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SEED VARIETIES AND QUANTITIES OF CHEMICAL FERTILIZERS USED IN AGRICULTURAL PRODUCTION IN NORTHERN NIGERIA

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ABSTRACT

Two separate researches were conducted in northern Nigeria. The first study (1996/97) covered Kano, Jigawa and Katsina States and the second (2002/03) covered Kano and Katsina States. These States have high agricultural production potentials and are significant in both biophysical characteristics and population density for the larger part of northern Nigeria. These two researches compared the seed types and quantities of chemical fertilizers used in the two separate agricultural seasons. The results showed that traditional crop varieties for sorghum (such as *Farafara, Kaura* and *Mori*), millet (such as *Zango* and *Dan Akaranja*) and cowpea (such as *Dan wuri* and *Dan Illa*) dominated the cropping system compared to improved varieties for these crops such as *Yarshawa, Gaya early* and *Samsorg 15* for sorghum, *Ex-Bornu* and *Lawur* for millet and *Kananado* and *ITA 60* for cowpea. However, for groundnut, improved varieties such as *RMP 12*, *RRB, Ex-Dakar* and *Yarkabara* were more prevalent than local ones such as *Yar Tsugune* and *Jar Jigilla*. The average rates of application of chemical fertilizer were 74.28 kg nutrient ha^{-1} in 1996/97 and 54.37 kg nutrient ha^{-1} for 2002/03. These application rates fell short of the recommended rates for some staples such as 220 -240 kg nutrient of N P K ha^{-1} for open-pollinated maize, 300 kg nutrient of N P K ha^{-1} for hybrid maize, 200 – 300 kg nutrient ha^{-1} for sorghum, 100 – 200 kg nutrient ha^{-1} for millet and 200 – 350 kg nutrient ha^{-1} for rice. The recommendations made included the need for more emphasis on the development of improved crop varieties that are adaptable to existing ecological and economic conditions; encouraging public and private sector partnerships in seed production and distribution, and the adoption of integrated soil fertility management approaches.

KEY WORDS: Seed variety, Fertilizer rates, Northern Nigeria.

INTRODUCTION

The increases in agricultural production required to meet the potential gaps between supply and demand for food in low-income countries are unlikely to be achieved anywhere without modification of traditional agricultural systems and a significant increase in purchased inputs, particularly seeds and fertilizers (Oram *et. al*., 1979). Since intensive and more permanent systems of agriculture as currently practised are themselves dependent on availability of improved farm inputs, different policies and programmes have been put in place in some countries to promote efficiency in the production, procurement and distribution of agricultural inputs. These policies are designed to:

(i) develop domestic farm input production capacity to meet the growing demand for farm inputs, thereby conserving foreign exchange as well as ensuring steady supply; and
(ii) ensure that agricultural inputs are made readily available to all categories of farmers in the right quantity, quality, place, time and at affordable prices through an efficient and cost-effective procurement, distribution and marketing system (Ogunfowora, 1996).

Fertilizers and improved seeds have come to be seen as the easiest and most scale-neutral inputs to raise agricultural productivity (Lele and Adu-Nyako, 1991). The potential of good/improved seeds to increase significantly crop outputs and thereby increase food supplies and accelerate agricultural development are said to have long been recognized in Nigeria (Olorunnipa, 1987). Similarly, fertilizers are an important and sometimes indispensable source of the nutrients required for plant growth and food production (Bumb and Baanante, 1996). In both traditional and modern farming systems, harvested crops remove nutrients from the soil and unless these nutrients are replenished in adequate quantities, the natural resource base may be degraded through nutrient depletion and soil degradation (Bumb and Baanante, 1996). In many countries of sub-Saharan Africa, nutrient removal exceeds nutrient replenishment by a factor of 3 to 4, resulting in an annual loss of more than 8 million tonnes of nutrients (Stoorvogel and Smaling, 1990). Considering also that natural processes can replenish only limited quantities of the nutrients removed, these nutrients must be supplied through external sources (Bumb and Baanante, 1996). This paper discusses the use of seeds and chemical fertilizers as critical biological inputs in northern Nigerian agriculture.

LITERATURE REVIEW

Requirements for Improved Seeds

A strong case for the production and distribution of good quality seeds was made by FAO (1970) in one of its International Working Papers (IWP) as follows:

> "Good seed is the foundation of good crops. It is also, from the farmer's point of view, a relatively cheap and simple input, requiring little technical knowledge, or (in most cases) specialized equipment. In areas of limited physical potential, seed of varieties resistant to disease and climatic hazards may be practically the only contribution which modern technology can make to crop improvement. On the other hand, quality seed of high yielding varieties may be the key which unlocks the door to a dramatic surge of productivity (through increasing yields and permitting ore than one crop per year) when combined with the use of other inputs under more favourable environmental conditions.
>
> Whilst a sound seed programme is an important element of any programme to increase crop production, the direct benefits which have been attributed to improved varieties in analytical studies of the contributions of individual components of such programmes to yields of crops

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> in the past have often been relatively small-perhaps around 10 percent. This has been radically changed by the advent of high yielding cereal varieties, and has rendered a dynamic program to ensure an adequate and continuing supply of quality seed not merely desirable, but essential to the success of the whole strategy of food production in many developing countries. For this reason we accord it the highest priority, not merely as an end in itself, but as a key enabling factor in the economic use of the other inputs on which our objectives depend."

At another conference in 1977, the FAO stressed seed production as an urgent and rewarding area for investment. Oram *et. al*. (1979) argue that work by the international agricultural research centres has demonstrated that significant benefits can be obtained from making available to farmers clean, genetically pure, and disease and weed-free seed varieties even where little genetic improvement has been made and that, better germination, seedling vigour, and more even plant populations result in higher yields .

The FAO (1973) in a separate analysis showed that many countries still do not have adequate organizations for either varietal improvement or production and distribution of improved seeds. Of the 30 study countries covered in the FAO (1973) seed review work, very few had more than an embryonic seed production and distribution service backed by adequate quality control and legislation; although most were undertaking varietal improvement research (Table 1). In most countries, research institutions had the main responsibility for multiplying and distributing seed to farmers; for example, in Nigeria, prior to the establishment of the National Seed Service (NSS) in 1972, and the emergence of the Agricultural Development Projects (ADPs) in 1974, the production and distribution of certified seeds were largely handled by individual research institutes which included the Institute for Agricultural Research (IAR), the Nigerian Institute for Oil Palm Research (NIFOR), Cocoa Research Institute of Nigeria (CRIN), National Cereals Research Institute (NCRI), the research units in the Faculties of Agriculture of Nigerian universities and special agricultural programmes such as the National Accelerated Food Production Programme (NAFPP) (Ogunfowora, 1996). Consequent upon this loose and uncoordinated arrangement, the production and distribution of certified seeds and other planting materials were inefficient and cost-ineffective, resulting in inadequate supply and reduction in technical efficiency (Ogunfowora, 1996). The commercial seed sector is therefore weak in nearly all developing countries. In contrast, the seed industry in most economically advanced countries plays the major role in multiplication, distribution, and to an increasing extent, in varietal improvement (Oram *et. al*., 1979).

The countries with relatively strong and well-organized research, seed production, and regulatory systems include (Nigeria, Egypt, Kenya, Mali, Malawi, Senegal, the Sudan, Bangladesh, India, the Philippines, and Sri Lanka (Ora, *et. al*., 1979). Even in these countries, there are weak spots, and few provide the full coverage required for the major cereals (Oram *et. al*., 1979). FAO (1973) noted that in most countries, cereals and annual "industrial" crops are generally the most advanced systems, while those dealing with pulses, roots and tubers other than potatoes, fodder crops, and vegetables trail behind. The FAO (1973) review also noted that the lack of an adequate centralized system for collecting data pertaining to seed production, quality control, and distribution is a major deficiency in most seed programmes.

Most farmers save part of their crop for the following year's seed (Oram *et. al*., 1979). Annual seed renewal is not necessary for self-pollinated crops such as rice, wheat, barely, groundnuts, and some pulses as well as open-pollinated non-hybrid varieties of maize, sorghum, and millet (Oram *et. al*., 1979). However, because of the deficiencies in government and private seed industries, very few countries are producing enough seed, even of staple food crops, to enable farmers to renew their seed once in five years (Oram *et. al*., 1979).

Some studies (Oram *et al*, 1979; Ogungbile *et al* 1999) have shown that when farmers always use seed from their own land, it degenerates progressively from mixture with weeds and other varieties. Further problems arise from inadequate seed supplies; for example, it is impossible to distribute a new and highly promising variety to more than a limited number of farmers (Oram *et. al*., 1979). Similarly, it also is impossible to replace a widely grown variety in an emergency, such as widespread disease (Oram *et. al*., 1979). Supplies of seeds from minor crops usually are even more inadequate and thus cannot be sown as a substitute for a staple that has failed (Oram *et. al*., 1979).

The efforts of government or international agricultural research institutions has been reported to be frustrated by lack of effective seed services to produce and distribute improved genetic material to farmers (Oram *et. al*., 1979). In such cases, it is argued that additional expenditure on research may very well be unrewarding, but that establishing a seed organization should be accorded equal priority with research on varietal development (Oram *et. al*., 1979).

The 1990 seed investment requirements for the study countries shown in Table 2 include only the costs of producing certified seeds of rice, wheat, coarse grains (maize, millet and sorghum), and pulses. The requirements are based on standard seed rate appropriate to each major crop, and the assumption that seed will be renewed every five years (Oram *et. al*., 1979). In making these calculations, it was assumed that all irrigated land will be planted to seed of high-yielding or improved varieties at a 20 percent renewal rate per year (Oram *et. al*., 1979). In the case of rainfed land, it was assumed that modern varieties will be used on about a quarter of the total area by 1990 ---- again with a renewal rate in terms of purchased certified seed of once in every five years (Oram *et. al*., 1979). The area assumption for modern varieties was based on trial estimates in a number of countries of the proportion of the total cropped area that would be needed to achieve a relatively high yield under intensive cultivation if the rest of the rainfed area remained under traditional systems (Oram *et. al*., 1979). In most cases, the intensive area required worked out to between 20 and 30 percent of the total (Oram *et. al*., 1979).

The incremental capital cost of $310 million (N39.990 billion) for certified seed (Table 2) does not cover requirements for a number of annual "industrial" crops such as oilseeds (including soya and groundnuts), tobacco, cotton, roots, sugarcane, tubers, or vegetables (Oram *et. al*., 1979). Based on IWP computations, prorated for the study countries, additional $150 million (N19.350 billion) would have to be added to cover the costs of commodities listed above which contribute directly or indirectly to food supplies (Oram *et. al*., 1979).

Table 1. Seed Organization status in 30 low-income countries

Country	Varietal improvement	R	W	M	M/S	P	G	Seed production and Distribution	Quality Control	Legislation	Promotion
		Main crops									
Asia			20	x				Department of Research and Extension	In early stages	None	Govt. with farmers at 10 percent premium
Afghanistan	Yes: wheat, barley, maize										
Bangladesh	Yes: accelerated breeding program	10	25					Research Services/Agricultural Development Cooperation State farms/farmers	Mainly seed testing	Limited	Agricultural Development Corporation
Burma	Yes: improved varieties available	x	X	x	x	x	x	Rice, best: wheat, pulses, groundnuts	Limited quality control	None	n.a.
India	Yes: advanced Federal and state services	5	10	10	10	x	x	Indian Agricultural Research Institute with National Seeds Corporation, State govts.	Yes: Through NSC and States	Seeds Act	NSC, States, Commerce
Indonesia	Yes: CRI Bogor and institutions	x	X	x	x	x	x	Central Research Institute with extension seed farms and villages	Poor processing and no certification	Under study	Govts. Private seed farms
Nepal	Yes: breeding, rice, wheat, maize	x	X	x	x			Research service with Agriculture Supply corporation	Inspection and certification	None	Price controlled for rice. Rice and maize controlled by ASC.
Pakistan	Yes: improved varieties	x	X	x	x	x	x	Govt. farms/Agric. Dev. Corp. co-ops and commission agents	Inspection and certification	None	Certified seed subsidized govt.
Philippines	Yes: advanced on rice and maize	x		x	x	x	x	Bureau of Plant industry	Yes, BPI, rice, maize, legumes	None	Certified seed subsidized govt.
Sri Lanka	Yes: especially rice, vegetables	70		x	x	25	25	Govt. farms and co-ops.	Seed testing	None	Certified seed subsidized, price fixed.
Latin America											
Bolivia	Yes: limited, no "official" varieties	x	x				x	Govt. for wheat, rice, potatoes; private for maize	Limited by staff	None	Ministry of Agriculture and Commerce
Haiti	Yes: introduction and testing	x		x				Research Services: no systematic production	Very little, limited by staff	Imports	Agricultural Research Institute
Africa											
Benin	Some			x	x		x	Well-organized for cotton, otherwise poor	No local standards	None	Government arrangements
Burundi	Yes: also purity and germination, limited	80	60	10	20	30	70	Govt. and commercial; processing poor	No local standards	None	Fixed prices
Cameroon	Yes: introduction and testing	x		x	x	x	x	Govt., research institute, commercial, mainly industrial	No local standards	None	Commercial. Limited for food
Chad	Yes	x			x		x	Various govt. and semi-autonomous bodies	No local standards	None	Fixed prices cotton/groundnut. Limited for food.

		Main crops									
Country	Varietal improvement	R	W	M	M/S	P	G	Seed production and Distribution	Quality Control	Legislation	Promotion
Egypt	Yes: strongly organized, including hybrids	33	100	50	20	25	100	Govt. seed farms/private crops	International standards	Yes	Production subsidized
Ethiopia	Yes: intensified but regional program weak		x	x	x	x		Research, institutes, and some govt. farms	Poor, no national plan	Imports only	Limited, improvement urgent
Kenya	Yes: introduction and breeding		x	x		x		Well-organized for maize, wheat, fodders	Good, esp. maize	Yes	Kenya Farmers Association (good)
Madagascar	Yes	x		x			x	Research, institutes, only rice significant	Field inspection only	None	Research institutes
Malawi	Yes: introduction and breeding	x		x		x	x	Research, institutes and extension service	Extension service	Limited	Mainly govt., one small farm
Mali	Yes: introduction and breeding	x	x		x		x	Govt., effective for rice, groundnuts	Basic seed only	None	Govt. subsidies
Mauritania	Some: introduction	x			x	x		Mainly unorganized commercial exchange	Seed testing only	None	Minimal
Niger	Yes: introduction and breeding	x		x	x		x	Research, institutes, and farmer crops	Some testing and certification	Limited	Prices subsidized or controlled
Nigeria	Yes: introduction and breeding, Federal/State	x		x	x	x	x	Research, institutes, and state farms	Varies with state	No national scheme	Very little commercial seed production
Senegal	Yes: introduction and breeding	20			15	8	70	Research, institute, and national or private seed farms	Certification standards introduced	Limited	Mainly govt.
Sierra Leone	n.a.	x		x		x	x	Moderate level	n.a.	n.a.	n.a.
Sudan	Yes: introduction and breeding	x	20		x		x	Mainly wheat and cotton, being extended	Wheat/cotton mainly	None	Govt. subsidy
Togo	Some testing							Not officially organized	Initiated	None	None
Uganda	Yes: breeding	x			x		x	Only good for cotton	Initiated	Under study	New scheme initiated
Upper Volta	Limited	x			x		x	Very rudimentary	Limited to cotton	Cotton	Government

Source: Food and Agricultural Organization of the United Nations, *Seed Review 1971-72* (Rome: FAO, 1973).
*R = Rice, W – Wheat, M/S = Millet/Sorghum, P = Pulses, G = Groundnuts, Figures shows percent area under certified seed where data available.

Table 2: Additional investment requirements for certified foodgrain seed in 36 low-income countries, 1990

Country	1990 HYV area[a]	Total HYV Area Seed Requirements[b]	Certified Seed Requirements[c]	Percent of Area Sown with HYV 1976[d]	Incremental Requirements for Certified Seeds[e]	Incremental Capital Costs of Producing Certified Seeds[f]
	(million hectares)	(thousand metric tons)		(percent)	(thousand metric tons)	($1,000)
Asia						
Bangladesh	6.06	151.50	30.30	24	23.03	10,363
Burma	3.27	65.40	13.08	10	11.77	5,296
India	76.17	3,275.31	655.06	37	113.06	185,877
Indonesia	11.57	208.26	41.65	30	29.16	13,122
Nepal	1.24	35.96	7.20	38	4.46	2,007
Pakistan	10.17	620.37	124.07	50	62.03	27,913
Philippines	3.90	62.40	12.48	62	4.74	2,133
Sri Lanka	1.06	21.20	4.24	32	2.88	1,296
Total	113.44	4,440.40	888.08	39	541.73	248,007
North Africa/ Middle East						
Afghanistan	2.06	185.40	37.08	37	23.37	10,516
Egypt	2.72	244.00	48.80	6	45.90	20,655
Sudan	3.25	48.75	9.75	5	9.27	4,172
Total	8.03	475.15	95.63	15	78.54	35,343
Africa						
Chad	0.43	3.22	0.64	…	0.64	280
Gambia	0.06	1.00	0.20	…	0.20	90
Mali	0.74	8.51	1.70	…	1.70	765
Mauritania	0.10	1.30	0.26	…	0.26	117
Niger	1.07	11.50	2.30	…	2.30	1,035
Senegal	0.71	8.95	1.79	…	1.75	787
Upper Volta	0.91	8.95	1.79	…	1.79	806
Sahel Total	4.02	43.43	8.69	…	8.64	3,880
Benin	0.26	2.70	0.54	…	0.54	243
Cameroon	0.59	6.01	1.20	…	1.15	518
Guinea	0.50	6.00	1.20	…	1.20	540
Nigeria	7.83	79.00	15.80	…	15.75	7,088
Sierra Leone	0.19	2.07	0.41	…	0.41	185
Togo	0.19	2.00	0.40	…	0.40	180
Guinea Total	9.56	97.78	19.55	…	19.45	8,754
West Africa	13.58	141.21	28.24	…	28.08	12,634
Total	0.23	2.35	0.47	…	0.47	211
Burundi	2.27	82.63	16.52	6	15.60	7,020
Ethiopia	0.76	7.75	1.55	3	1.50	615
Kenya	1.32	22.88	4.58	…	4.58	2,061
Madagascar	0.49	4.98	1.00	…	1.00	450
Malawi	0.26	2.70	0.54	…	0.54	243
Rwanda	0.14	1.40	0.28	…	0.28	126
Somalia	1.44	14.83	2.97	…	2.94	1,323
Tanzania	0.98	9.95	1.98	…	1.98	891
Uganda	1.26	16.38	3.28	…	3.28	1,476
Zaire	9.15	165.85	33.17	3	31.70	14,265
East Africa						
Total	0.31	3.63	0.73	…	0.73	329
Latin America	0.23	2.65	0.53	…	0.53	239
Bolivia	0.54	6.28	1.26	…	1.26	568
Haiti	144.74	5,231.89	1,046.38	…	680.43	310,817
Total						
36 Country Total						

Notes:

a Assuming that all irrigated land and 25 percent of rainfed area will be sown with high-yielding varieties (HYV) of cereals and pulses by 1990. Based on area indicated for 1990.

b. Based on seedrates of 90 kilograms of seed per hectare of wheat, barley, and pulses; 20 kilograms of seed per hectare of rice; and 10 kilograms of seed per hectare of course grains.

c. Twenty percent of total requirements, that is, seed renewed every fifth year.

d. Estimate of area under HYV in 1976 taken from Dana G. Dalrymple, *development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations,* Foreign Agricultural Economics Report No. 95 (Washington, D.C.: U.S. Department of Agriculture, 1978).

e. Requirement for additional area to be sown with HYV by 1990.

f. Assuming a capital cost of $450 to generate a flow of one additional ton of seed. Total cost for a certified seed requirement of 1.04 million tons would be $470.9 million; incremental cost for 680,430 tons would be $310.8 million.

Source: Oram *et. al*., 1979

The Importance of Chemical Fertilizer

Chemical fertilizer is required for both food security and resource conservation. The contribution of chemical fertilizer to increased crop production and the reversal of the downward spiral of population pressure and environmental degradation include the following:

(i) It provides much-needed nutrients to the soil, thereby increasing crop yields and food production;

(ii) More crops mean more biomass to be ploughed back to maintain the supply of organic matter and vegetative cover, thus enhancing moisture retention, nutrient use efficiency, and soil productivity,

(iii) It enables adoption of high-yielding varieties (HYVs), which can increase cereal yields severalfold;

(iv) By increasing crop production through fertilizer use in high-potential areas (those with better soils and favourable agro- ecological conditions), pressure to clear habitat-rich forests for crop production can be reduced;

(v) A one-time, heavy application of phosphate rock and lime, followed by annual maintenance applications of fertilizer, can enhance and sustain the productivity of acid soil, which has considerable potential for food production in many countries;

(vi) It plays an important role in enhancing biological nitrogen fixation. Legumes, through symbiosis with bacteria, can fix nitrogen with their root nodules. However, their N-fixation capacity is greatly influenced by the availability of phosphorus (P) and potassium (K) in the soil and by soil pH (its acidity or alkalinity). Phosphorus is one of the major chemical elements in all living cells and plays an extremely important role in a plant's energy reactions (Khasawaneh et al. 1980). Potassium, on the other hand, influences many of the cellular and basic processes such as photosynthesis, protein synthesis, and carbohydrate transport in crops (Munson and Runge, 1990). Because many soils in the tropics are deficient in P and are acidic, legumes cannot fix the large amounts of N they need to produce higher yields. By increasing the supply of P through fertilizer application, the N-fixation capacity of these crops can be increased; and

(vii) It makes an important contribution to inter-generational equity by preserving and sustaining the natural resource capital in the soils (IBSRAM, 1987; Brady, 1993; Bumb and Baanante, 1996).

Fertilizer use is said to have increased in both the developed and the developing countries, although at a much higher rate in the latter (Bumb and Baanante, 1996). For example, fertilizer use in Africa increased from 0.5 million metric tonnes in 1959/60 to 3.5 million metric tonnes in 1994/95 (FAO, 1994; FAO, 1996). In the West African sub-region, for instance,similar growths in fertilizer consumption were observed for countries such as Nigeria, Burkina Faso, and Senegal, but reductions were observed for others such as Ghana, and Niger between 1984/85 and 1993/94; for example, fertilizer consumption increased from 277,000 tonnes in 1984/85 to 505,920 tonnes in 1993/94 for Nigeria, while it reduced from 8100 tonnes to 6,000 tonnes between 1984/85 and 1993/94 for Ghana (Table 3). The growth in fertilizer use in West African countries has been attributed to:

(a) intensification of agriculture as fallow periods reduced and policies for increased food production are implemented; and (b) increases in cultivated areas in some of the countries growing cash and industrial crops on which most of the fertilizers are used. (Ofori, 1999).

In general, much of the progress achieved during recent decades in increasing the productivity of food crops in small-farm agriculture is said to have resulted from wide application of the high-payoff input model of technical change (Byerlee and Heisey, 1992). This specific model of technical change is said to have largely consisted of the combination of improved, input-responsive varieties and increasing levels of chemical fertilizers, which serve as a substitute for increasingly scarce land, presumably in the face of rapid population growth (Hayami and Ruttan, 1985).

METHODOLOGY

Description of the study area

Two separate studies were conducted in northern Nigeria at two different time periods. The first was in 1996/97 and covered Kano, Jigawa and Katsina States, while the second was in 2002/2003 and covered Kano and Katsina States. These States have a high agricultural production potential and are considered representative in terms of biophysical characteristics and population density for the larger part of northern Nigeria (NARP, 1995; Ogungbile *et. al*., 1979). The three States have part or all of their territories located in the Sudan Savanna zone in Nigeria, which extends between latitude $9^{o}30'$ and $12^{o}31'$N and longitudes 4^{o} to $14^{o}30'$E ---- being roughly 2700000km^2 (Ogungbile *et. al*., 1999). There exist distinct dry and wet seasons in the three States, with peak rainfall in August. Annual rainfall ranges between 600 and 1000mm, with virtually all the rains received within 4 – 5 months (Ogungbile *et. al*., 1999). The length of the growing period is about 100 – 150 days and temperatures are relatively stable during the growing season at 20 – 25^{o}C (Ogungbile *et. al*., 1999). Most of the soils are ferruginous tropical soils, developed on sandy parent material and crystalline acid rocks (Abalu *et. al*., 1979). In general, the soils are of low clay and organic matter content, hence have very low cation exchange capacity and are poorly buffered (Abalu *et. al*., 1979). Farmers generally differentiate between upland soils and those located in valley bottoms (or *fadama*), but by far the highest fraction used is the upland soils generally used for rainfed crops (Ogungbile *et. al*., 1979). The cropping systems in the States are cereal-based, dominated by sorghum, maize and millet. The legume crops of importance are cowpea and groundnuts. Farmers also often take advantage of "fadama" to invest in dry season production of vegetables, mostly tomatoes, onion and pepper. Livestock production is an integral part of the farming system, as there is hardly any rural household without one form of animal or the other (Ogungbile *et. al*., 1999). Animals are owned and managed by mixed farmers and agropastoralists. Both crops and livestock are sources of employment, food and income for farmers. Crop residues and byproducts are used as livestock feed and the animals, in turn, provide draught power used for farm operations. (Ogungbile, *et. al*., 1999).

Sampling Procedure

In the first survey in 1996/97, three Local Government Areas (LGAs) were selected in each of the three States of Kano, Jigawa and Katsina on the basis of rainfall distribution, soil fertility and types of production systems (Table 4). Subsequently, in each LGA, one village was selected along a North-South gradient in each State on the basis of five criteria, namely: annual rainfall in the last 5 years; major production systems for the northern and southern Sudan Savanna Zone; ethnic groups; village geographical position within each State; and village accessibility (Table 4). Lastly, 144 households were randomly selected in the three States. In the second survey in 2002/2003, two Agricultural Development Programme (ADP) Zones, one located in the northern-most and driest parts of a State and the other in the southern-most and wettest parts were selected (Table 5). Lastly, 60 farmers were randomly selected in each of the two ADP Zones in each State (Table 5).

Data Collection and Analysis

Data were collected in the two surveys using questionnaires. Semi-structured interviews with farmers, groups and key informants were also held. The surveys consisted of several visits to the respondents mainly to obtain information on their general family background and farming activities. The timing of the visits, to a large extent, was such that crops were still on the field so that crop identification could take place and farmers could easily recall their agricultural activities. The data collected were analyzed using descriptive statistics.

Table 3. Fertilizer consumption in five West African countries (tons of nutrients)

		YEARS						
Country	Nutrients (N, P_2O_5, K_2O)	1984/85	1985/86	1986/87	1990/91	1991/92	1992/93	1993/94
Burkina Faso	N	4219	4736	6780	9214	9000	9300	9000
	P_2O_5	4175	4460	5950	7545	6800	8000	8000
	K_2O	3062	2940	3610	4407	4047	4030	4000
Total		**11456**	**12136**	**16340**	**21166**	**19847**	**21330**	**21000**
Ghana	N	5000	5000	4100	8000	7000	7000	3000
	P_2O_5	1400	4300	2000	3000	200	2000	2000
	K_2O	2000	3200	1500	2000	800	1100	1000
Total		**8100**	**12500**	**7600**	**13000**	**17000**	**10100**	**600**
Nigeria	N	131000	135000	140000	209960	212000	270000	220000
	P_2O_5	96000	105000	92000	96140	110550	95800	155920
	K_2O	50000	52000	30000	94240	106550	129800	130000
Total		**277000**	**292000**	**262000**	**400,340**	**429,100**	**495,600**	**505,920**
Niger	N	1500	2136	1228	1396	198	900	1000
	P_2O_5	736	1097	493	700	249	400	400
	K_2O	100	338	264	203	83	100	100
Total		**2338**	**3571**	**1985**	**2299**	**530**	**9500**	**1500**
Senegal	N	8000	7000	7500	5950	8599	9000	14000
	P_2O_5	5700	1500	7500	2650	5109	6000	6000
	K_2O	5000	6000	6000	3404	1744	2000	5000
Total		**18300**	**20500**	**21000**	**12004**	**15452**	**17000**	**25000**

Source: Ofori, 1999.

Table 4: Location and biophysical details of selected Local Government Areas (LGAs) and villages in Kano, Jigawa, and Katsina States of Nigeria.

				Coordinates	
State	Selected LGA	Village name	Agro-ecological zone	Latitude	Longitude
Kano	Bebeji	Kofa	Southern Sudan	11^{o}34’	8^{o}17’
			Southern Sudan		
	Alabazu	Panda		11^{o}31’	8^{o}04’
			Northern Sudan		
	Bichi	Badume		12^{o}12’	8^{o}19’
	Birni Kudu	Kantoga	Southern Sudan	11^{o}30’	9^{o}23’
Jigawa					
			Northern Sudan		
	Kaugama	Dalari		12^{o}36’	9^{o}48’
			Northern Sudan		
	Gumel	Gijigami		12^{o}34’	9^{o}25’
Katsina	Malumfashi	Gora	Southern Sudan	11^{o}55’	7^{o}43’
			Northern Sudan		
	Kankia	Rimaye		12^{o}19’	7^{o}54’
			Northern Sudan		
	Batagarawa	Barhim		12^{o}58’	7^{o}41’

Source: Field Survey, 1996/97

Table 5. Distribution of farmers in Kano and Katsina States of Nigeria.

State	ADP Zone	Relative Climate	Headquarters of ADP	Total No. of Farmers in ADP	No. of Farmers selected
Kano	I	Wet	Rano	34394	60
	II	Dry	Danbatta	35032	60
Katsina	I	Dry	Ajiwa	34543	60
	II	Wet	Funtua	34440	60

Source: Field Survey, 2002/03

RESULTS AND DISCUSSION

Varieties of seeds grown:

The varieties of seeds grown by farmers in the selected States at the two different surveys periods, 1996/97 and 2002/2003, were mostly local cultivars, the breeds of which were, to a large extent, saved from the previous years' crops, though purchases of seeds from local markets to supplement those saved also occurred. The range of local cultivars of each crop was rather large and often difficult to distinguish. For example, the same local crop cultivar was called by different names, depending on the locality. Crops with preponderance of local names included sorghum (*Farafara, Mori, Dan Ilela, Kaura, Dan-Hamza*), millet (*Zango, Baragadi, Dan-Degali, Dan-Dusai*) and cowpea (*Kananado, Dan-Illan* and *Dan-Mahi*). Some of the cultivars with local names are said to have likely been adaptations of some of the improved varieties over the years through ADP extension services (Ogungbile *et. al*., 1995).

Unimproved varieties of crops are characterized by their adaptation to local conditions (Abalu *et. al*., 1979). Farmers preferred the traditional sorghum cultivars in any year with favourable weather, because they believed that they are higher yielding than the improved varieties if the rainy season lasts long enough for the cultivars to mature.

The traditional varieties, in general, matured late and exposed farmers to risks when the growing season was short. The increasingly erratic rainfall pattern in the study area meant a shift to such early-maturing sorghum varieties as *yar-gumel* and *yar-washa*, Ex-Bornu millet and improved varieties of groundnut. *Kananado* cowpea variety was widely grown, not only because it gives reasonable yields without any chemical control, but also because it produces good fodder for livestock feed. According to Ogungbile *et. al*., (1999), in the dry areas of the Sudan Savanna Zone, the need for good quality livestock fodder during the dry season overrides the alternative for high cowpea yield without fodder. The local and improved varieties of crops grown in the different ADP zones of the sampled States are as shown in Tables 6, 7 and 8.

Table 6. Major crop varieties in different zones of Kano State, Nigeria.

Crop	Zone I	Zone II	Zone III
Sorghum	Farafara	Zango (nearly extinct)	Farafara
	Kaura	Farafara	Kaura
	Mori	Kaura	Yala
	Yarwasha[1]	YarTsanyawa[1]	
	Gaya early[1]	Yar Gexawa (Buha Maza)	
	Samsorg 15[1]		
Millet	Ex-Bornu[1]	Zango	Zango
		WuyanBijimi	Lawur[1]
		Dan Akranja	
Groundnut	RRB[1]	RRB[1]	Kwalci
	RMP12	Ex-Dakar[1]	Yar Ghana[1]
Cowpea	Kanado[1]	Kananado	Kananado
	Danwuri		Kembas
	Dan Illa		
	ITA60[1]		

1. Improved variety

Source: Field Survey, 1996/97; 2002/03

Table 7. Major crop varieties in different zones of Jigawa State, Nigeria.

Crop	Zone I	Zone II	Zone III
Sorghum	Baka daniya	Garbi	Garbin
	Farafara	Guguza	Babba diya
	Jankaura	Yar daudu[1]	Kaura
		Yar Dumel[1]	Yar Labba[1]
		Yar washa[1]	Yar washa[1]
		Kaura	Makaho wayo
Millet	Zango		
	Lawur		
	Ex-Bornu[1]		
Groundnut	Ayaya	Ex-Dakar[1]	Gana
	Yar kabara[1]		
Cowpea	Kananado	Kananado	Kananado
	Tokarabaka		Jampus
	Dan Illa		Aluko
	ITA60[1]		

1. Improved variety

Source: Field Survey, 1996/97; 2002/03

Table 8. Major crop varieties in different zones of Katsina State, Nigeria.

Crop	Zone I	Zone II	Zone III
Sorghum	Farafara Kaura Jar Dawa	Kaura Farafara Mori Bagaji Rubus Samsorg 14[1]	Farafara Jan Dawa (Yar Barhim) Yar Ruruka (Samsorg 14)[1]
Millet	Zango Ex-Bornu[1] Ex-Bornu[1]	Not significant	
Groundnut	Yar Tsugune Kalle (RM012) Ex-Dakar[1] J5[1]	Kalle (RMP12[1]) Ex-Dakar[1]	Yar Tsugume Ex-Dakar[1] RMP12[1] Jar Jigila
Cowpea	Kananado Dan Illa Dan Arbain ITA60[1]	Kananado Dan Illa TVX[1]	Dan Illa Kananado

1. Improved variety

Source: Field Survey, 1996/97; 2002/03

Chemical Fertilizer Use:

Average chemical fertilizer nutrient use per hectare for the two different agricultural seasons (Table 9) shows that though average application rates were noticeably higher in 1996/97, the rates of application in both 1996/97 and 2002/03 fell short of the recommended rates per hectare for most staples shown in Table 10. The observed low fertilizer use intensity agrees somewhat with the findings of the FAO (1997), Bumb and Baanante (1996) and Oram *et. al* (1979) to the effect that fertilizer use in Africa is generally sparse, averaging between 10 – 18 kg per ha of cropland which is far below the long-term economic optimum. Barbier (1999) and the FAO (1997) attribute the poor productivity of African agriculture to be a reflection of the comparatively low level of use of external inputs and that, whereas average fertilizer usage is much higher in other developing regions of the world, and has increased since the early 1980s, the rate of application on Africa's cropland has hardly changed (Table 11). Reardon *et. al*., (1999) similarly point to the low use of fertilizer across Africa as a major cause of concern, from both the food-production and the environmental perspectives and that the widespread "capital-deficient" unsustainable intensification in Africa is a major force behind farmland degradation and productivity loss. Some of the factors reported in literature as constraining growth in per hectare fertilizer use in most developing countries include the following: foreign exchange shortages (as most countries are dependent on imports); budget restrictions on account of competing demands on available resources; high fertilizer prices; inadequate institutional and physical infrastructure; the removal of subsidies; low farm incomes; inflexible packaging in 50kg bags which constrain purchase by farmers with limited resources; and lack of political commitment to the promotion of growth in fertilizer use, reflected in excessive dependence on fertilizer aid to meet domestic fertilizer requirements (Harrison, 1990; Bumb and Baanante, 1996; Place *et. al*., 2003). Bumb (1989) argues that such excessive dependence on fertilizer aid introduces uncertainty in fertilizer use because most fertilizer aid commitments are short-term and adhoc.

Table 9. Chemical fertilizer quantities used by farmers in Kano, Jigawa and Katsina States of Nigeria.

1996/97		2002/2003	
State Village	Kg/ha	State/ADP	Kg/ha
Kano		**Kano**	
Kofa	68.1	Rano	68.46
Panda	77.3	Danbatta	14.51
Badume	95.0	Mean	41.49
Mean	80.1		
Katsina		**Katsina**	
Gora	70.6	Funtua	51.62
Rimaye	114.0	Ajiwa	82.85
Barhim	58.5	Mean	67.24
Mean	81.03		
Jigawa			
B/Kudu	62.4		
Dalari	63.0		
Gijigami	59.8		
Mean	61.7		

Source: Field Survey, 1996/97; 2002/03.

Table 10. Recommended Chemical fertilizer nutrient application rates.

Crop	Kg/ha
Maize (open-pollinated)	NPK 220 -240
Maize (hybrid)	NPK 300
Guinea corn	NPK (basal) + Urea (topdress) 75 - 100
Millet	NPK (basal) 100 -200
Upland rice	NPK 160
Lowland rice	NPK 240
Groundnut	SSP (broadcast) 300 + MOP (broadcast)50
Cowpea	SSP (broadcast) 100
Soybean	SSP (broadcast) 100 – 120
Sesame	NPK (basal) 220
Cotton (June-sown)	Boronated SP 125+ CAN 125
Cotton (July-sown)	Boronated SP 62.5

Source: Onwueme and Sinha, 1991; JARDA, 1996.

Table 11. Global trends in agricultural productivity and input use, 1979-95.

Geographic region	Gropland (million ha) 1995	Cropland per capita 1995	Cereal yields (kg/ha)		Land use (million ha) Irrigated land as % of cropland		Fertilizer use (kg) per ha of cropland	
			1980	1995	1979-81	1995	1979-81	1995
Africa	193	0.27	1,124	1,128	6	6	18	18
Asia	472	0.14	2,072	3,060	29	35	67	144
Europe	135	0.19	3,655	4,316	10	12	225	156
North and Central America	277	0.61	3,260	3,918	10	11	91	89
Oceania								
	53	1.87	1,089	1,886	4	5	37	46
South America								
USSR (former)	121	0.38	1,710	2,606	7	8	45	54
	226	0.77	NA	1,301	8	9	80	19
World	1,476	0.26	2,160	2,752	15	17	81	89

NA = Not Available

Source: FAO, 1997.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This paper investigated the use of seeds and chemical fertilizers in agriculture in some northern Nigerian States in two different agricultural seasons, 1996/97 and 2002/03.. The evidence presented in the paper point to the predominant local crop varieties and to low levels of use of chemical fertilizers, far short of the recommended rates. The availability of these two biological inputs of the appropriate quality, at the right time, in the right amounts, and at affordable prices, is therefore critical to effective agricultural development in northern Nigeria. The following recommendations become necessary.

(1) Considering the dominance of traditional crop varieties in the agricultural production system in the study areas, fertilizer-responsive improved crop varieties need to be developed locally and adapted to local ecological and economic conditions. Though a certain amount of "stop-gapping" may be necessary by adopting improved varieties from other countries, it is important that the new seed technologies be developed domestically and adapted to local ecological conditions. The beginning of the process should be to test as many crops varieties locally as possible, verify how they fit into local production systems, and then begin breeding programmes around those varieties that are adapted (Schuh, 1993).

(2) An important part of biological research to develop improved crop varieties should involve collaborative linkages between local and international agricultural research institutes and the creation of significant opportunities for international assistance through such organizations such as the FAO, the World Bank, regional banks and bilateral arrangements. The goals of such linkages should be to: (i) introduce as much new crop material and other biological innovations as is possible, relevant and adaptable to local conditions; and (ii) help national research and seed production services attain adequate laboratory standards as well as those for field inspection, processing, and quality control of seed (Schuh, 1993; Oram *et. al*., 1979).

(3) The development of private enterprise in seed production and distribution in partnership with government crop breeding and quality control services should be encouraged as a fruitful division of labour particularly in countries where the public sector is often over-burdened as is the case in Nigeria and skills are at a premium. Studies are said to have demonstrated that, in general, a country cannot get by only with biological researches done only in the private sector or the public sector andthat complete dependence on any one will result in under-investment in biological research (Schuh, 1993).

(4) Given that quantities of chemical fertilizers used per hectare were short of the recommended rates, complementary means of providing plant nutrients should be sought. The adoption of integrated soil fertility management approaches are likely to be very useful, as they acknowledge the need for both chemical and organic inputs to sustain soil health and crop production due to positive interactions and complementarities between them (Buresh *et. al*., 1997; Vanlauwe *et. al*., 2002).

(5) Research on suitable formulas and doses of chemical fertilizers for the climate and soils of the study sites should be accorded some priority. The arguments have been that: modest doses of chemical fertilizers based on such researches can produce useful yield increases at low cost and that appropriate soil and crop management systems reduce the amount and frequency of application of chemical fertilizers while also increasing the efficiency of their utilization by crops (Harrison, 1990; Lal and Okigbo, 1990).

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