelian and Sudanian-savanna zones.

Sampling procedure and data collection

The survey was carried out from November 2006 to February 2007. A purposive random sampling was used to select project sites. In each country, 75% of all project sites were selected. Next to every selected project site was a control site (a neighboring village) where GSP did not intervene. In each project site, 15 on-farm trial participants were selected from the population of participants and 10 non-trial participants were selected from the population of non-participants. Finally, 10 households were randomly chosen from the population of households in the comparator villages (ie, the control site). In case the number of on-farm participants was less than 15 farmers, enumerators were asked to survey all on-farm trial participants with the remaining unchanged.

The distribution of households selected to on-farm trials as well as the control sites according their participation or non-participation is presented in Table 6. Overall, 1190 households were selected and interviewed in the three countries including 868 households in the project sites and 322 in the neighboring villages. Of the households located in project sites, 450 participated in on-farm trials and 418 were non-trial participants.

Table 6. Distribution of villages and farmers in GSP pilot and control sites by country.

	Pilot villages			
Region	Participants	Non-participants	Control villages	Total
Mali	122	123	98	343
Niger	106	167	97	370
Nigeria	222	128	127	470
Total	450	418	322	1190

Source: ICRISAT/NARS survey, 2006/07.

Data was collected at the household and plot levels using structured survey questionnaires. Survey questions included modules on (1) socioeconomic and demographic profile of the households, (2) diffusion mechanisms pathways including knowledge of varieties and sources of first information and adoption and dis-adoption of groundnut varieties; (3) use of modern varieties at plot level, (4) diffusion pathways of modern varieties, (4) utilization, consumption and commercialization of groundnut, (5) household transactions, (6) household perception of modern varieties relative to local varieties, (7) farmers' estimate of losses due to GRD in Nigeria and foliar diseases in Niger and Mali and finally (8) households' perception of changes in welfare resulting from the use of modern groundnut varieties.

Profile of varieties investigated in the study

The pre-released and released varieties in the three countries are presented in Table 7. Following FPVS trials conducted during the 2003/04 to 2004/05 crop seasons, the varieties selected by farmers are described below:

Nigeria

The modern varieties targeted are SAMNUT 21, SAMNUT 22 and SAMNUT 23.

(1) SAMNUT 21 (UGA 2)

This variety, also known as UGA 2, was developed jointly by the University of Georgia in the USA and the Institute of Agricultural Research (IAR) in Nigeria. It results from a cross between (RMP 12 × ICGS (E) 52). It is a medium-maturing variety with vegetative cycle between 115 and 120 days. It is a Virginia type and is resistant to GRD and foliar diseases. It has high oil content estimated to 51%. The potential pod yield is about 2.5 tons and 4 tons of haulm on-station and about 1.5 tons on-farm under the best agronomic practices. It was officially released in 2001 but was introduced in on-farm trials in many northern states since 1996. The adaptation zone is between 700 to 1000 mm annual rainfall.

(2) SAMNUT 22 (M572.80 I)

This variety is also known as M572.80 I under IAR nomenclature. It was selected in 1980 under irrigation at IAR's Mokwa research station in central Nigeria. It results from a cross between RMP 91 x (4753.70 x 3520.71). It is a medium maturing variety with a vegetative cycle of between 115 to 120 days. It is of Virginia type, resistant to GRD and tolerant to cercospora leafspots. It has moderate oil content estimated to 45%. The potential on-station pod yield is about 2.5 tons/ha and 1.5 tons on-farm. It was officially released in 2001 but was already introduced in on-farm trials in many northern states since 1996. The adaptation zone is the Sudan and Guinea savannah zones (which have average annual rainfall of 700-1500 mm).

(3) SAMNUT 23 (ICGV-IS 96894)

This variety is also known as ICGV-IS 96894 under ICRISAT nomenclature. It results from a cross between ICGV-SM 85048 and RG 1. It was developed by ICRISAT in partnership with IAR in Nigeria. It is an early maturing variety with vegetative cycle between 90 and 100 days. It is of Spanish type, resistant to GRD and foliar diseases. It has high oil content estimated to 53%. The on-station potential pod yield is about 2.0 tons and 4 tons of haulm. On-farm yield potential is about 1.5 tons. It was officially released in 2001 but was already introduced in on-farm trials in many northern states since 1996. The adaptation zone is between 700-1000 mm annual rainfall.

Other varieties being grown by farmers include 55-437, RMP 12, RMP 91, RRB and other local varieties. Although 55-437 and RRB are popular varieties, they are highly susceptible to rosette which nearly wiped out the entire groundnut industry in Nigeria in the mid 1970s. On the other hand RMP 12 and RMP 91 though resistant to GRD, are very late maturing (more than 120 days) and are no longer adapted to the short-season environment of the dry savanna zone of Nigeria, where most of the crop is grown.

Mali

The varieties targeted are ICG (FRDS) 4, ICG (FDRS) 10, ICG 7878, JL 24, Fleur 11 and ICGV 86124.

(1) ICG (FDRS) 4

This variety was developed by ICRISAT in India and introduced to West Africa. It is an early-maturing variety with vegetative cycle averaging 90 days. It is of Spanish type, resistant to rust and tolerant to

late leafspot. It has a moderate oil content estimated to 48%. The potential pod yield ranges between 1100 and 1500 kg/ha. It was officially released in 2002 but was already in use in on-farm trials in the Kolokani region since 1998. Its zone of adaptation is between 700 to 1000 mm annual rainfall.

(2) ICG (FDRS) 10

This variety results from a cross between (Ah 65 x NC Ac 17090) F2-B1-B1-B2-B1-B1-B1-B2. It was developed by ICRISAT in India and introduced to West Africa. It is a medium maturing variety with vegetative cycle averaging 115 days. It is of Spanish type, resistant to rust and tolerant to late leafspot and drought. It has a moderate oil content estimated to 48%. The potential on-farm pod yield averages 2000 kg/ha. It was officially released in 2002 but was already introduced in on-farm trials in the Kolokani region since 1998. The adaptation zone is between in the 700 to 1000 mm annual rainfall.

(3) ICG 7878

This is a germplasm line selected from screening of germplasm for foliar disease resistance. It originates from North Carolina, USA and was adapted to West Africa. It is a late maturing variety with vegetative cycle averaging 120 days. It is of the Virginia type, resistant to early and late leafspots. The potential pod yield ranges between 1500 and 1800 kg/ha. It was officially released in 2002 but was already used in on-farm trials in the Kolokani region since 1999. The adaptation zone is between 700 to 1500 mm annual rainfalls.

(4) Fleur 11

Originates in China but was introduced in Senegal through Peanut CRSP. It is early maturing (85-90 days) and significantly out-yields the widely adapted 55-437. It has larger seeds than 55-437 and was released in Senegal in 1988. ICRISAT introduced the variety in Mali through regional variety trials.

(5) ICGV 86124

This variety was developed by ICRISAT in India and introduced to West Africa. It is early maturing, high yielding and tolerant to drought.

(6) JL 24

This is a selection from an exotic collection 94943, released in 1978 in India as Plus Pragati. It has an average pod yield of 1.8 t/ha, shelling percentage of 75%, average oil content of 50.7%, average 100-seed weight of 53.7 g based on data from several trials conducted over three to four years. Other morphological features include dark green leaves, early maturity (90 days in West Africa), smooth pods and compact bearing. This variety is widely adapted but is susceptible to foliar diseases and insect damage. It lacks fresh seed dormancy, making it vulnerable to field sprouting if harvesting is delayed.

There are other varieties being grown in Mali such as 47-10, 55-437, 28-206, TS32-1, ICGS (E) 34 (ICGV 86065) and CN 94C. Apart from ICGS (E) 34, these varieties were introduced more than five decades ago and are highly susceptible to foliar diseases.

Niger

The varieties targeted in Niger are ICG 9346, J 11, Fleur 11, RRB, T 181-83, T 177-63, O-20 and T 169-83.

(1) ICG 9346

This is a germplasm line selected by farmers from a large characterization nursery of groundnut germplasm. It was selected based on high pod, oil and cake yields.

(2) J 11

A variety collected by ICRISAT in India in 1965 and introduced in 1988 in West Africa through the ICRISAT groundnut improvement program. It is early-maturing with vegetative cycle of between 90 and 100 days. It is of the Spanish type, tolerant to aflatoxin but susceptible to foliar diseases. It has moderate oil content between 42 and 45%. The potential pod yield ranged between 1.5 and 2.0 kg/ha. It was introduced in on-farm trials in the Gaya district in Niger since 2000. The adaptation zone is around 700 mm annual rainfall.

(3) Fleur 11

This variety was introduced in Niger in 1991 by the ICRISAT groundnut improvement program. Its dissemination was enhanced by the Groundnut Germplasm Project (GGP) since 1996.

(4) RRB (Resistant Red Bulk)

This was developed by the Institute for Agricultural Research (IAR) in Nigeria in 1988 and introduced in Niger through the GGP. It is crossbred between KH149 A (rosette resistant) x 2424.74 (rosette susceptible). Pods which are moderately constricted are clustered around the base of the main stem. The seed coat is red, and 100-seed weight is between 32 to 35 g. Leaves are large and pale green. Its oil content is estimated to 53.55%, it is drought tolerant but susceptible to GRD and leaf spot diseases. The adaptation zone is between 700 and 1000 mm annual rainfall.

(5) T 181-83

This variety was introduced by INRAN. It is an early maturity variety with crop cycle averaging 90 days but is susceptible to foliar diseases. Its oil content is estimated to 49%. The average yield on-station is estimated at about 2 t/ha.

(6) T 169-83

Introduced by INRAN, this is an early maturing variety with a 90-day crop cycle. It is susceptible to foliar diseases with yield averaging 2 t/ha under on-station conditions. The percentage oil content ranges from 49 to 50%.

(7) T 177-63

Introduced by INRAN, this is an early maturing variety with a 90-day crop cycle. It is susceptible to foliar diseases with yield averaging 2 t/ha under on-station conditions. The percentage oil content ranges from 49 to 50%.

(8) O-20

Introduced by INRAN, this is an extra-early maturing variety with crop cycle between 85 to 90 days but it is susceptible to foliar diseases. The average yield on-station is estimated to about 2 t/ha.

Other varieties grown in Niger include 55-437, 44-16, 47-16, TS 32-1 and 796 and are the so-called local varieties. They were introduced over five decades ago. It is important to note that some of the varieties included in FPVS were ‘introduced’ more than three decades ago but were never made available to smallholder farmers. However, through the ICRISAT groundnut improvement program,

the regional trials under GGP (1996-2002), and a follow-up program of dissemination (2003-2007), these varieties have been made available and accessible to farmers in the pilot sites of GSP.

Table 7. Characteristics of released and pre-release groundnut varieties in Mali, Niger and Nigeria.

Country/Varieties		Crop cycle (days)	Average yield (tons/ha)	Year developed/ introduced	Institution
MALI					
1	47-10	90	1.5	Introduced	IRHO/CRA Bambey
2	JL 24	90	1.5	Introduced	ICRISAT
3	TS 32-1	90	2.0	Introduced	INERA
4	55-437	90	2.0-3.0	Introduced	IRHO/CRA Bambey
5	Mossitiga	90	1.9	Introduced	INERA
6	ICGS (E)-34 (Demba Niouma)	90		Introduced	ICRISAT
7	Fleur 11	90	1.3	Introduced	China via ISRA
8	ICGV 7878	120	2.5	Introduced	ICRISAT
9	ICG (FDRS) 4	110	2.0	Introduced	ICRISAT
10	ICG (FDRS) 10	110	2.0	Introduced	ICRISAT
11	ICG 7878 (Waliyartiga)	120	2.0	Introduced	ICRISAT
NIGER					
1	55-437	90	2.0-3.0	Introduced	IRHO/CRA Bambey
2	T-169-83	90	2.5-3.5	1983	INRAN
3	T-181-83	90	2.0-3.0	1983	INRAN
4	TS 32-1	90	2.5-3.5	Introduced	INERA
5	796	90	2.0-3.0	Introduced	from Russia
6	KH 149-A	90	3.5	1973	IRHO
7	47-10	120	3.5	1977	IRHO
8	57-422	120	3.5	1957	IRHO
9	79-22	90	3.5	1979	IRHO
10	ICG 9199	90	3.5	Introduced	ICRISAT
11	ICG 9346	90	3.5	Introduced	ICRISAT
12	ICGV 96981	90	3.5	Introduced	ICRISAT
13	J 11	90	3	Introduced	ICRISAT
14	JL 24	90	1.5-2.5	Introduced	ICRISAT
15	RRB	90	2.5-3.0	Introduced	IAR
16	T-177-83	90	2.5	1983	INRAN
17	O-20	90	2.5	1983	INRAN

AT: Advanced testing, RE: Released
Sources: LABOSEM (2002) and INRAN (1994).

Table 7. cont'd. Characteristics of groundnut varieties released by country in West Africa.

	Country/Varieties	Crop cycle (days)	Average yield (tons/ha)	Year developed/ introduced	Institution
NIGERIA					
1	SAMNUT-1 (MK 374)	130-150	2.5-3.0	1960	IAR
2	SAMNUT-2 (SAMARU - 38)	130-150	2.5-3.5	1960	IAR
3	SAMNUT-3 (M-25.68)	130-150	2.8-3.0	1970	IAR
4	SAMNUT-4 (69-101)	130-150	2.5-3.0	1970	ISRA
5	SAMNUT-5 (M.599.74)	130-150	2.5-3.0	1970	IAR
6	SAMNUT-6 (M – 95.71)	130-150	2.0-2.8	1970	IAR
7	SAMNUT-7 (M104.74)	110-120	2.0-2.8	1980	IAR
8	SAMNUT-8 (M103.74)	110-120-	2.0-2.8	1980	IAR
9	SAMNUT-9 (59-127)	130-150	2.5-3.0	1980	IAR
10	SAMNUT-10 (RMP 12)	130-150	2.8-3.5	1988	INERA (Introduction)
11	SAMNUT-11 (RMP 91)	130-150	2.8-3.5	1988	IAR
12	SAMNUT-12 (M 318.74)	130-150	2.5-3.0	1980	IAR
13	SAMNUT-13 (Spanish 205)	90-100	2.0-2.8	1980	IAR
14	SAMNUT-14 (55-437)	90-100	2.0-2.8	1988	IRHO/CRA Bambey
15	SAMNUT-15 (F 452.2)	90-100	2.0-2.8	1970	IAR
16	SAMNUT-16 (M554-76)	130-150	2.5-3.0	1988	IAR
17	SAMNUT-17 (49-115B	130-150	2.5-3.0	1988	IAR
18	SAMNUT-18 (RRB)	100-110	2.0-2.8	1988	IAR
19	SAMNUT-19 (K720.20)	100-110	2.0-2.8	1994	IAR
20	SAMNUT-20 (M412.801)	120-130	2.8-3.5	1994	IAR
21	SAMNUT- 21 (UGA 2)	110-115	2.5	2001	IAR/ UGA
22	SAMNUT- 22 (M 572.80 I)	110-120	2.5	2000	IAR
23	SAMNUT- 23 (ICGV-IS 96894)	90	1.5-2.5	2001	ICRISAT-IAR

Sources: MDRH/DA/DS (1994) and IAR (1989).

Methods and baseline data

Descriptive statistics and ONEWAY analysis of variance were used to compare the relevant variables between adopters and non-adopters of groundnut varieties in 2006/07. Logit models were used to identify factors explaining adoption of the modern varieties. Tobit results were used to determine factors explaining the intensity of adoption. These results were compared with the baseline data collected in 2003/04 at project inception. In particular, project intervention should result in better access to seed of new varieties compared to the beginning of the project, area cropped to modern varieties should

have significantly increased, more institutions producing and marketing seed should have emerged as a result of project intervention. However, it would be difficult to assess the project impacts on the livelihood of the smallholder farmers with regard to more income, increased well-being, reduced vulnerability, improved food security and more sustainable use of natural resource base. This is due to the short duration of the project that does not suffice to conduct any impact analysis.

Results and discussion

Results are presented by country on household characteristics differentiating between adopters and non-adopters of modern groundnut varieties in 2006/07. They also include the diffusion mechanism of modern groundnut varieties assessing farmers' knowledge and source of first information on modern varieties as well adoption and dis-adoption of groundnut varieties, household participation in technology transfer activities, social capital and varieties grown during the last three years; groundnut commercialization and the traits preferred by farmers; and the factors explaining the probability of their continuing to use modern varieties and the determinants of intensity of adoption.

Household socioeconomic and demographic characteristics

The household level characteristics by uptake of modern varieties in Nigeria, Mali and Niger are presented in Tables 8, 9, 10 and 11.

Human and social capital

Nigeria. Survey results showed that users and non-users of modern groundnut varieties[*] do not differ significantly based on their age, dependency ratio, the proportion of illiterates and ethnicity, but differ on household size, work force, and the proportion of members that have the primary or tertiary school education levels. The average age of the household head is estimated to be 49 years with household dependency ratio estimated to 1.69. The illiteracy rate is estimated to 2.5% members of the households. About 98% of respondents belong to the Hausa ethnic group. The household size for users of modern varieties is estimated to 14 members significantly greater than 13 for non-users. The proportion of family members with tertiary school education level is significantly higher for users than non-users. Paradoxically the proportion of households with primary school education is higher for the non-users groups than adopters of modern varieties.

It was expected that adopters would be younger than non-adopters because adopters are likely to experiment new technologies, take more risk ie, be less averse to risk as opposed to non-adopters. Likewise, educated household heads should be more receptive to new innovations than less educated household heads. Therefore, it was expected that adopters would be more educated that non-adopters. The relationship between household size and adoption may be uncertain. In effect, large families may be less likely to adopt new innovations because of the risk of failure to ensure household food security. However, if households are wealthier, they could take more risk than otherwise. Therefore, even large households could experiment with new varieties. In general, the interaction between age, household size, work force and others such as wealth status, farm size, and level of education could produce confounding effects (Feder et al. 1985).

[*] Modern groundnut varieties in Nigeria are SAMNUT 21, SAMNUT 22 and SAMNUT 23.

About half the household heads invest their entire time in agriculture, against about 30% who are part-time farmers and the remaining do not work on-farm. The participation of the household head in labor in agriculture does not differ much among groups except for the sub-group of non-participants. However, one would expect adopters to invest more of their time in the farm business ie, to be full-time farmers because they will tend to manage their farming business more than had the case been otherwise. However, if farmers are engaged in other activities, they may be likely to generate more cash to re-invest in agriculture and thus invest in modern technologies including modern varieties.

Mali. Survey results showed that users and non-users of modern varieties* differ by age, family size, dependency ratio, education and ethnic group. Users are significantly younger (46 years old) than non-users (48 years old). There are significantly less members in households headed by users of modern varieties (18 members) against 20 members for non-users. There are significantly more dependents in households headed by non users (1.4) against 1.2 for users. The illiteracy rate is higher in households headed by users than non-users (74% of household members against 66% respectively). Similarly, the proportion of household members who have primary school level education is significantly higher for non-users of modern varieties than users. The same trend is observed for the proportion of household members who have attended Koranic schools. There are three main ethnic groups, Bambara, Malinke and Peulh. Users of modern varieties are mainly from the Bambara ethnic group (70%) against 50% for the non-users. There are more Malinke (22%) among non-users against 10% among users.

These results are consistent with the expected trends. In effect, adopters of modern technologies were expected to be younger than non-adopters because they could take greater risks; it was expected that household size would be smaller, that adopters would have fewer dependents and higher levels of education. Overall, agriculture is the major occupation for household heads interviewed: the figures were 98% of users against 99% of non-users with non significant differences.

Niger. Except for age and ethnic groups, there are no differences between the two groups based on family size, work force and education. Users of modern varieties* are older than non-users (49 years against 47 years). There are three major ethnic groups: Zarma, Hausa and Peulh. There are significantly less Zarma in the users' group (4%) than the non-users (15%). There are proportionally more Peulh in the users' group than non-users (9% against 4% respectively). However, the proportion of Hausa estimated to 82% is not significantly different in the two groups. The estimated family size is 10 members, with work force of 4.4 adult equivalents. The rate of illiteracy is high with 75% of household members with no significant differences between the two.

The trend on age was not expected: adopters were found to be older than non-adopters. This may happen if there are confounding effects between age and wealth, farm size or level of education. Agriculture is the major occupation for household heads; about 92% of users reported agriculture to be their major occupation against 93% for non-users.

Overall, these results are consistent with those selected in the baseline data. In Nigeria, the average age of household head was estimated to 47.5 years against 49.22 years; household sizes have increased from 12 to 13 members in 2006/07 and the total work force has remained the same, 6.35 against 6.23 adult equivalents. Similar trends have been found in Niger (Ndjeunga et al. 2006).

* Modern groundnut varieties in Mali are ICG (FDRS) 4, ICG 7878, Fleur 11, ICGV 86124, JL 24 and ICG (FDRS) 10.

Table 8. Household level characteristics by uptake of modern groundnut varieties in Nigeria, Mali and Niger in 2006/07 – Human Capital.

Variable		Overall sample (n=477)	Use of modern varieties: Did not use (n=217) Mean	Did not use (n=217) Std	Used (n=260) Mean	Used (n=260) Std	F value
Nigeria							
Age of household head		49.22	49.14	11.26	49.29	11.16	0.02
Household size		13.10	12.05	8.81	13.98	11.56	4.09b
Work force		6.23	5.75	4.88	6.63	6.67	2.60c
Dependency ratio		1.69	1.64	1.64	1.73	1.87	0.33
Education	Illiterate	0.025	0.369	0.188	0.0154	0.123	2.23
	Primary	0.111	0.138	0.345	0.088	0.285	2.97c
	Secondary	0.149	0.138	0.346	0.158	0.365	0.35
	Tertiary	0.092	0.051	0.219	0.127	0.333	8.32a
	Adult education	0.098	0.097	0.296	0.100	0.300	0.01
	Koranic school	0.577	0.576	0.495	0.577	0.495	0.00
Gender (male) (%)		99.37	99.54		99.23		
Marital status – married (%)		96.86	97.24		96.54		
Full time labor		0.48	0.456	0.499	0.5	0.500	0.91
Part time labor		0.294	0.272	0.446	0.311	0.464	0.89
Not working on farm		0.184	0.230	0.422	0.146	0.353	5.62b
Mali							
Age of household head		46.81	47.96	10.74	46.17	9.30	2.60c
Family size		18.98	19.95	9.22	18.45	6.33	3.17c
Work force		8.93	9.26	5.32	8.74	3.56	1.14
Dependency ratio		1.27	1.37	0.94	1.21	0.58	3.65c
Education	Illiteracy	0.70	0.74	0.26	0.66	0.31	9.15a
	Primary school	0.16	0.21	0.41	0.14	0.34	3.46c
	Secondary school	0.02	0.02	0.16	0.018	0.13	0.16
	Koranic school	0.12	0.19	0.39	0.08	0.27	8.73a
Literacy/numeracy		0.30	0.11	0.31	0.42	0.49	39.37a
Ethnic group	Bambara	0.63	0.50	0.50	0.70	0.46	14.15a
	Malinke	0.15	0.22	0.42	0.10	0.31	8.85a
	Sarakole	0.02	0.016	0.13	0.03	0.16	0.40
	Peulh	0.07	0.11	0.31	0.05	0.22	3.92b
Gender (female %)		45.48	39.34	-	48.87	-	-
Major occupation (agriculture)		98.54	99.18	-	98.19	-	-
Niger							
Age of household head		47.59	46.83	13.01	49.21	13.04	2.67c
Family size		10.12	10.40	6.30	9.54	5.16	1.63
Work force		4.40	4.41	3.15	4.36	3.20	0.02
Education	Illiterate	74.68	74.28	31.64	75.53	30.68	0.13
	Primary	14.05	14.62	35.41	12.82	33.58	0.21
	Secondary	6.22	5.93	23.66	6.83	25.35	0.11
	Koranic	33.24	31.62	46.59	36.75	48.42	0.95
Literacy/numeracy		9.18	9.49	29.36	8.55	28.08	0.08
Ethnic group	Zarma	11.35	14.62	35.41	4.27	20.76	8.67a
	Haoussa	82.16	80.04	39.89	86.32	34.51	2.02
	Peulh	5.95	4.35	20.43	9.40	29.31	3.67c
	Dandy	0.3	0.3	6.29	0	0	0.46
Gender (male %)		92.43	90.51	-	96.58	-	-
Major occupation (agriculture %)		92.97	93.28	-	92.31	-	-

a. significant at 1%; b. significant at 10%; c. significant at 10% probability level; - indicates 'not applicable'.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Physical assets

Table 9 presents the physical capital stock of households in the three countries.

Nigeria. On average, households cultivate about 7.5 ha over a cultivable area estimated to 8.41 ha with no differences between adopters and non-adopters. The area cropped with groundnut is estimated to 2.7 ha ie, about one-third of the cultivated area. The stocks of cultivable and cultivated land are not significantly different for users and non-users of modern varieties as well as the groundnut growing area. However, land values of users of modern varieties are estimated to be significantly higher than that of non-users. This may be explained by the fact that users of modern technologies are more receptive to new technologies and may have been investing more in land improvement options such as fertilizers or other production enhancing technologies such as pesticides.

The average values of livestock, equipment or draught animals owned by households surveyed is estimated to $1237, $273 and $560 respectively. However, there are no significant differences between users and non-users of non-modern varieties. Similarly, the proportion of households using inorganic fertilizers, organic and pesticides do not differ between users and non-users. On average, users of modern varieties use 74 kg/ha of inorganic fertilizers against 87 kg/ha for non-users. However, the organic fertilizer use intensity is estimated to 1858 kg/ha for non-users which is significantly less than 2444 kg/ha for users of modern varieties.

Compared to the baseline data in 2003/04, the average cultivated land has marginally increased from 7.38 ha to 7.51 ha in 2006/07. Similarly, the proportion of area planted with groundnut has slightly increased from 33% in 2003/04 to 36% in 2006/07. Although marginally significant, this may result from project intervention (Ndjeunga 2006).

Mali. Households cultivate on average 5.23 ha. However, users of modern varieties cultivate significantly more land on average (5.50 ha) than non-users (4.73 ha). The same trend is observed with cultivable land where users have on average 9.28 ha against 8.88 ha for non-users.

The average values of equipment and animal traction owned by households are higher for users of the technologies than non-users. On average users owned equipment worth about $349 against $208 for non-users and the value of traction animals is almost double for users ($645) than non-users ($355). However, the value of livestock owned is not significantly different for users and non-users. The proportion of households using inorganic and organic fertilizers or pesticides is very small and not significantly different between the two groups.

Niger. The average size of land cultivated by households is estimated to 7.6 ha with no significant differences between the two groups. However, users own more cultivable land than non-users (10.84 ha against 8.77 ha).

The values of land, equipment, animal traction and livestock are not significantly different between the two groups. On average, the value of land owned by households is estimated to $1009, the value of equipment to $259 and the value of animal traction to $446. The value of livestock owned by household is estimated to $2519 on average.

The proportion of households using fertilizers is still low with differences between users and non-users. The proportion of households using inorganic fertilizers is estimated to 10%, and that of households using inorganic fertilizers to 27%. About 35% of households surveyed use pesticides.

Compared to the baseline data in 2003/04, the average cultivated land has significantly decreased by 13.38 ha against 7.64 ha in 2006/07. However the proportion of area planted with groundnut has slightly increased from 27% in 2003/04 to 29% in 2006/07. This may have resulted from project intervention (Ndjeunga 2006).

Table 9. Household level characteristics by uptake of modern groundnut varieties in Nigeria, Mali and Niger in 2006/07 – Physical Assets.

Variable	Overall sample (n=477)	Use of modern varieties				
		Did not use (n=217)		Used (n=260)		
		Mean	Std	Mean	Std	F value
Nigeria						
Cultivated area (ha)	7.51	7.21	7.43	7.77	8.26	0.58
Cultivable area (ha)	8.41	8.16	8.25	8.63	10.16	0.30
Groundnut area (ha)	2.73	2.83	4.15	2.64	2.22	0.45
Total land value ($)	2568	1910	2434	3116	8941	3.72b
Value of livestock ($)	1237	1237	2461	1236	2502	0.00
Value of equipment ($)	273	252	343	290	1388	0.16
Value animal traction ($)	560	575	832	548	920	0.11
Mali						
Cultivated land (ha)	5.23	4.73	2.78	5.50	2.92	5.65b
Cultivable land (ha)	8.88	8.16	5.53	9.28	6.44	2.58c
Value equipment ($)	299	208	246	349	286	21.09a
Value traction animals	542	355	631	645	678	15.09a
Niger						
Cultivated area (ha)	7.64	7.60	8.14	7.72	6.16	0.02
Cultivable land (ha)	9.45	8.77	7.92	10.91	10.84	4.59b
Total value of land ($)	1009	977	1269	1079	1897	0.37
Value of equipment ($)	259	237	316	304	815	1.29
Value of animal traction ($)	446	448	648	442	689	0.01

a. significant at 1%, b. significant at 10%, c. significant at 10% probability level.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Household commercial transactions

The household commercial transactions are presented in Table 10.

Nigeria. The value of household sales is significantly higher for users of modern varieties than non-users. On average the value of total sales is estimated to $1063 for non-users against $1874 for users. The same trend is observed for crop sales and off-farm gross revenue. However, there are no significant differences between users and non-users based on livestock sales. However, the value of groundnut sales is estimated to $541 for users versus $141 non-users of groundnut varieties. It accounts for 69% of total crop sales for non-users against 72.64% for users of groundnut varieties.

Proportionally, while livestock represents a larger share of sales for non-users estimated to 38% of total sales, crop sales represent a larger share of sales for users of the technologies estimated to about 37% of total sales.

Mali. The total value of household cash sales is estimated to $261 with significant differences between the two groups. Users of the modern varieties sell more on average ($285) than non-users

($215). However, the proportion of crop sales to total sales is lower for non-users than users, ie, 38% against 61% respectively. A similar trend is observed for livestock (14% for non-users against 20% for users of modern varieties). The share of groundnut sales to total crops sales is estimated to 61% for non-users significantly less than users estimated to 76%. However, non-users of modern varieties generate proportionally more gross revenue from off-farm activities than users, 48% against 19%.

Niger. The value of household cash sales is estimated to $512 with no differences between the two groups. Similarly, there are no differences between users and non-users on the value of crop sales and off-farm gross revenue. However, non-users sell more livestock on average than users of modern varieties, $182 against $109 respectively. Groundnut sales represent a large share of crop sales. In 2006/07, groundnut sales accounted for 80% of total sales in pilot sites with no significant differences between users (82.27%) and non-users (79.38%).

Table 10. Household level characteristics by uptake of modern groundnut varieties in Nigeria, Mali and Niger in 2006/07 (all transactions in USD).

		Use of modern varieties				
	Overall sample	Did not use (n=217)		Used (n=260)		
Variable	(n=477)	Mean	Std	Mean	Std	F value
Nigeria						
Total crop sales	470	243	526	660	1342	18.51a
Off-revenue	403	225	552	552	1663	7.70a
Livestock sales	530	496	685	555	1048	0.36
Mali						
Value crop sales	141	82	124	174	173	26.85a
Value off-farm revenue	71	102	376	54	93	3.36c
Livestock sales	48	30	104	58	113	5.01b
Total cash sales ($)	261	215	453	285	236	3.64c
Niger						
Crop sales	171	153	206	211	631	1.74
Off farm revenues	188	206	513	149	247	1.29
Livestock sales	159	182	292	109	187	6.06b
Total cash sales	512	540	653	469	722	0.89

a. significant at 1%, b significant at 10%, c. significant at 10% probability level.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Social capital

Social capital is defined as the number of institutions in which the household is connected to and the number of members of household who belong to associations. Table 11 presents the social capital and regional characteristics of households.

Nigeria. On average, households are connected, each to one association. However users of modern varieties belong significantly to more associations on average than non-users, ie, 1.39 against 0.867. Similarly the number of household members that are connected to different associations is significantly higher for users, 9 members against 4 members for non-users.

Mali. There are differences between the group of users and non-users of groundnut varieties based on their connection to associations or institutions. On average, users of the technologies belong to more associations (1.5) than non-users (1.1).

Niger. Households using modern varieties are significantly more connected to institutions than non-users (1.52 against 1.35). However, there are no significant differences in the number of members belonging to associations in a household.

Overall, it can be noted that in the three countries, adopters of modern groundnut varieties are better connected to institutions than non-adopters.

Awareness, adoption and dis-adoption of groundnut varieties

Farmers' awareness of the existence of an improved technology is a criterion for evaluating the diffusion pathway plan or strategy. The decision to use a technology requires prior information on its existence or knowledge.

Table 11. Household level characteristics by uptake of modern groundnut varieties in Nigeria, Mali and Niger in 2006/07 – Social capital and regional characteristics.

		Use of modern varieties				
	Overall sample	Did not use (n=217)		Used (n=260)		
Variable	(n=477)	Mean	Std	Mean	Std	F value
Nigeria						
No. of institutions by household	1.149	0.866	0.749	1.385	1.068	36.22a
No. of members per household	6.851	3.732	6.763	8.973	25.279	6.27a
Control village	0.266	0.415	0.494	0.142	0.350	49.40a
On-farm trial participation	0.465	0.184	0.388	0.700	0.499	171.28a
Use of fertilizers	0.719	0.700	0.459	0.735	0.442	0.68
Use of manure	0.805	0.820	0.385	0.792	0.406	0.59
Use of pesticides	0.30	0.262	0.441	0.327	0.470	2.34
Mali						
Social capital	1.48	1.06	0.24	1.56	0.88	5.72b
Technologies						
Use of fertilizers	0.2	0	0	0.4	0.6	0.55
Use of manure	5.25	4.10	19.91	5.88	23.58	0.50
Use of pesticides	1.75	1.64	12.75	1.81	13.36	0.10
Niger						
Social capital						
No. of institutions	1.41	1.35	0.67	1.52	0.79	3.00c
No. of members in household	4.37	4.06	9.12	5.04	10.75	0.57
Technologies						
Use of inorganic fertilizers	10.27	8.69	28.23	13.67	35.65	2.15
Use of organic fertilizers	27.02	28.85	45.40	23.08	42.31	1.31
Use of pesticides	35.41	32.01	46.75	42.73	49.68	4.04b
Qty of fertilizer used (kg)	7.44	7.33	56.10	7.65	30.51	0.00
Qty of manure (kg)	800	756	1642	896	3115	0.32

a. significant at 1%, b. significant at 10%, c. significant at 10% probability level.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Knowledge of varieties and sources of first information and seed

Sources of first information

Nigeria. About 59% of households reported to be aware of the three improved groundnut varieties (SAMNUT 21, SAMNUT 22 and SAMNUT 23). The rates of awareness were not different between the three varieties. The rate of awareness of SAMNUT 21 is estimated to 34.38%, that of SAMNUT 22 to 35.01% and that of SAMNUT 23 to 32.70%. Other varieties were fairly well known. These include 55-437 known by 73.38% or the local known by 72.12%. In contrast, other varieties were less known such as RMP12 (9.85%), RMP 91 (3.56%) or RRB (18.03%) (Table 12).

Table 12. Main source of first information on groundnut varieties in Nigeria, Mali and Niger.

Source of information	Proportion of households (%)					
	Nigeria		Mali		Niger	
	OV	MV	OV	MV	OV	MV
On-farm trial on own farm	1.42	22.54	0.68	2.51	0.00	0.00
On farm trial on another farm	5.16	13.52	7.01	13.37	2.47	3.67
Field days	1.92	2.66	0.23	0.28	0.10	0.00
Farmer-to-farmer interaction	34.78	10.25	29.86	23.40	26.70	23.39
Relatives	21.44	1.43	36.65	4.18	40.41	7.34
Demonstrations/PRAs	2.02	2.66	0.91	0.28	0.51	0.92
ADPs/Extension services	25.68	39.14	0.68	0.28	10.93	26.61
Farmers' association	0.81	2.25	0.00	0.00	0.00	0.00
Research institutes	0.00	0.00	23.53	55.71	4.12	21.10
Development projects/NGOs	1.41	2.72	0.23	0.00	9.48	11.93
TV program	0.00	0.00	0.00	0.00	0.10	0.00
Not specified	0.00	0.00	0.00	0.00	0.41	0.00
Others	3.94	1.02	0.00	0.00	4.74	5.05

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

The major sources of information according to respondents were Agricultural Development Projects (ADPs) by 53.17%; other farmers (53.52%), relatives (36.27%), and on-farm trials (Table 12). About 83.10% of farmers who were aware of the modern varieties tested it. In effect, 59.76% of farmers aware of SAMNUT 21 tested the variety, 70.66% of farmers aware of SAMNUT 22 and 71.79% of farmers aware of SAMNUT 23 tested those varieties. The major reasons for not testing these varieties were poor access to seed for 76.83%, followed by lack of cash to purchase the available seed (15.94%).

Mali. About 71% of respondents were reported as being aware of the modern varieties. The variety Fleur 11 has the highest rate of awareness, 45% followed by JL 24 (31.40%), ICG 7878 (15.70%), ICGV 86 124 (14.83%) and ICG (FDRS) 4 (14.53%). Other varieties such 47-10 are well known to 78% of farmers and others are lesser known such as 55-437 (9.30%), 28-206 (3.78%), TS32-1 (5.52%) and CN 94 C (2.91).

Niger. About 38% of farmers were aware of the new varieties. The variety RRB has the highest rate of awareness (25.61%), followed by ICG 9346 (11.05%), T 169-83 (6.20%), T 181-83 (4.58%), T 177-63 (4.31%), J 11 (3.23) and Fleur 11 (2.16). Other varieties introduced more than three decades ago are known. These include 55-437 known by 33.15% (Table 12).

Reasons for not testing modern varieties

Table 13 summarizes the reasons for not testing new groundnut varieties.

Nigeria. The majority of farmers (78%) who have not tested new modern groundnut varieties reported seed availability and accessibility to be the major constraint. Other constraints although minor include lack of money to purchase seed or lack of information on crop management practices.

Mali. No reason was cited as a constraint for not testing new varieties because of large investments in the promotion of modern groundnut varieties in pilot sites. However, it can be noted that the major reasons for dropping other varieties are susceptibility to drought and pest and foliar diseases.

Table 13. Reasons for not testing groundnut varieties reported by households in Nigeria, Mali and Niger.

Constraint/reason	Proportion of households (%)					
	Nigeria		Mali		Niger	
	OV	MV	OV	MV	OV	MV
Seed availability	41.41	77.78	0.00	0.00	48.98	61.90
Small seed size	0.00	0.00	0.00	0.00	0.00	0.00
Late maturity	2.02	0.00	0.00	0.00	0.00	0.00
Consumed seed	0.00	0.00	0.00	0.00	0.00	0.00
Drought	0.00	0.00	30.00	0.00	4.08	0.00
Pests and diseases	0.00	0.00	60.00	0.00	0.00	0.00
Low yield	0.00	0.00	0.00	0.00	6.80	0.00
Lack of money	23.23	5.56	0.00	0.00	4.76	0.00
Poor seed color	2.02	0.00	0.00	0.00	1.36	0.00
Lack information crop mgt practices	5.05	4.17	0.00	0.00	0.68	4.76
Low market value/low oil content	0.00	0.00	0.00	0.00	4.08	9.52
Others	7.07	4.17	0.00	0.00	10.05	0.00
Not specified	3.03	8.33	10.00	0.00	13.61	23.81

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Niger. As in Nigeria, seed availability was cited as the major reason for not testing new groundnut varieties. Other reasons include the lack of information on crop management practices, low oil content or low market value.

Sources of first seed reported by households

Table 14 presents the sources of first seed of groundnut varieties in the three countries.

Nigeria. The same institutions are reported as being the major sources of first seed. For example, 55.97% of the farmers interviewed claimed that other farmers were their main source of first seed, followed by ADPs for 52.67% of the farmers interviewed and relatives by 30.04%. Other sources included on-farm trials (22.22%), IAR (15.23%) and ICRISAT (2.06%).

Mali. The major sources of first information on the modern varieties are research institutes (46.73%), friends and relatives (47.25%) or observed in neighbors' fields (23.12%). Few farmers reported on-farm trials as their first source of information (3.52%). About 98% of those aware of the new varieties actually tested the varieties. The major sources of first seed reported by respondents are: research institutes (48.74%), other farmers (57.79) and family members (46.23%).

Niger. The major sources of first seed of modern groundnut varieties are extension services and research institutes accounting for 26.66% and 27.18% respectively. Farmer to farmer exchange is also another major source representing about 20.51%. Other sources although minor include rural development projects, NGOs and relatives.

Table 14. Source of first seed of groundnut varieties in Nigeria, Mali and Niger.

Source of first seed	Proportion of households (%)					
	Nigeria		Mali		Niger	
	OV	MV	OV	MV	OV	MV
On-farm trials	2.74	23.40	0.00	0.00	0.00	0.00
Farmers	33.26	17.49	37.50	28.16	19.93	20.51
Relatives	21.83	1.97	0.00	0.99	32.60	7.18
Neighboring villages	0.00	0.00	0.93	0.00	4.43	2.05
Village market/Seed trader	2.29	0.00	0.46	0.00	10.09	4.10
Research institutes	2.06	15.27	25.24	57.66	5.07	26.66
ADPs/Extension services	26.06	36.95	1.39	0.00	11.93	27.18
Others	4.68	0.74	0.00	0.00	3.69	2.05
Projects – NGOs	0.00	0.00	0.00	0.00	9.35	8.72
Not specified	5.37	1.23	0.46	0.00	3.83	1.54

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Groundnut variety adoption, dis-adoption and non-adoption

The rate of adoption remains the key impact indicator of any applied breeding research and extension program. It shows the degree of acceptance, diffusion or rejection of new research outputs. The rate of adoption is here defined as the share of farm area utilizing the new varieties (Feder et al. 1985). It is believed that this method of assessing adoption rate provides a better quantitative measure for forecasting yields and economic rates of returns to research and extension programs (Masters et al. 1996). The proportion of farmers using the technology is a social indicator of farmers' interest in the new varieties. This section starts with reasons for not planting modern varieties during the season 2006/07.

Reasons for not planting modern varieties during the 2006/07 season

In Niger and Nigeria, seed access and availability were the major reasons for not planting seed of modern varieties during the 2006/07 cropping season. However in Mali, drought and pest and diseases are cited as the major reasons for not planting modern varieties (Table 15).

Table 15 . Reasons for not planting seed of groundnut varieties during the 2006/07 season in Nigeria, Mali and Niger.

Reason for not planting this season 2006/07	Proportion of households (%)					
	Nigeria		Mali		Niger	
	OV	MV	OV	MV	OV	MV
Consumed seed	4.03	2.27	0.00	4.00	0.94	0.00
Drought	0.57	12.50	55.91	56.00	9.69	9.09
Pest and diseases	15.80	0.00	15.45	18.00	0.94	0.00
Low yield	17.23	0.00	2.94	2.00	13.12	6.06
Lack of money	7.47	4.55	0.00	0.00	3.75	3.03
Seed access or availability	28.45	69.32	9.56	2.00	39.06	51.51
Low oil content	1.15	0.00	0.00	0.00	2.81	3.03
Low market value	4.31	5.66	0.00	0.00	2.19	3.03
Lack of information on crop management	1.72	1.14	0.74	0.00	0.00	0.00
Small sized seed	2.59	1.14	0.00	0.00	0.00	0.00
Others	3.16	4.55	7.36	4.00	25.62	18.18
Not specified	4.02	2.27	1.47	0.00	2.50	6.06

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Rate of adoption of new varieties

Table 16 presents the adoption rate by variety in the three countries. Adoption is the proportion of area planted with modern groundnut varieties.

Nigeria. The rate of adoption of new varieties in and around the pilot sites is estimated to 31.84% of groundnut area cropped. The rate of adoption was estimated to 11.75% for SAMNUT 22, 10.54% and 9.55% for SAMNUT 21. Varieties introduced more than four decades ago such as 55-437 had the highest rate estimated to 25.98% with local varieties accounting for 36.18% of groundnut area. On the whole, about 55% of the farmers planted new varieties.

The reasons for not planting new varieties during the 2006/07 season were reported as poor access to seed (34.64%), low yield (22.21%), pest and diseases (15.69%), lack of cash to purchase seed (14.38%) and 'consumed all seed' (11.77%).

The main sources of seed planted in 2006/07 were farmers' own-saved seed (57.63%), ADPs (31.78%), other farmers (19.92%), on-farm trials (7.63%) and relatives (6.78%). The major types of trade transactions are cash purchase (34.58%), gift or free (28.39%) and credit (5.93%). Seed exchange is limited to 4.66%.

Mali. The rate of adoption of new varieties here is estimated to about 43.71% of groundnut-cropped area. The rate of adoption is higher on Fleur 11 estimated to about 16% of groundnut area planted, followed by JL 24 (12.46%), ICG 7878 (5.25%), ICG (FDRS) 4 (5.06%) and ICGV 86124 (4.95%). The variety 47-10 which was introduced some four decades ago accounts for 41.07% of groundnut cropped area. The major reasons for not planting new varieties this season are low access to seed of new varieties for 46% of farmers who did not plant; susceptibility to diseases and pests

(35.12%), and the fact that seed was consumed before it could be planted (10.80%). On the whole, a large proportion of farmers, about 62.4%, are planting new varieties.

The major source of seed planted during the 2006/06 is by far farmers' own saved seed with 90.85%, followed by ICRISAT (9.86%) and other farmers (5.63%). The major types of seed transactions are: credit (62.8%) followed by cash transactions (38.89%), barter (9.15%) and seed exchange (7.04%).

Niger. The rate of adoption of new varieties is estimated to about 13.67% of groundnut area. The rate of adoption was highest for ICG9346 with 6.67 % of groundnut area, followed by RRB (5.84%) and T 177-63. Other varieties are at various stages of uptake. The oldest variety 55-437 is reported to be grown on 24.19% of groundnut cropped area. On the whole, 31.81% of farmers are planting new varieties.

Table 16. Proportion of area planted to new varieties relative to total groundnut area planted by selected farmers in pilot sites of Nigeria, Mali and Niger.

		Average proportion area planted	
Country	Variety	Average area (ha)	Proportion of area (%)
Nigeria	55-437	1.03	25.98
	RMP 12	0.064	2.29
	RMP 91	0.26	1.19
	RRB	0.171	2.53
	SAMNUT 21	0.393	9.55
	SAMNUT 22	0.499	11.75
	SAMNUT 23	0.411	10.54
	New varieties	1.30	31.84
Mali	ICG (FDRS) 4	0.07	5.06
	47-10	0.42	41.07
	ICG 7878	0.07	5.25
	Fleur 11	0.20	15.98
	Mossitiga	0.05	0.79
	55-437	0.02	2.63
	ICGV 86124	0.06	4.95
	JL 24	0.13	12.46
	ICG (FRDS) 10	0.00	0.00
	28-206	0.01	0.46
	TS 32-1	0.02	2.50
	Other ICGV	0.01	0.58
	New varieties	0.53	43.71
Niger	O-20	0.00	0.00
	55-437	0.41	24.19
	T 169-83	0.00	0.2
	ICG 9346	0.12	6.67
	T 181-83	0.00	0.09
	T 177-63	0.00	1.05
	TS 32-1	0.00	0.00
	RRB	0.11	5.84
	J 11	0.01	0.6
	Fleur 11	0.00	0.2
	44-16	0.00	0.0
	47-16	0.00	0.06
	JL 24	0.00	0.02
	New varieties	0.2451	13.67

Source: Regional Survey, ICRISAT/NARS, 2006/07.

Sources of seed planted and seed transactions during the 2006/07 cropping season

Table 17 presents the major sources of seed planted in 2006/07. In all the three countries, farmer-saved seed is the major source of seed accounting for 37% in Nigeria, 43% in Niger, and the figure is very high in Mali at 84%. The latter is largely explained by the large investments made in disseminating the technology in Mali. In Nigeria and Niger, extension services and research institutes are major sources of seed.

Table 17. Main source of seed planted this year (2006/07) in Nigeria, Mali and Niger.

Source of seed planted	Proportion of households (%)					
	Nigeria		Mali		Niger	
	OV	MV	OV	MV	OV	MV
On-farm trials	2.86	6.19	0.32	1.17	1.30	3.52
Other farmers	9.10	6.78	3.23	3.52	6.06	5.63
Relatives	6.25	2.95	1.29	0.39	2.16	0.70
Own saved seed	65.89	36.58	89.03	84.37	58.03	42.96
Seed trader	1.25	0.29	0.65	0.00	0.00	0.00
Extension services/ADPs	10.18	22.45	0.65	0.00	3.24	20.42
Research institutes	1.25	11.21	1.93	1.95	0.86	4.23
Village markets	0.00	0.00	0.97	0.00	17.06	7.10
Seed companies	0.18	0.00	0.00	0.00	0.00	0.00
Cooperatives/NGOs/projects	0.18	0.84	0.65	10.54	6.48	4.93
Others	0.89	0.00	0.00	0.00	0.00	0.00
Not specified	2.68	2.65	0.97	0.00	3.24	2.82

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

In the three countries, gift transactions are very important followed by cash transactions. There are, however, differences from country to country. In Mali, credit transactions are equally important. In Nigeria, credit transactions are important only with other varieties ie, non-modern varieties. In Niger, cash transactions are very important for other varieties. The relative importance of these transactions reflects the states of the diffusion of modern varieties. In effect, in Niger, farmers are at early stages of experimentation where seed exchange is still important, whereas in Mali, where farmers have been largely exposed to modern varieties and value the product, credit and cash transactions are predominant (Table 18).

Table 18. Means of acquiring seed this year 2006/07 (except for own saved seed) in Nigeria, Mali and Niger.

	Proportion of households (%)					
	Nigeria		Mali		Niger	
Seed transaction	OV	MV	OV	MV	OV	MV
Gifts/free	31.19	51.30	24.07	10.62	65.21	72.87
Credit in kind	1.49	2.60	27.78	57.87	1.38	5.43
Credit in cash	15.84	2.60	1.85	1.33	3.00	2.33
Cash on delivery	35.15	35.06	26.85	27.88	21.66	7.75
Payment in kind	1.98	0.65	9.72	2.21	1.15	0.00
Seed exchange	8.42	3.90	9.72	3.10	1.15	0.78
Barter	8.42	3.90	0.00	0.00	0.00	0.00
Other transactions	5.96	3.90	0.00	0.00	7.37	11.63

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Trends in adoption of modern groundnut varieties in Nigeria, Mali and Niger

Figures 3, 5 and 7 depict the proportion of area planted to new varieties during the last three years. In Nigeria, there is an increase in area planted to modern varieties from 2004/05 to 2005/06 which drops in 2006/07. This drop may be explained by rainfall conditions that were not favorable to modern varieties.

However, the cumulative number of farmers adopting modern varieties has been increasing steadily signaling farmers' interest in the new varieties (Figure 4). In addition, the uptake of modern varieties has already started in 1996 in Northern Nigeria with the ICRISAT groundnut improvement program. The dissemination was enhanced through GGP up to 2002. However, with GSP, using on farm participatory methods for technology dissemination and exposure to modern varieties, the number of adopters almost tripled.

In Mali, the area planted with modern varieties decreased from 2004/05 to 2005/06 and then increased in 2006/07. This was for similar reasons as in Nigeria, for 2005/06 was a drought year with poor crop establishment and subsequently for production as well.

As in Nigeria, the cumulative number of farmers adopting modern varieties in Mali has been increasing steadily, signaling farmers' interest in the new varieties (Figure 6). Using on-farm participatory methods for technology dissemination and exposure to modern varieties, the number of adopters increased significantly and nearly doubled from 2003 to 2004.

In Niger, the pattern is similar to that of Nigeria with large increase in proportion of area planted with groundnut varieties from 2004/05 to 2005/06 then a decrease in 2006/07 (Figure 7). This was due to similar reasons as in Nigeria: 2005/06 was a drought year with poor crop establishment and production.

As is the case in Nigeria and Mali, the cumulative number of farmers adopting modern varieties in Niger has been increasing systematically signaling farmers' interest in the new varieties (Figure 6). In addition, the uptake of modern varieties had started in 1996 in Niger with GGP. However, with GSP using on-farm participatory methods for technology dissemination and subsequent exposure to modern varieties, the number of adopters has more than doubled from 2003/04 to 2004/05.

In all countries, drought stress had a significant effect on the area covered by modern varieties. This signals the inability of modern varieties to cope with drought.

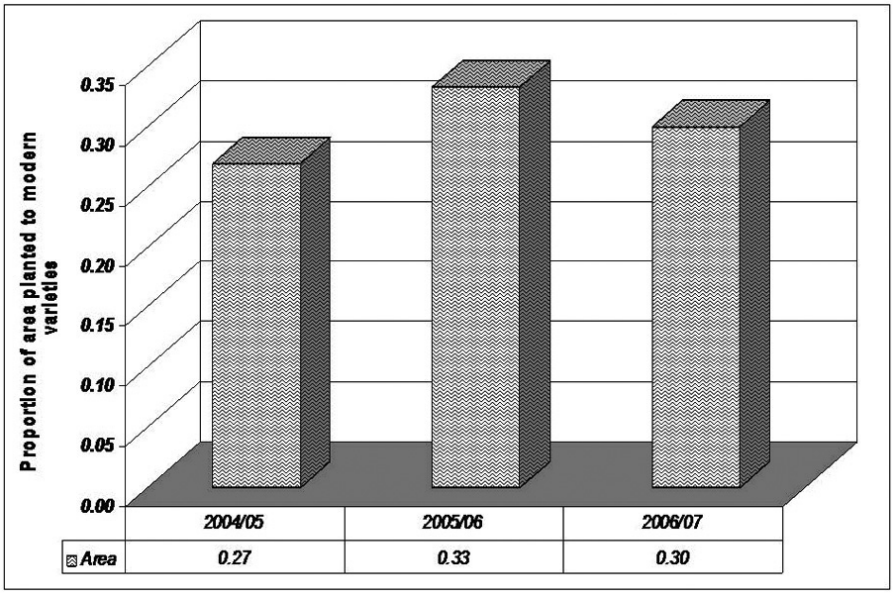

Figure 3. Proportion of area planted to modern groundnut varieties in Nigeria.

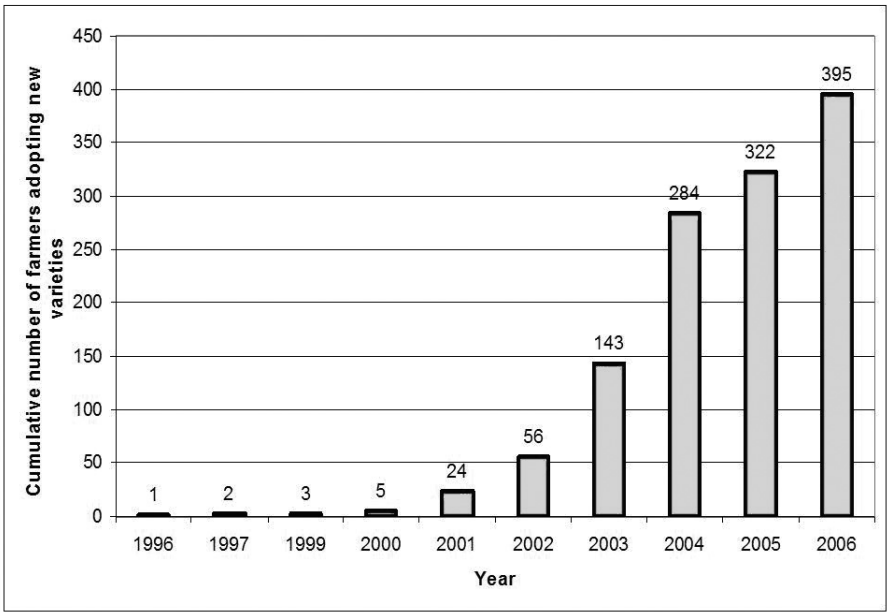

Figure 4. Proportion of farmers adopting new groundnut varieties in Nigeria.

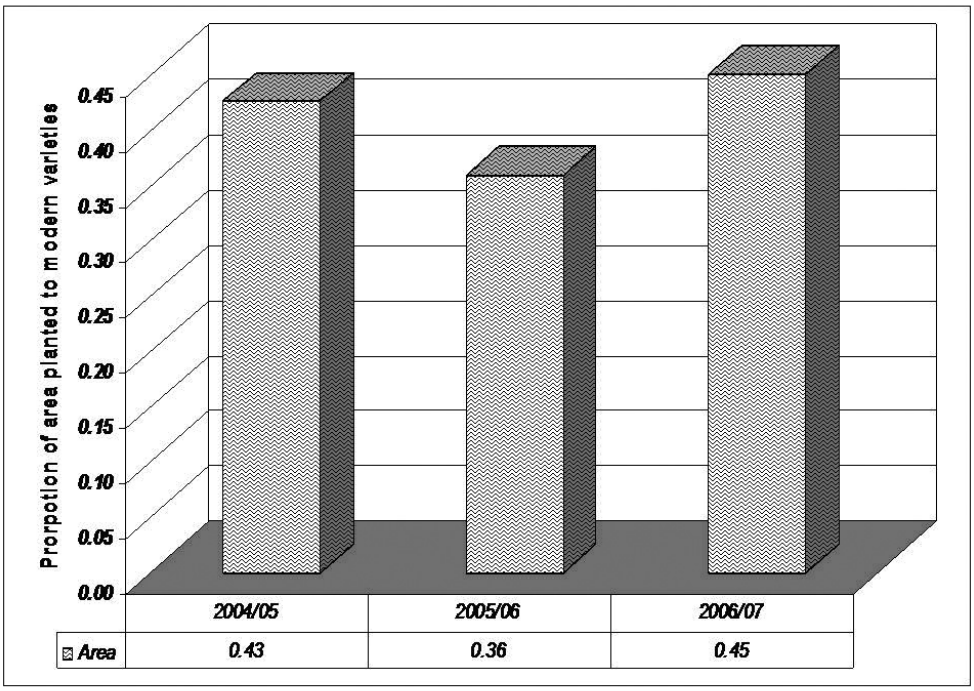

Figure 5. Proportion of area planted to modern groundnut varieties in Mali.

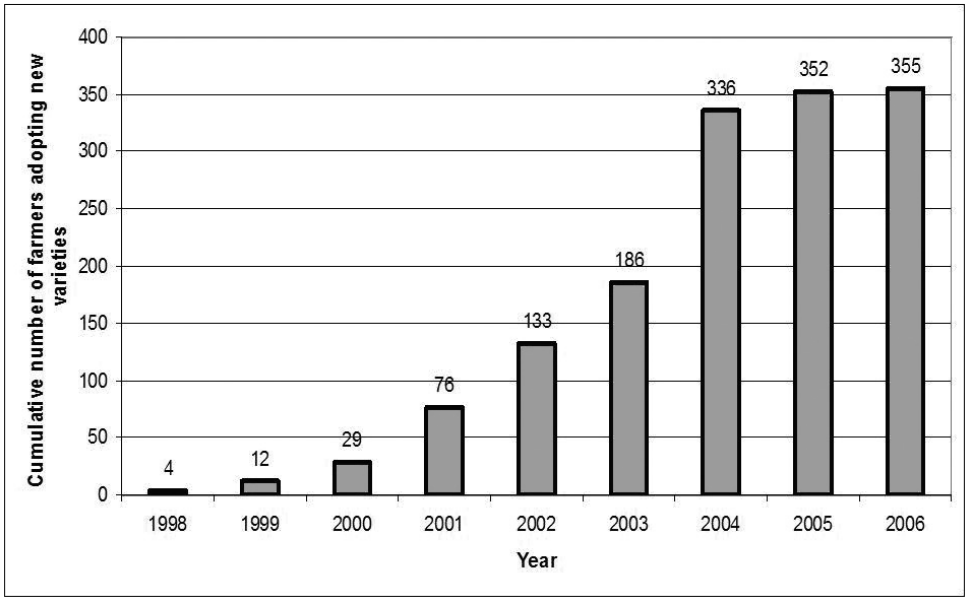

Figure 6 . Proportion of farmers adopting new groundnut varieties in Mali.

Are modern groundnut varieties spreading beyond the pilot sites?

Table 19 presents the adoption rate in the three countries based on the three categories of farmers: participants in on-farm trials, non-participants and farmers in the control villages. While the spillovers are moderate in Mali and Nigeria, it is rather limited in Niger.

Table 19. Adoption rate in village project sites and control sites in the three countries.

Country		Village project sites		Control villages	Total
		Participants	Non-participants		
Mali	% farmers	88.52	56.91	43.43	64.24
	% area	62.75	34.83	31.52	43.70
Niger	% farmers	50.00	25.31	24.55	31.84
	% area	15.52	13.59	12.04	13.67
Nigeria	% farmers	81.98	32.03	29.13	54.51
	% area	47.99	17.62	17.09	31.84

Desirable traits sought by farmers on new varieties

A thorough knowledge of the range of plant, seed and processing traits are valuable for crop improvement programs. The demands for improved groundnut varieties will likely 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 contribute to the productivity, efficiency and profitability of groundnut production in West Africa. Market prices also may be linked to desirable traits. In this study, farmers in Nigeria, Mali and Niger were asked to rate their most important preferred traits. The results are presented in Tables 20, 21 and 22.

Nigeria. Overall, the traits most preferred by farmers are high yield (27%) followed by resistance to rosette (10.60%), high market value (9.51%), early maturity (8.69%), resistance to other pest and diseases (7.23%) (Table 20). Other traits such as drought tolerance (6.86%), high oil content (6.68%), and color (6.53%) are also relatively important. Some of these traits are highly correlated. Varieties associated with high market value are those with high oil content preferred by oil processing companies. Likewise, drought tolerance and early-maturity may be strongly correlated because all varieties that mature earlier escape drought and farmers would perceive them as being drought resistant. The same trend is observed in the three varieties.

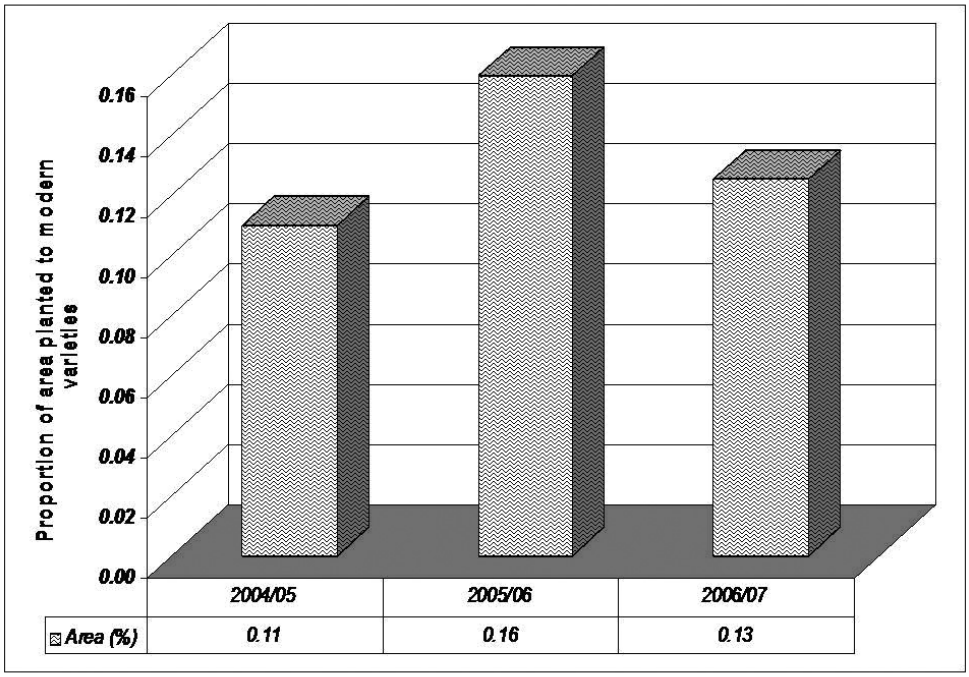

Figure 7. Proportion of area planted to modern groundnut varieties in Niger.

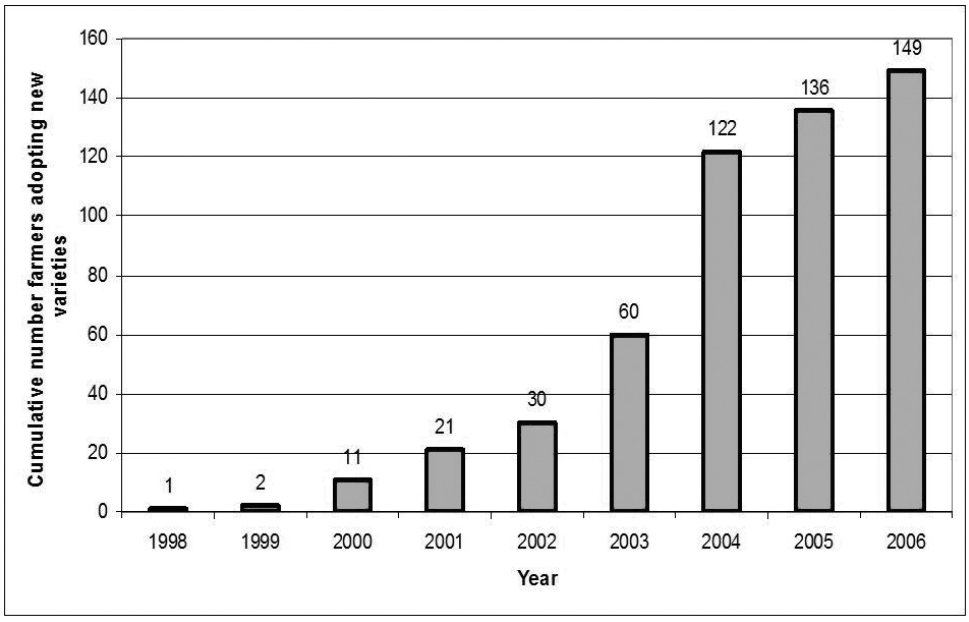

Figure 8. Proportion of farmers adopting new groundnut varieties in Niger.

Table 20. Preference for traits reported by farmers in Nigeria in 2006/07.

	Variety				
Trait	Samnut 21	Samnut 22	Samnut 23	Average	Rank
Color	8.89	4.56	6.14	6.53	8
High yield	27.73	25.16	28.33	27.08	1
Resistant to Rosette	10.24	10.48	11.09	10.60	2
Resistant to pests/diseases	6.48	8.20	7.01	7.23	5
Uniform maturity	5.54	6.41	5.87	5.94	9
Drought tolerance	6.27	8.44	5.85	6.86	6
Early maturity	7.95	9.07	9.04	8.69	4
Large seed	5.42	4.01	1.75	3.72	10
High market value	9.65	10.39	8.49	9.51	3
Easy to process	2.58	0.91	2.05	1.85	11
High oil content	4.50	8.23	7.32	6.68	7
High fodder	2.22	2.37	6.16	3.58	12
Easy to lift	0.76	1.50	0.88	1.04	13
Other traits	1.77	0.28	0.00	0.69	14

Source: Regional Survey, ICRISAT/NARS, 2006/07.

Mali. The traits most preferred by farmers are high yield for 23%, followed by early maturity (20.04%), disease and pest resistance (12.74%), high market value (9.73%), large pods (8.25%) and drought resistance (6.50%) (Table 21). However, there are differences between varieties. The variety ICG 7878 is largely preferred for its large pod size, disease resistance and high market value; ICG (FDRS) 4 is preferred for its higher yield, disease resistance and high market value. Fleur 11, ICG 86124 and JL 24 are largely preferred for higher yield, early maturity and high oil content.

Table 21. Preference for traits reported by farmers in Mali in 2006/07.

	Variety						
Trait	ICG (FDRS) 4	ICG 7878	Fleur 11	ICG 86124	JL 24	Average	Rank
Color	0.00	0.81	0.00	0.00	0.00	0.16	11.00
High yield	21.05	8.95	29.78	27.11	28.26	23.03	1.00
Resistance to pests/ diseases	34.21	27.65	1.01	0.00	0.81	12.74	3.00
Uniform maturity	5.26	1.63	6.07	9.60	6.91	5.89	8.00
Drought resistance	7.02	7.32	6.10	4.29	7.78	6.50	7.00
Early maturity	0.00	0.81	32.87	33.16	33.36	20.04	2.00
Large pods	7.02	30.08	1.33	0.00	2.82	8.25	6.00
High market value	20.18	17.89	4.00	4.14	2.44	9.73	5.00
Easy to process	0.88	0.00	2.04	1.11	1.62	1.13	9.00
High oil content	1.75	0.81	16.80	22.61	15.57	11.51	4.00
High fodder	2.63	2.44	0	0	0.41	1.10	10.00
Other traits	0	0	0	0	0	0.00	12.00

Source: Regional Survey, ICRISAT/NARS, 2006/07.

Niger. Resistance to disease and pests, high yield, early maturity, high oil content and uniformity in maturity are the first five traits preferred by farmers in Niger (Table 22). There are differences between varieties. While RRB is preferred on parameters of high yield, disease and pest resistance, early maturity, high oil content and color; ICG 9346 is preferred mainly for early maturity, disease and pest resistance and large pods. The variety J 11 is largely preferred for high oil content, high yield, uniform maturity and early maturity.

Overall, higher yield, disease and pest resistance, early maturity, high market value and high oil content are the most common variety traits sought by farmers in the three countries.

Table 22. Preferences for traits by farmers in Niger, 2006/07.

Variety	T 169-73	ICG 9346	RRB	J 11	Average	Rank
Color	3.33	0.00	8.54	0.00	2.97	11
High yield	23.33	8.33	27.68	16.67	19.00	2
Resistance to pests/diseases	54.92	33.33	12.47	8.93	27.41	1
Uniform maturity	4.76	0.00	5.16	13.69	5.90	5
Drought resistance	0.00	8.67	3.48	8.33	5.12	7
Early maturity	0.00	33.33	11.46	13.10	14.47	3
Large pods	0.00	16.67	6.73	0.00	5.85	6
High market value	4.76	0.00	8.64	0.00	3.35	9
Easy to process	3.33	0.00	5.72	4.76	3.46	8
High oil content	0.00	0.00	9.77	21.43	7.80	4
High fodder	5.56	0.00	3.14	4.17	3.22	10
Other traits	0.00	0.00	0.00	8.93	2.23	12

Source: Regional Survey, ICRISAT/NARS, 2006/07.

Farm costs and returns structure

Net returns analysis

Agricultural research is expected to develop products that give high returns when adopted by users. The survey was used to compute and compare the costs and returns structure of groundnut production using local and improved varieties. Table 23 shows the costs and returns for both local and improved varieties. Overall the major costs are borne on seed and labor. However, in Nigeria, fertilizers and pesticides account for significant share of the costs. The level of fertilizer use was found to be higher for modern varieties than local varieties. This partially explains the higher yield obtained apart from the genetic potential of modern varieties.

The costs of production are lower for local varieties. For example, the cost of production is estimated to $297/ha for local against $332/ha for modern varieties in Mali. Similarly, the cost of production is estimated to $207/ha for local varieties against $242/ha for modern varieties in Nigeria. The average cost of production of modern varieties was estimated 12% higher than the local varieties in Mali, 27% higher in Niger and 17% higher than the local varieties in Nigeria. This cost may be assumed to relatively high especially in Niger where farmers may be cash constrained. In this case farmers do not adopt new varieties without some form of financial assistance.

The economic returns were considered generally high mainly due to substantial yield advantage. Gross income was obtained by summing seed and haulm values and the net return was calculated by deducting total costs from gross revenues. The net income (returns/ha) was estimated to $153 for the local and $293 for the modern varieties in Mali. The same trend was observed in other countries. The net income of the modern varieties was 97% higher than that of modern varieties. The highest was found in Niger where improved varieties generate 166% more income than the local varieties. In Nigeria, the percentage increase in income from modern varieties was estimated to 87%. This signals the relative economic advantage from using modern varieties.

Table 23. Costs and returns of groundnut production in Mali, Niger and Nigeria.

	Country					
	Mali (FCFA)		Niger (FCFA)		Nigeria (Naira)	
Item	Local	Improved	Local	Improved	Local	Improved
Revenues						
Pod yield (kg/ha)	665	825	440	629	829	1090
Seed value	200165	278025	123640	172346	40345	61767
Haulm value	25021	34753	13738	19150	4483	6863
Gross Income	225186	312778	137378	191496	44827	68630
Gross Income ($)	450	626	275	383	359	549
Costs						
Variable cost						
Planting seed costs	29200	43800	28000	42000	4800	5600
Seed shelling	0	0	0	0	64	64
Pesticides	250	250	222	290	274	418
Fertilizers	0	0	911	957	2726	3521
Manure	0	0	3615	4540	750	750
Land rent	0	0	0	0	2000	2000
Labor costs						
Land preparation	NA	NA	NA	NA	2500	2500
Sowing	NA	NA	NA	NA	1500	1500
Weeding	NA	NA	NA	NA	4500	5000
Fertilizer application	NA	NA	NA	NA	500	500
Pesticide application	NA	NA	NA	NA	500	750
Harvesting	NA	NA	NA	NA	2500	3500
Assembling and packaging	NA	NA	NA	NA	2050	2600
Cost of bags	NA	NA	NA	NA	1250	1600
Labor all activities	107000	110000	70000	84000	NA	NA
Maintenance equipment	1500	1500	1500	2000	NA	NA
Maintenance traction animal	3000	3000	2500	2500	NA	NA
Fixed cost						
Depreciation on tractor equipment	7052	7052	3000	3000	NA	NA
Depreciation on small equipment	500	500	500	500	NA	NA
Total costs (LC)	148502	166102	110248	139787	25914	30303
Total costs ($)	297	332	220	280	207	242
Net returns (LC)	76684	146676	27130	51709	18913	38327
Net returns ($)	153	293	54	103	151	307

LC=local currency, 1US$=500 FCFA=125 Naira; NA= Not applicable.

Table 24 shows the summary statistics of the net income for adopters and non-adopters. The average income from adopters was estimated to $204/ha significantly higher than $123/ha for non-adopters in Mali. It was the highest in Nigeria where adopters generate on average $304 against $146 for non-adopters.

Table 24. Summary statistics of mean net income of adopters and non-adopters by country ($/ha).

		Country		
		Mali	Niger	Nigeria
Non-adopters	Mean	123	63	146
	Std	62	35	102
Adopters	Mean	204	109	308
	Std	46	41	740
% gains over non-adopters		66%	73%	111%
Overall	Mean	176	77	235
	Std	53	31	554
	F-value	71.30a	47.83a	9.88a

a. significant at 1% probability, b. significant at 1% probability, and c. significant at 1% probability.

Unit cost of production

Research should produce technically efficient outcomes, more output per unit of input use. The unit cost can be used as a measure of efficiency. Unit cost of production was calculated as the total costs divided by the total yield on a hectare basis. Table 25 presents the yield and unit cost assessment of groundnut production of one hectare of local and modern varieties. The results show that the unit cost of production was lower by 11% in Niger and Nigeria and by 10% in Mali. Though modest the yield advantage over the local was estimated to 43% in Niger, 31% in Nigeria and 24% in Mali.

Table 25. Yield and unit cost assessment of groundnut production, 2006/07.

		Country		
		Mali	Niger	Nigeria
Yield (kg/ha)	LV	665	440	829
	MV	825	629	1090
Yield gains (kg/ha)		160	189	261
Yield gains (%)		24.06%	42.95%	31.48%
Total costs	LV	148502	110248	25914
	MV	166102	139787	30303
Unit cost	LV	223.31	250.56	31.26
	MV	201.34	222.24	27.80
Unit cost reduction		21.98	28.33	3.46
% unit cost reduction		9.84%	11.31%	11.06%

LV=Local Varieties; MV=Modern Varieties.

Contribution to household's income and income distribution

As noted earlier, the improved cultivars have significant yield gains over the local varieties. Farmers growing modern varieties generate 160 kg/ha in Nigeria, 189 kg/ha in Niger and 261 kg/ha in Mali over local varieties. This has occurred despite the fact that farmers did not adopt the entire recommended package. Undoubtedly if they had adopted the entire package, yields could have been higher accompanied with significant reduction in the unit cost of production.

The net income advantage was substantial. The average net income of adopters was 665 higher than non-adopters in Mali, 73% in Niger and 111% in Nigeria (Table 24). These income impacts contribute to food security as many household see their revenues increasing and can access better food, goods and services to improve their livelihoods.

The distributive effects on household types were partially analyzed using the Gini coefficient. The Gini concentration ratios were computed for the sample of farmers interviewed in each country and also in the sub-groups of farmers classified into poor, average and rich farmers based on their assets endowments (cultivable land, value of equipment, value of livestock). The Gini concentration ratios based on the distribution of income derived from groundnut were estimated to be 0.395 in Mali, 0.501 in Nigeria and 0.488 in Niger. This ratio indicates that there is a better distribution of income from groundnut in Mali than in other countries (Table 26).

Table 26. Summary statistics of mean net income of households by type and by country ($/ha).

		Type of farmers		
Country	Statistic	Poor	Average	Rich
Mali	Mean	157	187	180
	Std	46	54	55
% over the poor		0%	19%	15%
Niger	Mean	79	74	73
	Std	34	25	26
% over the poor		0	-6%	-8%
Nigeria	Mean	162	242	261
	Std	28	552	700
% over the poor		0	49%	61%

Groundnut utilization and marketing

A large proportion of groundnut produced is sold. In Nigeria, 63% of groundnut produced was sold in 2004/05 or 2005/06 and less than 16% is sold and the remaining kept as seed. No significant differences were found between adopters and non-adopters. This is partially explained by the fact that farmers are still at an early stage of adoption. In Niger, 74% and 78% of groundnut production was sold and the remaining consumed or kept as seed. The situation is somewhat different in Mali where 47% and 55% of groundnut produced was sold in 2004/05 and 2005/06 respectively. There has also been a slight imperceptible increase in the proportion of sales in Niger and Mali reflecting the introduction of modern varieties that have in turn increased the quantity produced (Table 27).

Table 27. Commercialization of groundnut by households in pilot sites in Mali, Niger and Nigeria (proportion of transactions).

Selling points		Country					
		Nigeria		Mali		Niger	
		OV	MV	OV	MV	OV	MV
	Village markets	67.97	72.30	55.43	43.03	37.15	14.71
	Urban markets	14.99	10.81	21.11	15.16	28.64	45.59
	Farm gate	2.90	5.41	0.00	0.82	0.65	0.00
	Local dealers	4.43	1.69	0.29	1.64	1.31	2.94
	Home	8.01	6.76	21.70	37.30	30.11	32.35
	Not specified	1.02	1.35	0.00	0.00	2.13	4.14
	Others	0.68	1.69	1.47	2.03	0.00	0.00
Perception of price	Good	42.08	34.12	64.22	84.84	32.24	29.41
	Fair	28.28	38.85	32.26	5.74	31.10	18.38
	Poor	2.55	0.68	2.05	8.20	14.08	8.09
	Not specified	26.41	26.35	1.47	1.23	22.58	42.12
Distance to selling points	Long	21.98	26.01	29.91	18.85	28.31	52.21
	Near	70.53	63.18	68.33	77.46	68.09	44.85
	Not specified	7.50	10.71	1.76	3.69	3.60	2.94
Readiness to sell	Sometimes	12.61	17.57	5.87	1.23	22.42	21.32
	Always	87.22	82.43	92.96	97.95	76.27	78.68
	Not specified	0.17	0.00	1.17	0.82	1.31	0.00
Buyers	Consumers	22.83	16.55	14.08	2.87	8.18	8.82
	Brokers	29.64	22.64	0.28	0.00	14.24	2.94
	Local traders	13.29	11.49	19.94	13.93	26.35	34.56
	Oil processors	0.34	1.01	0.29	0.41	14.73	16.91
	Urban traders	4.77	6.42	37.24	33.20	15.22	18.38
	Wholesalers	14.48	30.74	0.59	0.00	4.91	0.00
	Retailers	4.60	1.01	0.29	0.00	1.15	1.47
	Others	1.36	4.39	27.27	49.59	4.58	11.03
	Not specified	1.36	0.34	0.00	0.00	0.00	0.00

OV=Other Varieties; MV=Modern Varieties.
Source: Regional Survey, ICRISAT/NARS, 2006/07.

Nigeria. The proportion of sale transactions made through village markets (69%) is higher than those made in urban markets (14%), home (8%) or farm gate (4%). There are no differences between modern varieties and other varieties (Table 27). The results reveal that short distance trade is very important. About 68% of the transactions are made across a short distance, and 23% over long distances. Less than 5% of the transactions are made at the farm gate. Farmers claimed to easily find buyers of groundnut for 86% of the transactions made. About 21% of the sale transactions are made with consumers, 27% with brokers, 20% with wholesalers and a few with oil processors.

Mali. More than 50% of sale transactions are made in the village markets, 19% in urban markets and 28% at home. As in Nigeria, 72% of the transactions are made within short distances while the remaining are made across long distances. Farmers reported to always find buyers for 95% of the transactions. About 17% of the sale transactions are made with local traders, 36% with urban traders and about 9% with consumers.

Niger. The proportion of sale transactions made through village markets is estimated at 33%, almost equivalent to those made through urban markets (32%) and home (31%). There are not very many differences between modern varieties and other varieties (Table 27). Short distance trade is again very important. Nearly 64% of the transactions are made within short distances, and 33% at long distances. Less than 5% of the transactions are made at farm gate. Farmers claimed to easily find buyers of groundnut for 77% of the transactions made. About 28% of the sale transactions are made with local traders, 25% with processors, 12% with brokers and 16% with urban traders.

Price of groundnut products

Nigeria. For about 39% of the sale transactions made by farmers, the prices were judged good, 32% fair and very few were categorized poor. Table 28 presents groundnut selling prices reported by farmers in 2006/07 in the three countries. Prices here reflect the aggregate value of traits characterizing the varieties. In Nigeria for example, SAMNUT 23 was sold at a higher price than other varieties probably because of its high oil content and early maturity. Overall, modern varieties were sold at 10 cents more than local varieties.

Mali. Farmers reported 73% of the sale transactions to be good, 21% to be fair and the remaining poor. In Mali, the variety ICG 7878 was sold at high rates. In effect, its large pod size, taste (edible) and disease resistance justify its high market value. This is followed by other modern varieties such as ICG (FDRS) 4, Fleur 11 and JL 24. Overall, modern varieties were priced 8 cents more than other varieties.

Niger. The scene in Niger is different from the other two countries. While ICG 9346 is priced high in the local market, followed by J 11 and TS 32-1, overall the price of modern varieties was lower than that of local varieties. Farmers especially expressed a strong preference for 55-437, an old variety introduced some 40 years ago.

Table 28. Price of seed by country and variety, 2006/07.

		Local currency/kg		$/kg		
Country	Variety	Mean price (local price/kg)	Std dev.	Mean price ($/kg)	Std dev.	No. of transactions
Nigeria	55-437	85	19	0.68	0.15	78
	SAMNUT 21	78	7	0.62	0.06	35
	SAMNUT 22	86	16	0.69	0.13	56
	SAMNUT 23	89	22	0.71	0.18	45
	Other varieties	73	24	0.58	0.19	179
	Modern varieties	85	17	0.68	0.14	136
Mali	ICG (FDRS)4	336	28	0.67	0.06	55
	47-10	270	33	0.54	0.07	133
	ICG 7878	358	46	0.72	0.09	58
	Fleur 11	327	40	0.65	0.08	121
	ICG 86124	306	48	0.61	0.10	26
	JL 24	321	39	0.64	0.08	69
	Other varieties	301	46	0.60	0.09	334
	Modern varieties	337	41	0.67	0.08	234
Niger	55-437	242	87	0.48	0.17	132
	ICG 9346	280	122	0.56	0.24	13
	TS 32-1	227	138	0.45	0.28	7
	RRB	206	96	0.41	0.19	34
	J 11	229	58	0.46	0.12	4
	Other varieties	204	93	0.41	0.19	399
	Modern varieties	199	90	0.40	0.18	65

Source: Regional Survey, ICRISAT/NARS, 2006/07.

Factors affecting adoption of modern varieties

Adoption of innovations has attracted considerable literature among development economists because it is a key driver for promoting economic development in less developed economies. Adoption is defined as the degree of use of a new technology and its potential. Aggregate adoption, on the other hand, is measured by the aggregate level of use of a new technology within a given population or geographical area.

The rate of adoption is a critical variable in estimating the returns to research and development investments. It is the relative speed with which an innovation is accepted and utilized by members of a social system (Rogers 1962). It is defined as the proportion of the area planted with modern varieties over the total area planted to the crop. Many farmers have hypothesized factors driving adoption decisions to include: (1) human capital involving socio-personal characteristics such as age

and education, household size, total work force etc, (2) technological attributes; for instance, varieties may not have characteristics sought by farmers or required by the market, or farmers perhaps cannot afford to implement the recommended technological package, (3) socioeconomic factors such as farm size, endowments in physical assets, access to credit, and (4) poorly functioning input supply and delivery systems, underdeveloped product markets, poor access to credit facilities etc.

Econometric models often used to derive quantitative measures of farm technology adoption behavior include binary choice models such as the logit or probit models where the dependent variable is a dummy that takes the values of 0 or 1. Generally the value 1 indicates that the farmer possesses particular characteristics to belong to the group of adopters and 0 represents those who do not do belong to the group of adopters. The tobit model is also frequently used in which the dependent variable is the proportion of area planted to new varieties over the total area planted with the crop.

Dependent variables

The dependent variable in the logit model is a dummy variable (0, 1) with 0 representing the group of households that have not planted modern groundnut varieties in 2006/07and 1 for farmers who have planted modern varieties. In the tobit model, the proportion of area planted to modern varieties relative to the groundnut area planted with groundnut is the dependent variable. The latter dependent variable is censored at zero.

Explanatory variables

The explanatory variables used in logit and tobit models included the following:

- Household level variables: value of assets owned (equipment, traction animals, other animals); total area cultivated; dependency ratio; total cash sales as proxy to access to financial resources; characteristics of the household head – educational attainment (none, primary, secondary, literacy training, other); age; occupation (agriculture as main occupation) or labor participation (full-time, part-time, or not engaged in labor), household size, work force proxy by adult equivalents, etc.;
- Technology attributes (drought, diseases and pests, yields, market value);
- Institutional environment (number of household members who belong to a farmers' association as a proxy for social capital, affiliation to seed institutions, number of training in seed production, participation in seed activities, on-farm trial participants and pilot village);
- Regional characteristics – dummy variable for each region. In Nigeria, there are dummies by state (Jigawa, Kano, Katsina), in Niger (Dosso, Maradi and Zinder) and Mali (Koulikoro and Kita) dummies by region.

Tobit and logit results

Mali. The results from the logit model of adoption of modern groundnut varieties in Mali (Table 29) suggest that most determining factors for the probability of adoption are the participation in on-farm trials (+), distance to on-farm trials (-), the location in Kolokani relative to Kita (+), affiliation of farmers' associations producing seed (+), disease and pest resistance (+), social capital (+), family size (-) and the age squared (-). Other variables had the expected signs but were not significant.

Table 29. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Mali.

	Tobit model		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Age of household head (years)	0.0184874	0.028315	0.088183	0.131651	0.0135747	0.02047
Age squared	-0.0001974	0.000287	-0.00116	0.00134	-0.0001778	0.00021
Family size	-0.0380217a	0.014763	-0.1285876c	0.07073	-0.0197944a	0.01151
Illiterate	0.1141026	0.127089	-1.01372	0.673727	-0.156049	0.1051
Primary school	0.153319	0.113048	-0.19372	0.523872	-0.0309888	0.08713
Secondary school	0.0641092	0.276976	0.040607	1.05033	0.006176	0.15786
Cultivated area	-0.0281889b	0.014585	-0.04282	0.069245	-0.0065917	0.01077
Marital status	-0.1091968	0.072386	0.052469	0.320802	0.008077	0.04936
Work force	0.0410566	0.026927	0.148113	0.123533	0.0228	0.01939
Agriculture main occupation	0.1076893	0.277716	0.289514	2.19291	0.0484575	0.39628
Dependency ratio	-0.0103619	0.061366	-0.15488	0.251188	-0.0238418	0.03903
Distance to on-farm plot	-0.0412886	0.222638	-13.64161a	0.861441	-2.099953a	0.42491
Project site	0.2213189	0.277507	14.51756a	0.909939	2.234795a	0.4565
On-farm trial participation	0.6669511a	0.214003	15.73656a	0.94658	2.422445a	0.48907
Value of equipment	0.0001604	0.000206	7.69E-05	0.001108	0.0000118	0.00017
Total cash sales	-0.0001458	0.00017	-0.0009	0.000856	-0.0001378	0.00014
Value of livestock	-0.0000183	2.15E-05	0.000121	0.000141	0.0000187	0.00002
Value of animal traction	0.0002099a	7.54E-05	0.000531	0.000359	0.0000818	0.00006
Koulikoro (ref.)	0.678581a	0.140001	1.753072b	0.625497	0.3011006b	0.12736
Seed availability	-0.3581332b	0.149655	-0.06812	0.683082	-0.0106809	0.10904

Table 29. cont'd. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Mali.

	Tobit model		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Seed consumption	-0.0666898	0.195349	-0.11675	1.098192	-0.0185873	0.18064
Affiliation to seed institutions	0.186444b	0.094938	1.903131c	1.103425	0.3705806c	0.21011
Disease and pest resistance	0.0240893	0.128092	2.497377b	1.119163	0.1964827a	0.05617
Low yield	0.4027793	0.2596	1.513322	1.237556	0.143582a	0.06967
Social capital	0.2144221a	0.053116	2.018282b	1.006585	0.310689a	0.11288
Number of demonstrations	0.1073412b	0.053104	0.126393	0.356586	0.0194565	0.05506
Always sell	0.0337655	0.116181	0.179566	0.470724	0.0270276	0.06946
Low market value	1.166621c	0.585399	-	.-		
Training in seed production	-0.1280937c	0.063571	-	-		
Constant	0.930499	1.408881	68.88562	101.5688		
σ	0.5365761	0.030551				
Number of uncensored	153					
Total number of observations	341		341			
Pseudo R2	0.271		0.3849			
LR chi(32)	181.56a		159.18a			

a. significant at 1% probability level, b. significant at 5% probability level and c. significant at 10% probability level.

Participation in on-farm trials is a significant variable that increases the probability of adoption. In effect, farmers who have experimented and tested new varieties are likely to adopt because they have learned and identify themselves the desired traits. Likewise, those who are next to experimental plots have observed these varieties also during the crop cycle and have obtained information from on-farm trial participants on some non-observable traits on those varieties. The affiliation to farmers' associations dealing with seed production is an ideal forum of exchange of information on seed and varieties. Likewise, the number of institutions in which farmers are connected may explain farmers' exposure to information on new varieties.

Disease and pest pressure were perceived as significant constraints to adoption of modern varieties even prior to research and development intervention in the pilot sites. Research institutions have therefore introduced varieties that are resistant/tolerant to diseases and pests. This may largely explain

the uptake of modern varieties in those sites and the fact that this trait increases the probability of uptake by farmers.

The negative sign on family size implies that large families decrease the probability of adoption of modern varieties. This may be explained by the fact that large families are more vulnerable than smaller families and may not want to take the risk of jeopardizing food security by using modern varieties. The negative and significant sign on age squared shows that there is an optimum age below and above which the probability of adoption decreases.

Compared to Kita, the location of farmers in Kolokani increases the probability of adoption. This is largely explained by more than 10 years of testing and exposure to modern varieties in Kolokani compared to Kita where farmers were less exposed to modern varieties.

Intensity of adoption

Similar results as above are recorded on the intensity of adoption. The factors that most determine intensity of adoption of modern varieties are family size (-), cultivated area (-), participation in on-farm trials (+), value of animal traction (+), seed constraint (-), affiliation to farmers'associations dealing with seed (+), market value (+), the number of household members who belong to an association (+), the number of demonstrations in which the household head has been involved (-), the number of training in seed production (-), and location in the Kolokani region (+). Other variables although not significant had the expected signs.

Large families are less likely to intensify with modern varieties compared to smaller families. This may be explained by the need for less exposure to risk of failure that may have an adverse effect on food security. A decrease in cultivated area may be a response to intensification thus using modern varieties that yield more per unit area. Participation in on-farm trials is essential to intensification as farmers know the potential of varieties and are ready to plant proportionally more modern varieties.

Farmers who own animal traction power are more responsive to modern technologies and can already cultivate large areas and thus more likely to intensify with modern varieties. Seed availability is a significant constraint to intensification as seed supply is limited compared to the current demand in the pilot sites. Some significant traits imbedded were reported to be significant in intensification for example, the varieties with high market values. Other institutional factors such as social capital, affiliation to farmer association focusing on seed multiplication, training in seed production were found to be significant in explaining the intensity of adoption.

Nigeria. The results from the logit model of adoption of modern groundnut varieties in Nigeria suggest that factors that most determine the probability of adoption are participation in on-farm trials (+), the distance to pilot sites (-), total cash sales (+), value of livestock (-), the state of Kano relative to Jigawa (+) and the state of Katsina relative to Jigawa (+); seed availability (-), affiliation to seed institutions (+), pest and disease resistance (+), social capital (+) and part-time farming (+) (Table 30).

Participation in on-farm trials is a significant variable that increases the probability of adoption. In effect, farmers who have experimented and tested new varieties are likely to adopt because they have learned and identify themselves the desired traits. Likewise, the closer farmers are to experimental plots the higher will be the probability of adoption. The affiliation to farmers' association dealing with seed production is a nice forum of exchange of information on seed and varieties. Likewise, the

number of institutions in which farmers are connected may explain farmers' exposure to information on new varieties.

Disease and pest pressure was found to be a significant constraint to adoption of modern varieties. This may be explained by the resurgence of GRD that wiped out groundnut production in the 1970s and 1980s. Farmers are likely to shift to rosette resistant varieties if the latter have other characteristics sought by farmers.

Compared to Jigawa, extension services (ADPs of Kano and Katsina) have been largely involved in on-farm trials and seed multiplication and distribution. This may explain why uptake is low in Jigawa compared to Kano and Katsina.

Table 30. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Nigeria.

	Tobit results		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Age of household head (years)	-0.0324457b	0.016641	-0.00331	0.110678	-0.000708	0.02368
Age squared	-0.0002842c	0.000153	-1.9E-05	0.001058	-4.15E-06	0.00023
Family size	-0.0145964b	0.00732	-0.012708	0.045466	-0.0027185	0.00973
Illiteracy	-0.0041735	0.391367	-0.65229	1.845155	-0.1528494	0.45808
Primary school	0.0556291	0.104449	0.225607	0.5567	0.0465134	0.11058
Secondary school	0.0006717	0.098085	0.2184	0.595403	0.0481151	0.1349
Cultivated area	-0.0022152	0.005195	-0.01197	0.030012	-0.002561	0.00641
Marital status	0.1928913	0.11468	0.983116	1.121847	0.2103014	0.23974
Work force	-0.018278	0.012691	0.016503	0.079079	0.0035302	0.01692
Dependency ratio	-0.0005433	0.001098	-0.00114	0.005933	-0.0002431	0.00127
Distance to on-farm plot	-0.0094866	0.097214	3.647984a	0.506316	0.7803513a	0.10838
On-farm trial participation	-0.6169685a	0.157909	2.992048a	0.809765	0.640038a	0.17194
Value of equipment	0.0000442c	0.000024	7.2E-05	0.000389	0.0000155	0.00008
Total cash sales	0.0000127	1.26E-05	0.0002112c	0.000115	0.0000452b	0.00002
Value of livestock	-0.0000346b	1.55E-05	-0.0002116b	9.95E-05	-0.0000453b	0.00002
Value of animal traction (Naira)	0.0000167	3.29E-05	-6.1E-05	0.0002	-0.000013	0.00004

Table 30. cont'd. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Nigeria.

	Tobit results		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Kano (ref. Jigawa)	0.2916916a	0.083904	1.395688a	0.498849	0.2715103a	0.0859
Katsina (ref. Jigawa)	0.5722092a	0.094637	3.437469a	0.63285	0.4802208a	0.06246
Seed access and availability	0.0483362	0.075172	1.957636a	0.459104	0.3230381a	0.06092
Consumption of seed	-0.4103967b	0.211686	-1.03442	1.294292	-0.2473863	0.31897
Affiliation to seed institutions	0.0913501	0.07067	0.9071509b	0.432491	0.1793392b	0.0785
Drought	-0.4016682	0.300818	1.147226	2.638514	0.1865735	0.29279
Pest and disease resistance	0.4086437a	0.097278	2.466724a	0.677916	0.3181679a	0.05279
Low yield	0.1228544	0.100967	0.05859	0.684762	0.0124224	0.14393
Cash to purchase seed	0.0155831	0.154806	0.232205	0.848393	0.0476017	0.16602
Social capital						
Members of farmers' seed associations	0.1563273c	0.090752	1.524371b	0.658942	0.2813357a	0.10683
Training crop management	0.0260107	0.052525	0.297141	0.385181	0.0635624	0.08257
Full time (ref. not on farm)	0.0647805	0.103217	0.332435	0.531013	0.0711879	0.11357
Always sell (0=no, 1=yes)	0.0081605	0.099205	0.44247	0.586852	0.0999467	0.13807
Part-time farmers (not on farm)	0.1847856b	0.095588	1.098122b	0.536445	0.210301a	0.09066
Constant	1.107695	0.705567	b-16.32562	4.112086		
σ	0.4547677	0.026112				
Number uncensored	154					
Total number of observations	334					
Pseudo R2	0.33		0.5519			
LR chi2 (32)	194.24a		239.49a			

a. significant at 1% probability level, b. significant at 5% probability level and c. significant at 10% probability level.

Intensity of adoption

The factors most determining intensity of adoption of modern varieties are age of household head (+) and age squared (+), family size (+), participation in on-farm trials (+), value of equipment (+), value of livestock (-), family size (-), the state of Kano relative to Jigawa (+), Katsina relative to Jigawa (+), pest and disease resistance (+), social capital (+), participation in seed activities (+), number of training on seed production (+) and part-time farming (+).

Niger. The results from the logit model of adoption of modern groundnut varieties in Mali suggest that determining factors for the probability of adoption are the rate of illiteracy (-), marital status (-), total cash sales (+), Maradi and Zinder regions relative to Dosso region (-), seed availability (-), affiliation to farmers' association seed producers (+) and social capital (+) (Table 31). Other variables had the expected signs but were not significant.

As in Nigeria, participation in on-farm trials, social capital, affiliation to farmers' associations and the region explain the adoption of modern varieties. In addition, the volume of total cash sales was found to be a driver to adoption. The contraints included education of household heads, marital status, the location in the regions of Maradi and Zinder, and seed availability. Other variables had the expected signs but were not significant.

The locations in Maradi or Zinder were perceived to drive down the adoption of modern varieties. In effect, on-farm trials started in the Dosso region more than a decade ago. In addition, during GSP, farmers were exposed to modern varieties through participatory variety selection trials involving both mother and baby trials. In regions such as Maradi and Zinder, it is just recently with the inception of GSP that farmers started to be exposed to modern varieties. This may partially explain why uptake has not been very important in those two regions. Seed availability is still a major constraint to adoption, requiring more efforts in empowering community based systems at producing seed and making it available at affordable price to end-users.

Intensity of adoption (Tobit model)

Similar results are recorded in Niger on the intensity of adoption. The most determining factors for the intensity of adoption of modern varieties are illiteracy rate (-), marital status (-), the value of equipment (+), the region of Maradi relative to Dosso (-), seed consumption (-), affiliation to seed institutions (-), low yield (-), social capital (+), and training in crop management. Other variables although not significant had the expected signs.

Table 31. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Niger.

	Tobit results		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Age of household head (years)	0.026177	0.029655	0.0828979	0.067767	0.016267	0.01325
Age squared	-0.00021	0.00029	-0.0007632	0.000667	-0.00015	0.00013
Family size	-0.00704	0.017832	-0.0429952	0.042813	-0.00844	0.00839
Illiterate	-0.3404658c	0.206152	-0.8249858c	0.480202	0.1618816c	0.09402
Primary school	0.25125	0.197762	0.0989256	0.410312	0.01909	0.07782
Secondary school	0.5558704c	0.290546	0.2234435	0.621356	-0.04181	0.11049
Cultivated area	-0.01631	0.010433	-0.0157993	0.021725	-0.0031	0.00426
Marital status	-0.2558012b	0.12282	-0.5772254b	0.29788	-0.1132652b	0.05821
Work force (adult equivalents)	-0.03906	0.033226	0.0089204	0.080057	0.00175	0.01571
Agriculture main occupation	-0.12641	0.231973	-0.1042035	0.506061	-0.02087	0.10328
Dependency ratio	-0.00141	0.001366	-0.0003304	0.003038	6.48E-05	0.0006
Distance to on-farm plot	0.462259	0.510512	0.7537636	1.053832	0.147906	0.20687
Project site	0.704854	0.574244	1.10218	1.215742	0.216274	0.23846
On-farm trial participation	0.067978a	0.03987	0.581273	0.25496	0.11406	0.20092
Value of equipment	0.0003393a	0.000136	0.0004631	0.000338	9.09E-05	0.00007
Total cash sales	0.00015	0.000117	0.0004851b	0.000282	0.0000952c	0.00006
Value of livestock	2.82E-06	6.23E-06	-2.07E-06	0.000018	-4.06E-07	0
Value of animal traction	3.17E-06	0.000113	0.0002642	0.000251	5.18E-05	0.00005
Maradi (ref. Dosso)	-0.9339927a	0.226854	-1.586922a	0.483364	a-.2420027	0.05297

Table 31. cont'd. Tobit and logit results on intensity and probability of adoption of new groundnut varieties in Niger.

	Tobit results		Logit model		Marginal effects	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	dy/dx	Std. Err.
Zinder (ref. Dosso)	-0.18757	0.1846	0.1273284	0.433559	0.025526	0.08869
Seed availability	0.17581a	0.132061	0.8962309a	0.301239	0.1900108a	0.06666
Seed consumption	1.008297b	0.502927	1.802205	1.41413	0.421049	0.30452
Affiliation to seed institutions	0.3320777b	0.130401	0.6893935b	0.298957	0.1281861a	0.05222
Disease and pest resistance	0.193933	0.634725	-0.7104452	1.612258	0.116064	0.2107
Low yield	-0.4273822b	0.214728	-0.5290748	0.467962	-0.09346	0.07328
Lack of cash	-0.30996	0.255468	-0.186596	0.522252	-0.03521	0.09451
Social capital	0.2476739a	0.0766	0.3253601c	0.179497	0.0638433c	0.03505
Participation in farmers' associations	0.13717a	0.063665a	0.8191688b	0.331192	0.1549424a	0.06006
Training crop management	0.1137655b	0.070044	0.2683058	0.198388	0.052648	0.03892
Always sell (0=no, 1=yes)	0.19164	0.14375	0.5084042	0.331429	0.0941372c	0.05737
Low market value	0.153295	0.396514	0.5739614	0.870382	0.125419	0.20631
_cons	-2.84842	2.692487	-4.453776	5.570192		
σ	0.732063	0.064558				
Number of uncensored	89					
total number of observations	363		363			
Pseudo R2	0.1677		0.1773			
LR chi2(32)	78.04a		81.88a			

a. significant at 1% probability level, b. significant at 5% probability level, c. significant at 10% probability level.

Conclusions and implications

The results show diffusion and adoption of groundnut varieties have increased significantly in GSP pilot sites in the three countries. The rate of adoption increased from 10 to 32% in Nigeria, from about 32 to 44% in Mali and from 3 to 13% in Niger. Adoption has spread beyond the pilot sites. In Mali, 88.52% households' on-farm trial participants are growing modern varieties, 56.91% among non-participants and 43.43% in the control sites. The same pattern is observed in Niger and Mali.

Adopters of modern varieties have generated significant yield and net income gains and the unit cost of production has been moderately reduced. The yield gains from adopting modern varieties were estimated to 24% in Mali, 43% in Niger and 31% in Nigeria. Similarly, the mean net income gains from adoption were estimated 66% in Mali, 73% in Niger and 111% in Nigeria. The percentage unit cost reduction was moderate estimated to 10% in Mali, 11% in Niger and Nigeria. The latter shows that yields are still very low. This is explained by the low use of inputs such as fertilizers to boost yields to its full potential under farmers' conditions.

The major drivers of adoption have been identified to be the exposure of farmers to modern varieties via on-farm trials, the development and empowerment of farmers' associations and the involvement of small-scale seed producers tasked at producing seed of preferred varieties and the involvement of research institutes at supplying breeder seed and/or foundation seed. A number of constraints to adoption remain. These include seed access and availability, pest and diseases problems and credit constraints.

To realize the full benefits of modern groundnut varieties, farmers in West Africa would have to adopt management practices that will significantly increase yields. There is still a wide gap between farmers' realization and yields on-station. In addition, there is a need to develop groundnut markets. Though farmers are not complaining of lack of markets for their sales, their products have so far targeted only the domestic markets, and the price they receive is often low.

Questions remain about the capacity of the domestic groundnut market to absorb additional production. There is a need to address aflatoxin issues through the use of proper crop management technologies and storage infrastructure so as to enlarge the demand base to allow farmers to access the broader regional and international markets.

Adoption of modern groundnut varieties will be enhanced if governments and donors could invest more in the development of institutions and institutional arrangements that will deliver seed at affordable cost to smallholder farmers. Arrangements have to be developed to ease access to credit to farmers and organize farmers through collective actions to benefit more from the sale of their products.

References

Badiane O and **Kinteh S.** 1994. Trade Pessimism and regionalism in African countries: The case of groundnut exporters. Research Report 97. IFPRI.

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

FAO. 2002. Agricultural exports and imports database. www.fao.org.

Farrington J, Carney D, Ashley C and **Turton C**. 1999. Sustainable livelihoods in practice: Early applications of concepts in rural areas. *Natural Resources Perspectives*, Number 24, June 1999. Overseas Development Institute, London.

Feder G, Just R and **Zilberman D**. 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*. 33(2):255-298.

Greene WH. 1990. Econometric analysis. Macmillan Publishing Company.

Holloway RE. 1977. Perceptions of an innovation: Syracuse University Project Advance. (Doctoral dissertation, Syracuse University, 1977). Dissertation Abstracts International, 572-573A.

INRAN. 1994. Catalogue Nigerien des varietes de cereales et legumineuses. Ministere de l'Agriculture et de l'Elevage. Institut National de la Recherche Agronomique du Niger. Republique du Niger.

Kinteh S and **Badiane O.** 1990. The market potential for groundnut products facing West African countries and the role of regional markets. Washington DC, USA: International Food Policy Research Institute.

LABOSEM. 2002. Catalogue officiel des espèces et variétés. Laboratoire des Semences. Direction Générale de la Réglementation et du Contrôle. Ministère de l'Agriculture, de l'Elevage et de la Pêche. République du Mali (Tomes 1 & 2).

Mayeux A, Waliyar F and **Ntare BR.** 2003. Groundnut varieties recommended by Groundnut Germplasm Project (GGP) for West and Central Africa (in En., Fr.). International Crops Research Institute for the Semi-Arid Tropics (ICRISAT): Patancheru 502 324, Andhra Pradesh, India. ISBN 92-9066-456-8.

Ndjeunga J, Ntare BR and **Shilling R.** 2002. Global and regional perspectives of the groundnut market: Competitiveness of African producers. Pages 49-67 *in* Conservation, Evaluation and Dissemination of Groundnut Germplasm and Foundation Seed Production and Distribution for the West African Region: Proceedings of the final workshop of the Groundnut Germplasm Project (Ntare BR, Mayeux A and Waliyar F (eds.) (In Eng.). 22-24 April 2003, Bamako, Mali. Patancheru 502 324, Andhra Pradesh, India: International Crops Research institute for the Semi-Arid Tropics. 158 pp. ISBN 92-9066-454-1. Order code CPE 144.

Ndjeunga J, Ntare BR, Waliyar F and **Ramouch M.** 2006. Groundnut seed systems in West Africa: Current practices, constraints and opportunities. CFC Technical Paper No. 40. PO. Box 74656, 1070 BR Amsterdam, The Netherlands: Common Fund for Commodities; Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics. 232 pp.

Ndjeunga J, Ntare BR, Waliyar F, Ondio Kodio J and **Traore A.** 2003. Assessing the diffusion of groundnut varieties in Mali. International Arachis Newsletter No. 23. Pages 33-35.

Ntare BR, Waliyar F, Ramouch M, Masters E and **Ndjeunga J.** 2005. Market prospects for groundnut in West Africa. CFC Technical Paper No. 39. PO Box 74656, 1070 BR Amsterdam, The Netherlands: Common Fund for Commodities; Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics. 252 pp.

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.

Rogers EM. 1995. *Diffusion of innovations* (4th ed.). New York: The Free Press.

Rogers EM and **Shoemaker FF.** 1973. Communication of innovations: A cross-cultural approach. New York: Free Press.

Surry DW and **Farquhar JD.** 1997. Diffusion theory and instructional technology. *Journal of Instructional Science and Technology*. Volume 2. No 1, May 1997.

Wyner NB. 1974. A study of diffusion of innovation: Measuring perceived attributes of an innovation that determine rate of adoption. (Doctoral dissertation, 1974) Dissertation Abstracts International, 3583A.

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

PO Box 776, Bulawayo, Zimbabwe

www.icrisat.org

454-2007