OAU / STRC / SAFGRAD / BENIN
INA RESEARCH STATION
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(REP. POP. DU BENIN)

FARMING SYSTEMS RESEARCH PROJECT

ANNUAL REPORT FOR 1985

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* Until 4 February 1986.

** 20% of their time.-

INTRODUCTION.

Farming System Research takes as its starting point, the view that rural farmers when utilising the available resources and operating a diversified production system, face in various degrees some physical, biological and/or socioeconomic constraints.

Given a certain level of resource base, the farmer's most limiting production constraints may be alleviated by infrastructural improvements, reorganisation of the production system ; improving the farmer's technical know how and/or some technological change.

In recent years, the availability of grains namely Sorghum, maize, millet, cowpea and groundnuts plus the inadeguacy of forage shrubs for animal feed and other uses have become more and more problematic in the Semi-arid zone of Africa. Frequent occurences of drought, insuffient moisture due to short and unpredictable rainfall coupled with detetiorating soil resource base have rendered some of the traditional production systems in the zone extremely risky.

OBJECTIVES.

Following the signing of an agreement between the peoples' Republic of Benin and OAU/STRC in March 1985 a SAFGRAD/BENIN FSR Programme development (NDUNGURU and NGAMBEKI, 1985) was initiated with the following main objectives :

1. To strengthen the national farming systems Research Programme so as to develop a method of production to integrate crop and animal production as well as techniques to conserve soil moisture and other resources.

2. To assist the National Farming System in establishing a functional link between research development and farmers.

3. To conduct baseline socioeconomic surveys in selected villages in order.

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a) To obtain basic information on the existing crop and livestock production systems.

b) To identify location-specific physical, biological and socioeconomic constraints to agricultural production.

c) To select sites and participating farmers for purposes of conducting on farm adaptive agronomic trials (researcher and/or farmer managed agronomic trials) in collaboration with Natonal research programme.

d) To design agronomic trials that are directed to addres to the identified constraints and the needs of farmers.

THE DEVELOPMENT OF EXTENSION SERVICE CARDER AND AGRICULTURAL RESEARCH SYSTEM IN BENIN.

Agricultural production plays a very important role in R.P. BENIN as a source of food supply means of livelihood and economic activity for over 60% of population which live in rural areas and more importantly as a foreign exchange earner, making over 77% of total exports as a source of raw materials for agro-industries. In 1977/78 the production levels of major food and cash crop in Benin were (inthousand tonnes) maize 308, sorghum 80, millets 2, rice 22, fonio 537, cassava/700, yam 650, beans 39, groundnuts 6 and cotton 10 (Adam and Boko 1983, MDRAC 1977-78). Cotton earned about 40% of the country's foreign exchange, followed by palm oil, groundnut, maize, coffee and cocoa. The Benin agricultural development is unique in that, the country has a strong agricultural extension system which is decentralized and organised at province level and focuses on cotton which is the principal foreign exchange earner. Between (1962 and 1971), the cotton extension service was managed by two French companies namely the French Company of textile plant development in Borgou Province and the French company (Societe d'Assistance technique et de Conseil) in the central Zou province, the two major cotton producing provinces in the country.

After 1971, the Benin Gorvernment created (Société Nationale pour la Production cotonière) SONACO, to take over from the French Companies and in order to develop and diversify Crop production, an agricultural development organisation "CARDER" was created for the six provinces. The objectives of CARDER were :

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1. To expand the extension service to all agricultural commodities.

2. To promote the creation of farmers' organisation, thus assisting the establishment of farmers cooperatives.

3. To assure provision of inputs to farmers and to organise marketing of farm produce.

On the other hand, the country has a weak research capacity although there are 13 agricultural research establishments in Benin with three Niaouli, Ina and Houeda focussing on food crops, one on cotton and fiber one on soils, one on palm oil, one on livestock one on processing, one on phytosanitary services and for rural economic studies, forestry, coffee and cocoa and coconut one on each. (NDUNGURU and NGAMBEKI, 1985).

APPROACHES OF SAFGRAD FSR/BENIN PROGRAMME DEVELOPMENT

The proposed methodology of the FSR/BENIN is presented in Fig. 1. At the initial stage, reconnaissance trips were made in mid-June 1985, through out the provinces and using a check list to examine the major agroclimatic, soils vegetation, cropping and cultural differences.

Some of the observations made during the reconnaissance trips were :

- most farmers grow cotton in pure stand. Fertilizers are normally applied and insecticides are also used. Few apply herbicides ;
- most food crops are grown in association. The common associations are maize/sorghum, sorghum/groundnuts, maize/groundnuts, sorghum/millet, cassava/maize, sorghum/cowpea.
- literary no high energy inputs inputs such as fertilizers are used by the farmers in growing food crops;
- Rainfall onset pattern and distribution is a major factor in determining the planting time of the crops ;
- Scanty data exixt on the performance of local varieties grown ;

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STAGE	ACTIVITIES	PARTICIPANTS
On-farm Exploratory Baseline Survey	1. Review of existing information. 2. Reconnaissance trips 3. Selection of sites and participating farmers 4. Socio-economic surveys for identification of crop (and livestock) production constr constraints	- Researchers : SAFGRAD and - INA Researchers - SAFGRAD Field Staff - Nationals on secondment - CARDER/Extension - Farmers
On-farm Adaptive Research	1. Review of available technologies 2. Station and researcher-managed trials for generation/screening of suitable technologies 3. Review of generated results 4. Researcher and farmer-managed trials for testing and adaptation of promising cultivars cropping, soil fartility and moisture conservation techniques.	idem
Testing and evaluation of modified systems	1. Designing of agronomic trials to address identified constraints 2. Farm level testing 3. Farmer's testing 4. Monitoring and Evaluation of promising technologies	idem
Technology transfer	1. Training and workshops 2. Links with extension	idem

- There is little available technology on food crops wich could directly be extended from the research station to the farmers;

- A suitable rotation involving cash and food crops may need to be devised for the Kouande district ;

- There is a serious soil degradation problem in Boukoumbe and a suitable method of soil conservation as well as aspects of agroforestry need serious consideration ;

- There seems to exist conflicting responses on the use of ridges and cultivating on the flat in both provinces. Studies along these line also merit attention ;

- Karimama district face a serious drought problem. There seems to exist a potential of introducing suitable varieties as well as water preservation techniques. Agroforestry studies also may prove useful.

In view of what was observed in the reconnaissance trips as welle as taking into consideration the proposed methodology for FSR (Fig.1.) in People's Republic of Benin it was decided to initiate work along three lines simultaneously :

a) Socio-economic studies at the six sites. These covered climate and soils, description of basic production systems, consumption pattern and food preferences, farmers priorities and goals, farmers social environment and the farmers production constraints (physical and socio-economic), causes of crop loss or failu labour constraints and the farmers infrastructural facilities.

b) Researcher managed trials at three sites in Borgou Province and c) trials at Ina Research Station aimed at generating technology for testing later in the farmers' fields.

In the sections that follow the socio-economic studies and their findings are reported first and the agronomic studies are reported later.

SOCIO-ECONOMIC STUDIES

With the help of extension personnel six villages (and Ina) were selected in such way as to represent the major cropping systems and agroclimatic zones.

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Selected villages include Birni-Lafia (Karimama District in Sudan-Sahel ; Bensekou (Kandi) and Koumagou (Boukoumbe) in sudan (Kouande plus Ina village to represent the northern Guinea, which covers the largest part of the region and has high population density. See map.

The criteria used for selecting a village were accesability, representativeness and high potentials for learning and model building for replicability, population density, availability of marketing facilities and existence of farmers' group organisations. Field assistants were then appointed each sent to reside in the village where posted to work. The fact that field assistants live in th village where they work makes the farmers regard them as part of the community, builds up mutual confidence not only with farmers but also with the extension personnel thus facilitating the working relationships as well as improving the quality of information collected.

With the help of extension personnel and village leaders a sample of 10 to 14 farmers from each of the selected villages and 2 to 6 farmers from an adjacent village were randomly selected making a total of 80 farmers for the socio-economic survey. A questionnaire designed (in French) covered farmers social and climatic environments, production systems, consumption patterns, infrastructural facilities, farmers' priorities and goals plus physical and socio-economic constraints to production. Information on these aspe was obtainned from repeated visits to farmers (including visits to their farms) in August through November covering the various agricu tural peak periods during the season. Frequent monitoring tours were made to each village and periodically questionnaire forms were withdrawn from the field to office to check on the accuracy of the information being collected. At the end of November, all questionnaire forms were withdrawn and data compiled and various types of analyses used.

SOCIO-ECONOMIC FINDINGS

Delineation of Agroclimatic Zones

The SAFGRAD/BENIN FSR Project covers two northern provinces, Borgou and Atacora spreding over three agroclimatic Zones.

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The delineation of these Zones, based on vegetation and rainfall, give (a) transitional from sudan to Sahel Savanna (400-600) in extreme north, (b) sudan savanna (600-800mm) in mid belt and (c) the northern Guinea savanna (800mm and above) on the southern part. See table 1. Analysis of rainfall between (1975-1982) as compared with long term average rainfall, indicates that in recent years, annual rainfall has decreased by as much as 400mm in extreme north and by as much as 200-300 mm in the southern part of the two provinces.

In the 1960's these zones had a mean rainfall of 900mm 1,000mm and 1,000-1,200mm respectively (Adam and Boko, 1983). But the rainfall figures between 1975-1982 give a mean rainfall of 412mm for the sudan-sahel, 760mm for sudan savanna and for the northern Guinea savanna 1014. 25mm.

The rainfall distribution in the sahelian savanna starts end of march/beginning of April, but does not stabilize till mid-May. From May, the rainfall increases gradually with a peak of about 108mm in August and drops sharply, cutting off end October/beginning of November.

As for the rainfall distribution in sudan savanna, it tends to begin late in April, with a peak of about 196 mm in August and cuts off quickly by end of October. See Fig. 2. The rainfall distribution in Northern Guinea starts by end of march, stabilizing in May increasing gradually to a peak of about 211mm in August and drops sharply, cutting off beginning of November.

The sudan sahelian zone has now a vegetation of grass savana with accacia trees, clay-sandy and clay soils. The sudan savanna has a vegetation of woody grass land savanna with oamy, sandy,soils. While northern Guinea zone has a vegetation of woody grass land moving into forest savanna with loamy-sandy soil.

DEMOGRAPHIC CHARACTERISTICS OF FARMERS

Borgou Province has area of 51.000 Km^2 (54% R.P. Benin) with population of 530.000 inhabitants (1985) giving a population density of 10.4 persons per km^2 Atacora Province has area of 31.200km with a population of 481.509 (1979) inhabitants giving a population density of 15.4 persons per km^2. (Fig 3)

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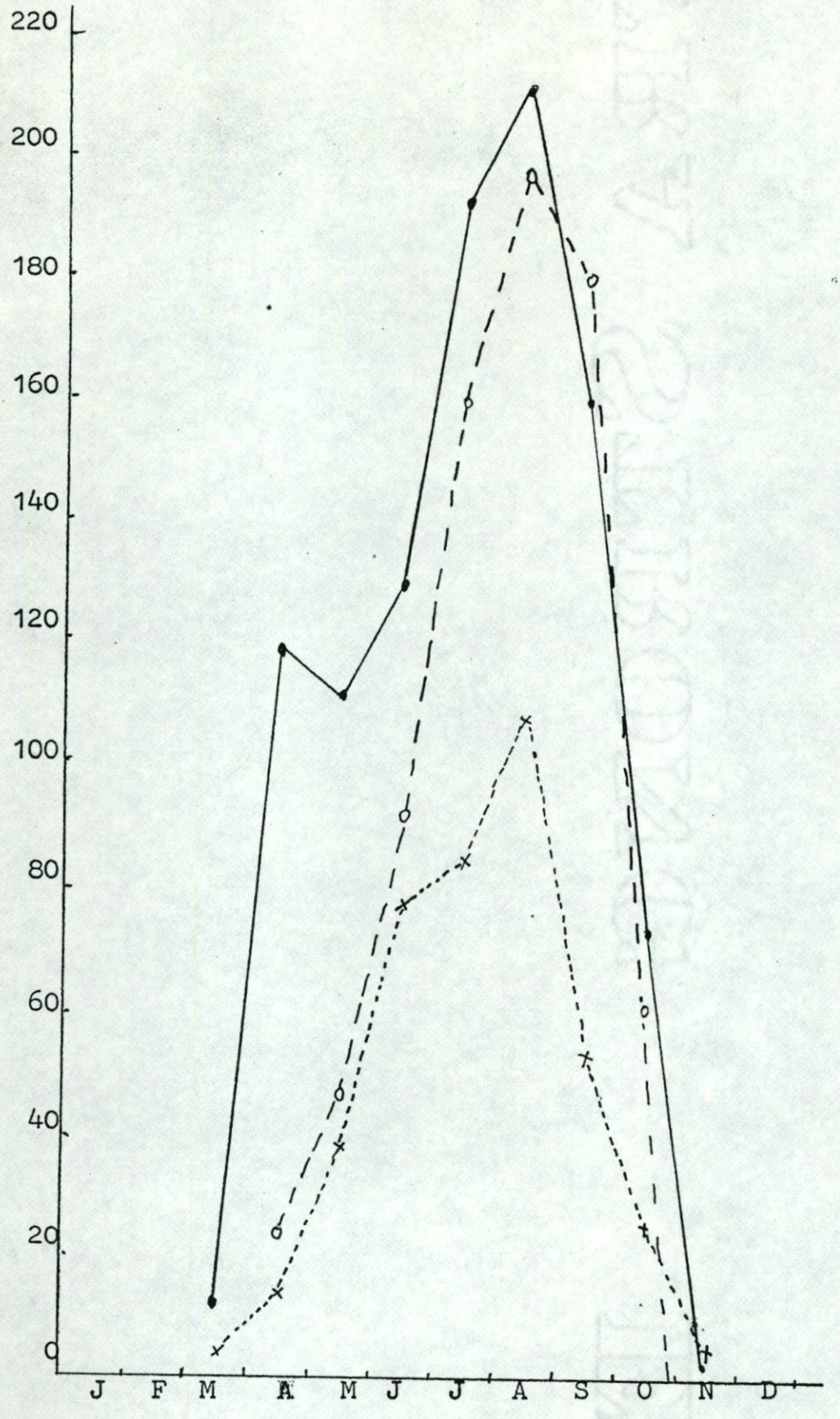

Fig. 2 Mean Annual Rainfall between 1975-1982
Sahelian savanna
Sudan savanna
Northern guinea savanna

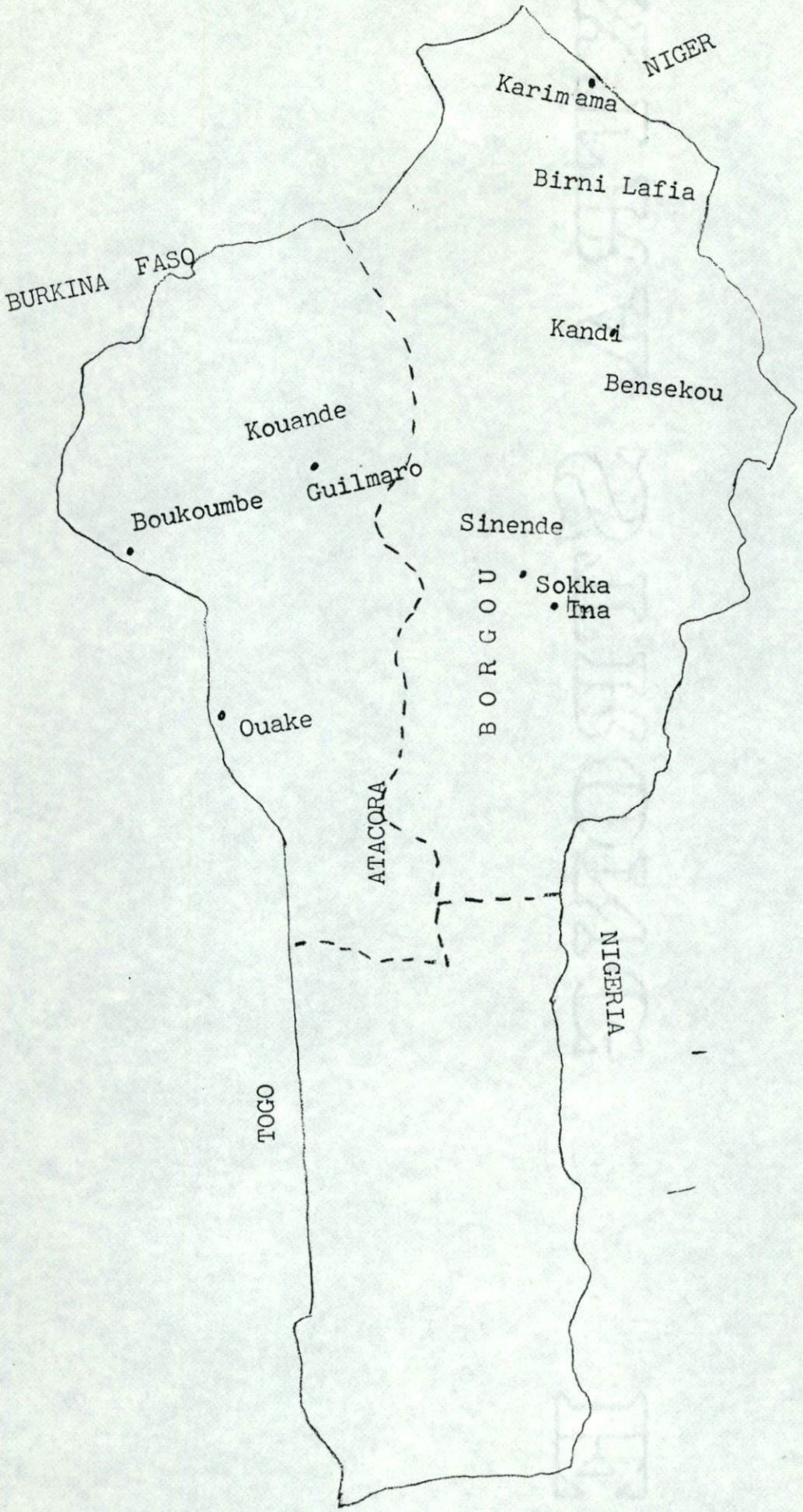

Fig 3 Map of R.P. Benin showing the two Northern Province and selected villages.

TABLE 1. AGROCLIMATIC CHARACTERISTICS OF THE STUDY AREA

Agroclimatic Zone	Vegetation	Soils	Mean Rainfall (1975- 1982) mm												
			Jan	Feb	March	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec	TOTAL mm
Sudan to Sahel Savanna. (400-600)mm	grass Savanna + accacia trees	clay sandy sandy clay			3.1	14.71	38.21	76.97	85.3	108.8	54.8	25.15	5.4		412.44
Sudan Savanna. (600-800)mm	Grass land Savanna	loamy sandy soil				24	47.3	91.2	160.7	196	180	61.3			760.5
Northern Guinea Savanna (800 +mm)	woody glassland savanna	loamy sandy soil			13.0	118.0	111.8	130.3	193	211.3	160.5	74.2	2.15		1014.25

Table 2. Shows demographic characteristics of the farmers in the different agroclimatic zones of the provinces. Active farmers in Borgou and Atacora provinces are relatively young with an average age of 43.2 years old and ages ranging from 16 to 72 years old. 9% of these farmers are between 16 and 32 years old, 41% with ages between 32 and 40.40 cent with ages between 40 and 56, while 10% have ages between 56 and 72 years old. However, farmers in sahelian zone have an average age of 37.7 years, those in sudan savanna zone 44 years old and those in northern Guinea savanna 44.4 years old.

Farm family sizes range from 2 to 19 with an average of 10 persons, of whom 51.3% are children between 0 and 15 years old. The farm families in sahelian zone have an average of 7 persons whom over 60 % are children.

Those in sudan savanna have an average family size of 10 persons, of whom 50% are children whereas family sizes in northern guinea savanna have an average of 0 persons of whom 40% are children.

The availability of family is on average 2.69 man-units per farm family in sahelian zone, 5.12 man-units per family in sudan savanna and 5. 23 man-units per family in the northern Guinea. Thus giving an average of 4.94 man-units per farm family in the whole region. Again on the regional basis 52.0 % are males whereas 47.2% are females. The age distribution of persons in each family is such that 19.9% have 0 to 5,19.5 age 6 to 10,11.9% ages 11 to 15,28.4 % AGES 16 to 30 and 20.3 % ages 31 to 72 years old.

EXISTING FARMING SYSTEMS

The farmers' existing system is characterized by (a) shifting cultivation where farmers leaves exausted land to lie fallow for 3 to 4 years and use fallowed land or shift all together to newly cleared sites ; (b) a diversified cropping system greatly dominated by crop associations and a significant component of livestock.

In order, therefore, to get a better understanding of the farmers' existing production systems, this study examines various aspects of the production systems in each agroclimatic zone.

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TABLE 2. DEMOGRAPHIC CHARACTERISTICS OF SELECTED FARMERS

ZONE	AVERAGE					AVERAGE NUMBER OF PERSONS BY AGE GROUPS					
	Farmer's age	Family size	Units available for farm labour man-days	N° of males	N° of Females	0-5	6 -10	11-15	16- 30	31 -46	46-60
Sudan-Sahel	37.7	7	2.69	3	4	2	2	1	1	1	+
Sudan-Savanna	44	10	5.12	5	5	2	2	1	3	1	1
Northern Guinea Savanna.	44.4	10	5.23	6	4	2	1	2	3	1	1
Grand average	43.2	10	4.94	5	5	2	2	1	3	1	1
Percentage of Total	.....	.....	.....	52.8	47.2	19.9	19.5	11.9	28.4	12.6	6.8

CROPPING PATTERNS

At the regional level, the cropping system is dominated by cotton, maize/sorghum, groundnuts, cassava, yams millets, yam/beans, sorghum/beans and yam/millet beans.

The most important crop enterprises in the sahelian zone are millets and cotton each being grown by 76 % of the farmers, sorghum and groundnuts where each is grown by 69 % of the farmers, then follows maize and cassava, each 23% and maize/sorghum 8 %. Others are beans, sorghum/beans, millet/beans, millet/sorghum and maize/sorghum cowpeas each grown by 7% of the farmers. See table 3.

As for the sudan savanna, cotton is the most dominant crop of the farmers, followed by cassava, groundnuts, millets, maize/sorghum and beans grown by respectively 85, 64, 57, 35 per cent of the farmers.

In Northern Guinea, Savanna, maize/sorghum is the most popular crop entreprise being grown by 75 % of the farmers. Other important crop entreprises in this zone are cotton grown by 49 % yams 44 % sorghum 40 % groundnuts 35 %, cassava 33 % and cowpeas 31 % of the farmers. Millets, yam/beans and beans are grown by 22,18 and 15 per cent of the farmers. Sorghum/beans and yam/millet beans are particularly grown by farmers in Atacora Province.

LAND UTILISATION

The average farm size in the region is 7.45 ha per farm family, with 6.5 ha under crop and 0.9 ha under fallow. Table 4 shows portion and percentage of the farm size planted to different crop entreprises in each agroclimatic zone.

In the sahelian zone, an average farm family plants 1.36 h (22 % the farm size) to sorghum, 1.06 ha (17 %of farm size) to mille 0.71 (12 % of farm size to cotton and 0.5 (8 % of farm size to groundnuts.

The family also plants about 13 % of the land to other crop entreprises, leaving 1.76 ha (28 % of the farm size) under fallow.

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TABLE 3 : PER CENTAGE OF FARMERS WITHIN EACH ZONE GROWING VARIOUS CROP ENTERPRISES.

CROP ENTERPRISE	SAHELIAN SAVANNA	SUDAN SAVANNA	NORTHERN GUINEA SAVANNA
Cotton	76	100	49
Maize/Sorghum	8	35	75
Groundnuts	69	64	35
Cassava	23	85	33
Millets	76	57	22
Sorghum	69		40
Yams			44
Cowpeas		21	31
Beans	7	35	15
Maize/Yam/Beans			9
Yam/Beans			18
Sorghum/Beans	7		13
Yam/Millet/Beans			13
Maize	23		11
Rice	7		2
Maize/Sorghum/Cowpeas	7		
Millet/Beans	7		
Millet/Sorghum	7		

TABLE 4 : LAND AREA (IN HECTARES) USED PER FARM FAMILY
(FIGURES IN PARETHENSES SHOWS PER CENTAGE OF FARM SIZE UNDER DIFFERENT CROP ENTERPRISES)

CROP ENTERPRISE	SUDAN SAHEL	SUDAN SAVANNA	NORTHERN GUINEA SAVANNA	REGIONAL AVERAGE
Cotton	0.71 (12 %)	3.84 (49 %)	1.58 (16 %)	1.69 (22 %)
Maize	0.19 (3 %)	0.14 (2 %)	0.4 (4 %)	0.4 (4 %)
Sorghum	1.36 (22 %)		0.37 (3.8 %)	0.43 (6 %)
Millets	1.06 (17 %)	0.07	0.12 (1 %)	0.31 (4 %)
Groundnuts	0.5 (8 %)	0.37 (5 %)	0.3 (3 %)	0.41 (5 %)
Yams		0.03	0.77 (8 %)	0.48 (6.4 %)
Cassava	0.06	0.39 (5 %)	0.19	0.21 (3 %)
Cowpeas		0.05	0.01	0.02
Beans		0.09	0.03	0.05
Rice	0.02		0.03	0.03
Maize/Sorghum	0.15 (2.5 %)	0.64 (8 %)	1.66 (17 %)	1.19 (16 %)
Maize/Yam/Beans			0.9 (9.4 %)	0.35
Yam/Beans			0.35	0.13
Cassava/Maize			0.05	0.01
Millet/Beans	0.19 (3 %)			0.03

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Maize/Sorghum/Beans	0.08		0.09*	0.05
Yam/Cowpeas		0.21	0.05*	0.06
Sorghum/Cowpeas		0.25		0.05
Maize /Millets		0.41	0.02*	0.11
Yam/Millets			0.16*	0.03
Sorghum/Millets		0.25*	0.05*	0.05
Sorghum/beans			0.34*	0.07
Yam/Millet/Beans			0.36*	0.08
Maize/Cowpeas		0.41		0.07
Others			0.86	0.34
Cultivated Land ha	0.4.32	6.9	8.89	6.55
Fallow ha	1.76	0.87	0.68	0.9

* Crop entreprises practised in Atacora Province.

A farm family in the sudan savanna, plants 3.84 ha (49 % of the farm size) to cotton, 0.64 ha (8 % of the farm) to maize/sorghum, 0.39 ha (5% of the farm) to cassava and 0.37 (5% of the farm) to groundnuts. Wheres in the northern guinea savanna, an average family uses 1.66 ha (17 % of the farm) for maize/yam/bean 0.77 ha (8 % of the farm) for yams and 0.4 ha (4 % of the farm) for maize. In the northern guinea savanna zone, there is a diversity of crop enterprise such that different families plant about 38 % of their farm to various crop enterprises leaving 0.68 ha (2% of the far under fallow. See Table 4.

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AGRONOMIC PRACTICES USED BY FARMERS

There are some agronomic practices and small farm equipement recommended by extension for cotton, maize and groundnut. Cotton is a crop that has a strong backing of extension service CARDER with economic incentives including credit facilities for ox-plough, fertilizers and insecticides plus free seeds and on farm purchases and handling of cotton at harvest.

In case of cotton, most farmers have adopted greater portions of the recommended practices namely the cotton seed variety (299-10-75)for the northern guinea savanna zone and mk 73 for the sudan and sahelian savanna zone. Farmers also apply NPK and urea fertilizers to cotton, spray insecticides five to six times and weed up to two times in sudan and sahelian zones or up to three times in the northern guinea savanna.

But in cases of maize and groundnuts, farmers are mainly picking up the improved varieties TZB and novara for maize and RMP. 12 and Moto for groundnuts and tending to ignore for example the use of fertilizers on food crops (and other recommendations).

Table 5 shows varieties of maize, groundnuts, yams and sorghum grown by farmers in each agroclimatic zone.

The most common agronomic practices used for food crops production are slash and burn, plough or dig the land, plant with fingers on flat or on ridges and mounds for yams and cassava, then hand weed with a hoe.

Table 6 shows the percentage of farmers using various agronomic practices in each zone. The types of land used for food crop are compound farm, plateau, valley or bottom land. In sahelian zone sorghum is often planted in compound farms nearest to the homestead which have higher fertility level, then millets maize and the rest of the sorghum are planted in valleys or bottom lands. In both sudan and northern guinea savanna zone most food crops are planted on plateaus.

As for land clearing, most of the farmers in the sahelian zone, use light clearing (see Table 6) which implies that there is not much vegetation to slash and burn.

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TABLE 5. Crop Varieties being used by farmers.

Crop variety Official/Local name	Per centage of farmers using the Variety.		
	Sahel Savanna	Sudan Savanna	Northern Guinea Savanna
Cotton L 299-10-75			Yes
MK 73	Yes	Yes	
Maize TZB		80	73
Novara			18
Kolokoli	38		
Groundnuts			
Moto	84	82	8
San			18
RMP 12			26
Yams			
Tassou			26
Wossou		80	
Sorghum			
Dobi			31
Esse Pan		79	
Kehulame	53		

TABLE 6 Per centage of farmers using various agronomic practices in each zone.

(a = Sahel, b= Sudan and c = Northern Guinea)

Agronomic practice and Zone		Cotton	Maize + sorghum	Groundnuts	millets	Sorghum	Cassava	Yams	Cowpeas	Beans	Maize	Yam/beans	Yam/beans/Millet
Type of land													
- Plateau	a)	76	-	-	-	-	-	-	-	-	-	-	-
	b)	42	28	28	21	-	28	-	28	-	-		
	c)	55	38	28	14	14	42	45	-	-	14		
- Valley/bottom land	a)	-	-	-	15	69	15	-	-	-	38		
	b)	-	-	-	-	-	-	-	-	-	-		
	c)	-	-	-	-	-	-	-	-	-	-		
Land clearing													
- Slash or cut and burn	a)	61	-	38	7	7	-	-	-				
	b)	28	-	28	14	-	14	-	14				
	c)	51	37	12	12	6	41	38	10		14	2	
- Light clearing	a)	23	-	31	76	69	-	-	-		38		
	b)	7	7	7	7	-	7	-	7		-		
	c)	8	18	20	20	-	-	8	-		12		
Soil Preparation.													
- use of ox-plough	a)	61	15	61	84	61	7	-	7		-		
	b)	36	14	42	14	-		-	28		-		
	c)	16	10	10	6	8		-	-		8		
- dig with hoe	a)	7		15	7	7							
	b)				-	-							
	c)	20	24		10	6			14		2		
- make ridges	a)	15	-	-	-	-					-		
	b)	-	-	-	-	-					-		
	c)	16	6	14	4	4					12		
- make mounds	a)						15	-				-	
	b)						28	7				28	
							38	51					

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Planting																
- on flat in lines	a)	28	15	23	46	46	7		-			15				
	b)	7	7	7	7				42			-				
	c)	22	22	16	8				10			4				
- on ridges	a)	15	-	-	-	-			-			-				
	b)	36	21	36	21	-			-			-				
	c)	33	16	18	4	6			2			16				
- on mounds	a)						15	-					-			
	b)						28	7					50			
	c)						38	51					-			
- with fingers	a)	46		46	46	46						31				
	b)	2	4	2		4	2		2							
	c)	2														
Fertilizer Aplication	a)	yes	-									-	-			
	b)	"	-									-	7			
	c)	"	2									6	-			

While both in the sudan and northern guinea savanna, farmers slash or cut bushes with trees and burn. However, wide scale bush burning during the dry season has been observed in the agroclimatic zones

Soil preparation in the sahelian zone is mostly by oxen, ir this zone, 84 % the farmers use ox-plough for millets 61 % use it for cotton, groundnuts and sorghum. In the sudan savanna, 42 % of the farmers use ox-plough for groundnuts, 36 % for cotton and 14 % use ox-plough for maize/sorghum and millets. In the northern guinea savar na, ox-plough is very rarely used. In this zone, 16 % of farmers use ox-plough for cotton, while only 10 % use it for maize/sorghum and groundnut. The most common methods used for land preparation in the northern guinea savanna, is to dig with a hoe make ridges especially for cotton and groundnut or make mounds for yams and cassava.

Planting in lines on flat is mostly used in both the sahelian and northern guinea savanna , and rarely used in sudan savanna. Whereas planting on ridges is more popular in sudan and northern guinea savanna. Farmers in sahelian zone frequently plant with fingers, whereas farmers in the order two zones plant in pocket holes with a hoe, a stick on " roullette " a rolling Castor (wheel).

Fertilizers are very rarely applied to food crops. In this study only 6% of the farmers were observed applying fertilizers on maize northern guinea savanna, 2 % maize/sorghum and 7% on yam/beans in the sudan savanna.

CROPPING CALENDAR

Land clearing for yams in both sudan and northern guinea savanna is done is september and soil preparation done beginning of November before the soils become hardened by the dry season. The tops of the yam mounds are mulched through out the dry season to maintain low soil temperature. Planting of the yams is done in February-March just before the rains.

In the sahelian zone, soil preparation is done in April and planting of food crops done before the end of May, whereas cotton is planted in early June. In sudan savanna, planting is also in early or late May, depending on the onset of the rains. In northern guinea savanna, soil preparation is done in March and planting done April/Ma

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again depending on the rains stabilize. However the optimal dates of planting in the northern guinea savanna is before first week of June, weeding in June and harvesting starts in October with millets and sorghum in both sahelian and maize in November and December.

FARMERS'RECOGNISED ADVANTAGES AND DISADVANTAGES OF CROP ASSOCIATION

The farmers' recognised advantages and disavantages of intercropping. As table 3 and 4 indicate, farmers in the region commonly plant in association cereal crops like maize and sorghum and millet and sorghum among other crop associations. When farmers in sahelian zone were asked for the advantages and disadvantages of these crop mixtures, farmers indicated that although interplanting cereal crops saves labour for timely planting of all crop and for weeding, it causes soils to degenerate much faster. About 38 % of the farmers pointed out that intercropping of beans, with either sorghum, millet or sorghum/millet appears to give good yields and benefits soils.

Farmers in the sudan savanna said that they intercrop in order to maximize calorie production that is obtaining a variety of sources of calories and minimizing the risks of crop failure as well as saving labour for weeding. But the farmers pointed out a number of disadvantages which they observed over time about the cropping system. The disadvantages observed include depletion of soil fertility; delays in maturity of some of the associated crops, retarded growth of plants of some of the associated crops and reductions in yields. Farmers in the sudan savanna zone, can plant as many as three cereals like maize, sorghum and millet in the same associatio

In the northern guinea, 55 % of the farmers gave the advantages of intercropping as saving labour for timely planting and weeding as well as maximizing the use of land. Then 47 % of the farmers believe that intercropping ensures the production of calorie requirements for the family and minimizes risks. Other advantages of intercropping given by farmers are maximizing cash income, increasing the quantity of crop residues and maintaining ecological balance for the soil micro-nutients. But about 47 % of the farmers observed that some of their crop associations particula ry millet/sorghum, yam/millet and yam/millet/beans accelerate the depletion of the soil fertility generally tend to give lower yields of respective crops in the association and often make physical movements and working in the field difficult.

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LIVESTOCK AND SOURCES OF LIVESTOCK FEED

Both in the sahelian and in the sudan savanna zones, livestock plays a very important role in the production system. Table 7 shows number of livestock per farm family and sources of livestock feed in rainy and dry season in each zone.

In the sahelian zone, an average farm family has over 6 domestic animals of which over 2 are oxen for draught power, 2 are cattle and 2 are goats and sheep. Although some camels can be seen in the area, they normally belong to the normadic cattle keepers who may have come across the boarders. For the local farmers do not keep camels. In sudan savanna, an average farm family has 8 domestic animals, of which 3 are oxen for draught power, 2 cattle and 3 goats and sheep.

In the northern guinea savanna, an average farm family has 11domestic animals of which the family may have two oxen or no oxen at all for draught power, about 6 cattle and 4 goats and sheep.

In terms of distribution, it should be noted that in the sahelian zone practically every farmer has oxen for draught power whereas in the sudan savanna, 78 % of the farmers have animal traction and only 12 % of the farmers in the northern guinea savanna have animal traction, making an average of 39 % of the farmers in the region with animal traction. It should also be noted that although there are more cattle in sahelian and sudan savanna zones, most of cattle belong to normads who do little or no farming and mainly move in search of grazing grounds.

Feeding of livestock during the rainy season is usually by grazing. But during the season when most vegetation get dried up and often burnt down by bush fires, feeding of livestock becomes a problem. In the sahelian savanna, livestock is moved further south in search of grazing grounds or use tree leaves and crop residues to feed their livestock.

In the sudan savanna, in 57 % of the cases, livestock is grazed in wet bottom lands. Whereas in over 20 % of cases, the livestock is moved further south. In the northern guinea savanna about 20 % of farmers graze in wet bottom lands, 10 % move their

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TABLE 7 Number of livestock per farm family and source of livestock feed in rainy and season in each zone.

ZONE	Number of livestock. (Figures in parenthese show percentage of farmers)				Source of livestock feed (figures show percentage of farmers)							
					rainy season			dry season				
	oxen for draught power	cattle	Goats + sheeps	total livestock	grazing	grazing in wet bottom land	transhu-mance	use tree leaves	crop re-sidues	Peels of food	(goats + sheep)	
Sahel ~~Savanna~~ Savanna	2.4 (100%)	2 (54%)	2 (54%)	6.4	92			80	15			
Sudan Savanna	3 (78%)	2 (43%)	3 (57%)	8	85	57	21					
Northern Guinea Savanna	0.4 (12%)	6 (45%)	4 (77%)	11	53	20	10	32		47		
Regional Average	1.2 (39%)	4.5 (46%)	3.5 (70%)	9.2	65	24	16	55	2.6	30		

* In the sahelian zone, there are two types of dwellers. Those who keep cattle and keep moving in search of grazing grounds, then those who practice farming. The purely cattle keepers were not included in this study.

livestock southwards and 32 % use tree leaves to feed the livestock inedible parts of food crops like peels are commonly used to feeding goats and sheep in this zone. See Table 7.

ECONOMICS OF EXISTING FARMERS'PRACTICES

Farmers' Farm Resource Use.

Apart from land, the most important farm resources are family labou animal traction and ox-plough. Cash income for purchased input like fertilizers small farm tools and seeds also plays a very important role. Table 8 shows a farmer's farm resource base in each agroclimatic zone.

Farm size, animal traction and family labour supply in man-units are already discussed in tables 7 and 13 but are included in Table 8 for completion.

As Table 8 indicates, a farmer in sahelian zone, uses up to 66.8 hours of ox-plough, while the farmer in sudan savanna uses 78.9 hours of ox-plough and a farmer in Northern guinea savanna uses only 37.2 hours of oxplough.

Considering all the farming activities during the agricultural season, a farmer in sahelian savanna zone spends a total of family and non-family labour of 485.8 man-days of which 55.8 are used for land clearing, 56 for planting, 138 for weeding and 188 man-days are used for harvesting.

The farmer in sudan savanna spends 806.95 man-days for all his farming activities as compared to his counterpart in Northern guinea savanna who spends 917.8 man-days.

The most labour demanding farming operation in each of the agroclimatic zone is harvesting, followed by weeding, soil preparation and planting. See Table 8. The labour requirements for soil preparation, ridging, mounding and planting are 104 man-days in the sahelian zone, 256.95 man-days in the sudan savanna and 226 man-days in the Northern guinea savanna. Considering the family supply in man-units of 2.69, 5.23 and 4. 94 for sahelian, sudan and northern guinea savanna respectively along with 6 day working week,

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TABLE 8. FARMERS' FARM RESOURCE USE.

ITEM	SAHEL SAVANNA	SUDAN SAVANNA	NORTHERN GUINEA SAVANNA
Farm size ha Animal traction			
Use of ox-plough for all crops hrs.	66.8	78.9	37.2
Family labour supply man-units	2.69	5.23	4.94
Total family and non-family labour used for all crops for (man-days)	485.8	806.95	917.8
- Land clearing	55.8	190	191
- Soil preparation	37	39.95	51
- Ridging	6	69	49.8
- Mounding	5	49	37
- Planting	56	99	89
- Weeding	138	160	240
- Harvesting	188	200	260
- Cost of purchased inputs CFA/Year.			
- Hire or cost of oxen + ox-plough	22 455	13 136	8 906
- Small farm tools	723	1 879	1 173
- Fertilisers for coton	13 500	87 107	23 377
- Seeds	730	6 071	2 129

it implies that the farmely in sahelian savanna needs 7 weeks to complete the farming activities up to planting, and the one in sudan savanna needs over 8 weeks where his counterpart in northern guinea savanna requires also 8 weeks. The implication of this analysis is that if the last planting date is first week of June, then soil preparation and planting activities must be started in March.

Table 9. TOTAL LABOUR REQUIREMENTS FOR SOME SELECTED CROP ENTERPRIS

CROP ENTERPRISES	LABOUR MAN/DAYS/HA	CROP ENTERPRISES	LABOUR MAN/DAYS/H
Cotton	170	Cassava	152
Maize	103	Yams	269
Sorghum	115	Maize/sorghum	141
Millets	125	Yam/Beans	280
Groundnuts	126.		

It also implies that if the on set of rains is late or if there is a prolonged dry spell, then farmers in each of zones face a high risk of late planting.

According to Table 8, a farmer in the sahel spends about 37.408 Francs (CFA), 108.193 CFA for the one in sudan savanna or 35.585 CFA for one in the northern guinea on purchased farm inputs such as hiring or buying ox-plough, small farm equipments, fertilisers and seeds. Table 9 shows total labour requirements for some selected crop enterprises. The most labour demanding crop enterprises are yam/beans, yams and cotton taking respectively 280, 269 and 170 man-days/ha from land clearing to harvesting. The other are maize/sorghum, millets and sorghum in pure stand, taking respectively 141, 125 and 115 man-days/ha. Maize appears to require relatively less labour, taking about 103 mandays/ha.

EFFICIENT UTILISATION OF FARM RESOURCES

In order to determine the efficiency levels of the available farm resource in the existing production systems, different analytical techniques were carried.

It was hypothesized that total cultivated land which is an indicator of total farm production, is a function of farmer's family size, farmer's age, total labour input, use of ox-plough,

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small farm tools and animal traction.

It was further hypothesized that a farmer manipulates this function, as he tries to overcome his production limitations in order to achieve his farm production objectives. This function is now examined using two types of analytical procedures (a) Regression analysis and (b) Principal component analysis both of which are powe ful analytical tools.

REGRESSION ANALYSIS

In order to examine the relative importance of different variables in the hypothesized function (model) alternative models were formulated.

Before going into these let us now explain the list of variables.

List of Variables :

HP = Hectarage under Principal crops.
G = Farmer's age.
FZ = Family Size.
FU = Family labour Units - a proxy for availability of farm famil labour supply.
TL = Total Labour input for all farming operations.
LC = Labour input for Critical farming operations that is land preparation, planting and weeding.
TP = Total cost of Purchased inputs - ox-plough, ox-cart, cut lass, axe, hoe, fertilizers weeder, maize, groundnuts and yam seeds.
OX = Hire or cost of oxplough and ox-cart.
AT = Animal Traction.
AN = Livestock.
OP = Cost of small farm tools like hoe, axe, cut lass, fertilizer and seeds.

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DEMAND FOR LABOUR CRITICAL FARM OPERATIONS.

Given the farmer's farm production function namely :

HP = f (FZ, G, TL, OX, OP, AN). (1)

alternative function (models) were formulated.

Given the fact that there is a short and mono model rainy season in the Semi-Arid zone, it is hypothesized that demand for labour for critical farming operations namely, soil preparation, planting and weeding is a very important factor that the farmer has to deal with. Thus the hypothesis that total cultivated area (as a proxy of total farm production) is function of farmer's family size, farmers age, labour inputs for critical farm operation and total cos of all purchased inputs.

HP = f (FZ, G, LC, TP). (2).
HP = f (LC, OX, OP) (3).

Another hypothesis considered is that family labour supply (FU) is very important to the farm family. Thus :

HP = f (FU,TL, OX, OP). (4).
HP = f (FU,LC, OX). (5).

REGRESSION ANALYSIS COEFFICIENTS

Table 10 presents the results from Regressions analysis of the above stipulated functions. In equation 6, total cultivated area is a function of farmer's family size, farmer's age total labour inputs, cost of ox-plough, cost of small farm tools and animal traction.

The most important variables in this equation 6, are total labour inputs,TL, hire or cost of ox-plough, and cost of small farm tools including fertilizers and seeds, OP.

The regression coefficients of these variables are all significant at 1 per cent level.

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TABLE 10. REGRESSION ANALYSIS COEFFICIENTS.

	Dependant Variable	Const	FZ	G	TL	OX	OP	AN	R^2	Functio
(6)	HP	-0.59	0.043	0.049+	$0.15(10^{-3})^{**}$	$0.78(10^{-4})^{**}$	$0.38(10^{-4})^{**}$	0.032+	63.7	Linear
		(-0.4)	(0.56)	(1.58)	(7.34)	(3.41)	(4.32)	(1.63)		
		Const	FZ	G	LC	TP			R^2	
(7)	HP	-0.55	0.025	0.056+	$0.56(10^{-3})^{**}$	$0.52(10^{-4})^{**}$			61.9	Linear
		(-0.39)	(0.33)	(1.86)	(7.23)	(7.34)				
		Const	FZ	G	LC	TP	AN		R^2	
(8)	HP	-1.27	0.016+	$0.37(10^{-2})$	0.09**	0.2**	$0.43(10^{-2})^{+}$		37.8	Log
		(-2.35)	(1.45)	(0.78)	(2.15)	(4.89)	(1.41)			
		Const	LC	OX	OP				R^2	
(9)	HP	0.36	0.14**	0.025*	$0.57(10^{-5})^{**}$				45.5	Log
		(1.2)	(3.86)	(2.5)	(4.5)					
		Const	FU	TL	OX	OP			R^2	
(10)	HP	1.19^{+}	0.25^{+}	$0.14(10^{-3})^{**}$	$0.73(10^{-4})^{**}$	$0.38(10^{-4})^{**}$			61.8	Linear
		(1.51)	(1.52)	(6.42)	(3.19)	(4.21)				
		Const	FU	LC	OX				R^2	
(11)	HP	(1.38)	0.54**	$0.18(10^{-3})^{**}$	$0.11(10^{-3})^{**}$				49.6	Linear
		(1.53)	(3.07)	(5.19)	(4.39)					

The use of animal traction is also significant at 10 Per cent level. The over all fitness of the regression equation is robust with R^2 at 63.7.

Equations 7,8 and 9 mainly concern with inputs for critical farming operations, LC, along with total cost of purchased inputs, TP, (E of 7) or together with animal traction (E of 8). The regression coefficients of LC and TP in equation 7 are both significant at 1 per cent level, whereas the coefficients of G is only significant at 10 per cent level.

In equation 8, which includes animal traction AN, along with LC and other variables, the regression coefficients of LC and TP are again significant at 1 per cent level, but those of FZ and AN are significant at 10 per cent level.

In equation 9, in which hire or cost of ox-plough, OX, is used in place of animal traction, AN, the regression coefficient of LC and OP are both significant at 1 per cent level. But that OX is significant at 5 per cent level.

Equation 10 and 11, focus on the availability of farm family labour supply, FU, along with other variables.

In equation 10, the regression coefficients of TL,OX and OP are all significant at 1 per cent level whereas that of FU is significant at 10 per cent.

In equation 11, the regression coefficients of LC and OX are both significant at 1 per cent level. The coefficient of FU is also significant at 1 per cent level.

The goodness of fit of equation 7 and 10 is quite robust with R^2 61.9 and 61.8 respectively. But the goodness of fit of equations 8,9 and 11 is less robust with values of R^2 at 37.8 45.5 and 49.5 respectively.

RELATIVE IMPORTANCE OF FARM INPUTS

In order to determine the relative importance of farm inputs in the production system, principal component analysis was carried out.

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In this analysis related variables are grouped together and each group forms a factor. The factors given by the analysis are factors 1, 2 and 3.

The importance of each factor is determined by whether or not its latent root, the Eigenvalue is greater than Unity.

Table 11 a shows factors and their eigenvalues, the most important factors are factors 1 and 2 with their respective eigenvalues 2.84 and 1.64 respectively.

Factor 1, accounts for over 47 per cent of variance, where factor 2 accounts for 27 per cent of the variance giving a cummulative per centage of 74.4.

The variables to be grouped in factor are considered according to the size of their factor loading. A factor loading of any variable is between 1 and 1. If the variable has a factor loading closer to either 1 or 1, then it is considered significant. But if its factor loading is closer to zero, then the variable is considere insignifiant.

Table 11b, present factor loading for the variables under consideration.

In factor 1, total farm labour and labour inputs for critical farm operations have factor loadings of 0.560 and 0.550 respectively. In factor 2, variables with high factor loadings are hire or cost of ox-plough and animal traction with factor loadings 0.673 and 0.634 respectively. Factor 3, whose latent root or eigenvalue is 0.7 being less than unity, has family labour supply with factor loading of 0.842.

The implications of the results from this analysis are that labour inputs play a major role in the agricultural production system. Then hire or cost ox-plough and animal traction play a supportive role in the production system.

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TABLE 11. RELATIVE IMPORTANCE OF FARM INPUTS : PRINCIPAL COMPONENT ANALYSIS.

11 a. FACTORS AND EIGENVALUES

FACTOR +	1	2	3
Eigen - value	2.84	1.62	0.7
Per Centage of Variance	47.33	27.07	11.66
Cummulative Per Cent	47.33	74.4	86.06

11 b. FACTOR LOADINGS

VARIABLES	FACTOR 1	FACTOR 2	FACTOR 3
Hectares	- 0.450	0.367	- 0.068
Family labour units	- 0.401	0.003	(- 0.842)
Total farm labour	(- 0.560)	- 0.096	0.342
Labour for critical farm operations	(- 0.550)	- 0.096	0.368
Hire or cost of ox-plough	0.002	(- 0.673)	- 0.055
Animal traction	0.145	(- 0.634)	0.176

FARMERS PRIORITIES AND GOALS

Each farmer was asked to rank his first, second and third priority that he is trying to achieve by taking farming as an occupation. Table 12 shows farmer's declared priorities in each agroclimatic zone. To ensure that there is enough food for the family throughout the year was number one priority for most of the farmers in each agroclimatic zone. This priority has a rank score of 3.4 out of the highest score of 4 for farmers in the sahelian zone 3.8 points out of 4 for farmers in the sudan savanna and 3.6 points out of 4 scores for farmers in the northern guinea savanna.

The second major priority given by farmers is to earn sufficient money for the family's vital basic needs. This priority score 1.2, 2.9 and out of 4 for the farmers in sahelian sudan and northern guinea savanna respectively. The third and fourth priorities declared by farmers were to earn enough money for children's education and to save for better standard of living in future.

Farmers were asked to rank from one to six, in their order of preference the major food crops. Table 13 shows farmer's prefered major food crops. In the sahelian savanna zone ; the major prefered food crops are sorghum, millets and maize with rank scores of 5.8, 4.6 and 2.3 respectively. There are other food crops consumed by farmers in this zone, but these are regarded as supplementary crops.

In the sudan savanna farmers'major prefered food crops are yams sorghum and maize with rank scores of 5.8, 4.4 and 3.7 respectively. Whereas farmers in northern guinea savanna, ranked yams as number one prefered food crop with a score of 5 out of 6, then ranked sorghum as number two followed by maize and millets with scores of 4.1, 3.4 and 1.6 respectively.

Considering the food crop preferences at the regional basis sorghum got the highest score of 5.3 followed by yams at 4.3 then maize, millets and beans with 3.3, 2.2 and 0.9 respectively. This implies that in the three agroclimatic zones, sorghum, maize and millets are important sources of calories, although yams plays a major role in the supply of calories, in both the sudan and northern guinea savanna zones.

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TABLE : 12 Farmers' declared priorities and Goals

Declared priority	Rank score of priority		
	Sahel Savanna	Sudan Savanna	Northern Guinea Savanna
- To ensure that there is enough food for the family through out the year.	3.4	3.8	3.6
- To earn sufficient money for the vital basic needs of farmer's family.	1.2	2.9	2.6
- To earn enough money for children's education.	0.8	0.86	0.9
- To save some money for better standard of living in future.	0.9	-	1.3
- To earn money for building a better house.	0.85	-	-

TABLE : 13 Farmers' Prefered Major food crops.

Rank score (figures in parenthese represent number of forms in which the food crop is eaten)

Food crop	Sahel Savanna	Sudan Savanna	Northern Guinea Savanna	Regional average
maize	2.3 (2)	3.7 (2)	3.4 (2)	3.3
sorghum	5.8 (2)	4.4 (2)	4.1 (3)	5.3
millets	4.6 (3)	1.8 (2)	1.6 (2)	2.2
yams		5.8 (4)	5.0 (3)	4.3
cassava	0.8 (2)	1.4 (3)	0.5 (3)	0.7
groundnuts			0.2 (3)	0.1
beans	0.8 (2)	1.2 (2)	0.8 (3)	0.9
cowpeas		1.9 (2)	0.6 (2)	0.7
Rice	0.5 (1)		0.4 (1)	0.4

With respect to each food crop, the number of forms in which it is eaten are indicated in parenthese in Table 13.

AVAILABLE INFRASTRUCTURAL AND COMMUNAL FACILITIES.

In put delivery system, infrastructural and communal facilities plays an important role in facilitating rural agricultural production systems. In our area of study, information was obtained on the existence and the number of farmers that have access to such facilities. Table 14 shows the percentage of farmers that have acces to various social and/or communal facilities.

The infrastructural and social facilities existing in the region include agricultural village cooperatives, two sources of agricultural credit namely CARDER and CLCAM (Caisse locale de Crédit Agricole mutuelle), local markets, communal storage and wells as a source of drinking water.

In the sahelian savanna, 69 % of the farmers belong to village cooperatives, 38 % have communal storage facility and 95 % have access to source of drinking water; Practically all the farmers have accessability to markets. In the sudan savanna 92 % belong to an agricultural village cooperative, 57 % have communal storage facility and 92 % have access to source of drinking water. Practically all the farmers have access to some type of agricultural credit and about 85 % of the farmers have access to markets. See Table 14. In the northern guinea savanna, relatively less number of farmers have access to any of the facility.

Table : 14 PERCENTAGE OF FARMERS WITH ACCESS TO INFRASTRUCTURAL AND COMMUNAL FACILITIES.

TYPE OF FACILITY	SAHELIAN SAVANNA	SUDAN SAVANNA	NORTHERN GUINEA SAVANNA
Agricultural cooperatives	69	92	69
Communal storage	38	57	39
Source of drinking water well.	95	92	69
Accessability agricultural credit	-	100	61
Accessability to markets	100	85	81

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FARMERS' PRODUCTION CONSTRAINTS

One of the objectives of this socio-economic study is to examine farmers' production constraints. These constraints could be agroclimatic, physical, technical or agronomic.

In examining the production constraints, three approaches were used. One approach, was to interact with farmers throughout the agricultural season, asking them to point out the production constraints they observe on their fields. The second approach was to examine the yields obtained and if these were dramatically reduced, then determine the factors that may be responsible for such losses. In the third approach, constraints are delivered from different analyses.

Table 15 shows farmers' declared constraints. According to table 15, farmers in the sahelian savanna zone observed two major production constraints. Thus late rains and torential causing water logging affected respectively 61 and 54 per cent of the farmers. In the sudan savanna, striga weeds and poor soils affected respectively 57 and 28 per cent of the farmers. Whereas in northern guinea savanna late rains and lack of alternative cropping technique affected respectively 41 and 70 per cent of the farmers.

Table 16 shows factors causing 10 to 15 per cent losses of crop yields in 1984 and 1985. Again late rains and poor soils came up as major constraints, followed by moisture stress. Late rains affected maize, millets, sorghum, yams and cotton in various degrees in each agroclimatic zone. Poor soils affected mostly sorghum and yams in the sudan savanna and in the northern guinea savanna. Whereas moisture stress affected mostly millets, sorghum and cotton in both the sahelian and northern guinea savanna zones. It also affected maize in the northern guinea savanna. See table 16.

Results from the various analytical tools, suggest that labour for critical farming operations like timely planting constitute one of the major production constraints. The use of ox-plough seems to be a good step in facilitating soil preparation and thus catching up with planting at the optimaldates.

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TABLE 15. FARMERS DECLARED CONSTRAINTS

CONSTRAINT	Percentage of farmers		
	Sahel Savanna	Sudan Savanna	Northern Guinea Savanna
- late rains	61	-	41
- problem of striga weeds	-	57	-
- poor soils	-	28	-
- torential rains causing water logging	54	-	70

TABLE 16. FACTORS CAUSING 10-15% LOSSES OF CROP YIELDS IN 1984 and 1985.

FACTOR	Crops	Percentage of farmers		
		Sahel Savanna	Sudan Savanna	Northern Guinea Savanna
Late rains	maize	-	42	51
	millets	15	-	10
	sorghum	7	57	45
	yams		42	53
	cotton			22
Poor soils	sorghum	7	90	46
	Yams		64	59
Moisture stress	millets	15		12
	maize			51
	sorghum	71	28	22
	cotton	14		22

CONCLUSION

In this study we delineated the agroclimatic zone of the region and examined demographic characteristics of the farmers in each zone. The farmers' existing farming systems in each zone have been examined from various points of view, including cropping patterns, land utilisation and agronomic practices used by farmers.

The importance of livestock in the region has also been examined. The economics of the existing farmers' practices have bee discussed. Farmers' priorities, production constraints and their fo preferences are also discussed.

III. AGRONOMIC STUDIES

Ideally the agronomic studies should have been initiated after the socio-economic studies data wad completed, analysed and interpreted, since the detailed information on the crops grown and their relevant agronomic practices in the cropping systems would have been defined. It was however considered relevant to initiate some agronomic trials after certain information had been gathered during the reconnaissance survey. The rationale behind the choice of the type of crops and issues to be investigated upon were :

- The existence of scarce information on the local varieties for purposes of comparison with the improved varieties where they existed, as the farmers were still using their local varieties.

- The lack of information on the performance of these varieties under the common farmers practices such as intercropping versus monoculture along which most improved varieties were developed.

- The recognition of the importance of cotton as a major cash crop.

- Evaluation of the performance of these crops fertilized with inorganic fertilizer compared with no fertilization at all as it is common with most farmers with food crops.

- Studying the effects of ridging or flat cultivation and assessing the merits of each as both practices are common in the area of study.

- Assess the potential of green manure in the cropping pattern.

Overall it implied that sometime and effort had to be devoted shoring up the on station reserch, in addition to the proposed Farming Systems Research. A set of researcher managed experiments were designed and these were carried out at four sites in the agroecological zones defined earlier.

The rainfall data during the growing season and the analys of soil samples from the selected villages and Ina Research Station are presented in Apendix 1. Specifically these trials were :-

.../...

1. Evaluation of the performance of local and improved maize and sorghum varieties in pure stand in association on the flat.

A field trial of maize and sorghum grown on the flat either in monoculture or in association was conducted at Ina, Sokka and Bensekou, during the 1985 cropping season. Two maize cultivars, a local and TZB and two sorghum cultivars Toko - Bensekou (local) and Ghana I (improved) were used. The treatments were M1 = local maize M2 = improved maize, S1 = local Sorghum, S2 = Improved sorghum, M1S1 Local maize/local sorghum, M1S2 = local maize/improved sorghum, M2S1 improved maize/local sorghum and M2S2 = improved maize/improved sorghum. Half the number of plots were fertilized with cotton fertilize at the rate of 150 kg ha of NPK at emergence and a top dressing of 5(kg/ ha of urea was applied and the remaining half received no fertilizer (Fo and F1, respectively). The experiment was factorial design replicated four times an 8 x 2.

Each plot mesured 5 x 4 m. Seeds were sown on the flat at a spacing of 80 cm between rows and 40 cm within the row, leaving two plants per hill. Crops were grown on alternate rows with maize being sown two weeks before sorghum. Thus the sowing dates were 12 and 29 July 1985, 15 and 29 July 1985 and 18 July and 4 August 1985, for Ina, Sokka and Besekou, respectively. The plots were weeded thre times during the season and at harvest the four central rows were harvested leaving 50 cm at the end of each row.

Plants emerged after 3 to 4 days at all the three sites with the exception of sorghum at Ina which emerged after 11 days. On the average maize tasselled before 60 days after sowing and in general sorghum flowered after 98 days after sowing. There existed n large differences between the local and improved varieties (Table 17

Table 17 effect of treatments on days to 50% emergence and flwering

SITE Treatments	INA		SOKKA		BENSEKOU	
	Emergence	Flower.	Emerg.	Flowering	Emergence	Flower.
Local maize	4	56	3	55	4	59
Improved/maize	4	56	3	60	4	59
Local sorghum	11	99	4	103	4	98
Improv. Sorghum	11	103	4	105	4	

.../...

The data were analysed by splitting the trial first to establish the bench marks of maize and sorghum and then a factorial analysis was done to evaluate mixed cropping. The mixed cropping analysis was done in two ways. One was to consider that one kilogramme of maize was equal to one kilogramme of sorghum and the analysis was done on the totals. The second method was to transform the data in relative yield totals which were obtained by taking the sum of each compoment species in the mixture.

$$R.Y.T = \frac{\text{maize yield intercropped}}{\text{maize yield in monoculture}} + \frac{\text{sorghum intercropped}}{\text{sorghum yield in monoculture}}$$

The results from both these analysis for Ina are presented in table 18.

Results are stated as being significant at P = 0.05. The application of the cotton fertilizer increased total yield by 50 % (1042 and 1565 kg respectively, for the unfertilized and fertilized treatments). The lowest yields were obtained with sorghum varieties (S1, S2) and the next lowest was achieved when improved maize TZB and improved sorghum Ghana I were grown in association. The highest yield on the other hand was recorded when TZB maize was grown in monoculture. There was no significant difference between treatments M1 M1S1 M1S2 and M2S1, but these treatments yielded less than TZB maize (Table 18).

There was a significant variety x fertilizer interaction and the overall groupings of the treatment are as presented in Table 18.

Examination of the relative yield totals (RYT) revealed that the highest values were obtained where crops were not fertilized whereas the lowest values were associated with fertilization, although there were exceptions to this generalization(Table 18). Mixing crops in low fertility levels may allow a better utilization of scarce resources.

.../...

These RYT values hoever should be interpreted with caution because the higher ones are mainly due to the sorghum yields and not necessarily due to the beneficial effects of intercropping.

Fertilization increased overall yield by 55 % at Sokka (866 and 1341 kg for unfertilized and fertilized, respectively).

The best yields at Sokka were obtained when TZB maize was grown either in monoculture or in association with local sorghum, and fertilized (Table 19). With the exception of where TZB maize and improved sorghum were grown in association the RYT values are higher than one indicating that mixing the crops had certain advantages.

The findings for Bensekou are presented in Table 20. The yields were in general lower than those from Ina and Sokka mainly because of striga which attacked the crops at Bensekou. Although the actual damage was not recorded both crops seem to have suffered equally from the striga attack. As was the case at Ina and Sokka fer lizing the plots significantly increased the yield of crops, althoug by only 36 % (407 and 558 kg, for unfertilized and fertilized, respe tively).

TZB maize variety was the best yielder whether grown in monoculture or in association with local sorghum. There was no significant difference between the two sorghum varieties and these yielded less than maize. A combination of local maize and local sorghum or local maize and improved sorghum gave the same total yield. Fertilization decreased the RYT.

Table 21 (d) shows the overall trend in maize yield at the three sites, Ina, Sokka and Bensekou. The highest yield was obtained when improved variety TZB was fertilized. Next was local maize when fertilized and when both varieties were not fertilized they yielded lowest and did not differ significantly from each other. Similar data analysis for sorghum was not available at the time of writing.

.../...

TABLE 18.

Effect of treatments on grain yield (kg/ha) and the relative yield total (RYT) values of crops grown on the flat at Ina

Treatment Combinations	Yield Maize	Yield Sorghum	Total Yield	RYT
S2Fo	-	210	210 a	
S2F1	-	225	225 a	
S1F1	-	403	403 a	
S1Fo	-	461	461 a	
M1S1Fo	539	380	919 b	1.26 abc
M2S2Fo	941	167	1108 bc	1.31 abc
M1Fo	1278	-	1278 bcd	-
M1S2Fo	1117	199	1316 bcd	1.68 bc
M2Fo	1353	-	1353 bcd	-
M2S2F1	1162	229	1391 bcd	1.08 ab
M2S1F1	1362	159	1521 cde	0.90 a
M2F1Fo	1312	385	1697 de	1.81 c
M1S2F1	1528	344	1872 ef	1.28 abc
M1S1F1	1775	361	2136 f	1.75 c
M1F1	2142	-	2142 f	-
M2F1	2829	-	2829 g	-
S E			225.52	0.29
C V			17.3 %	20.7 %

Means followed by different letters within each column are differed (P = 0.05) from each other. FO. and F1 denote unfertilized and fertilized respectively.

.../...

TABLE 19

Effect of treatments on yield (kg/ha) of maize and sorghum and the relative yield values (RYT) of the crops grown on the flat at Sokka.

Treatment Combinations	Yield		Total Yield	RYT
	Maize	Sorghum		
S2Fo	-	634	634 a	
M2Fo	769	-	769 ab	
S1Fo	-	807	807 ab	
M2S2Fo	655	182	837 ab	1.13
M1F1	898	-	898 abc	
M1S2Fo	666	236	902 abc	1.10
M1Fo	910	-	910 abc	
M1S1Fo	523	402	925 abc	1.06
S2F1	-	1047	1047 bc	
S1F1	-	1078	1078 bc	
M2S1Fo	750	399	1149 c	1.46
M1S2F1	649	533	1182 c	1.22
M1S1F1	688	767	1455 d	1.47
M2S2F1	1189	313	1502 d	0.92
M2S1F1	1123	575	1698 e	1.12
M2F1	1873	-	1873 e	
S E			135.23	0.14
C V			12.2%	11.5

Means followed by different letters within each column are significantly different (P = 0.05) from each other.

.../...

TABLE 20.

Effect of treatments on yield (kg/ha) and the relative yield values (RYT) of the crops grown on the flat at Bensekou.

Treatment Combinations	Yield Maize	Yield Sorghum	Total Yield	RYT
S2Fo	-	259	259 a	
M1Fo	306	-	306 b	
S1Fo	-	313	313 b	
M1S2Fo	105	253	358 c	1.30
S1F1	-		417 d	
M1S1Fo	154	263	417 d	1.34
S2F1	-	443	443 de	
M2Fo	475	-	475 e	
M2S2F1	306	219	525 f	0.89
M1S1F1	262	266	529 f	1.24
M2S2Fo	277	268	545 fg	1.61
M1F1	557	-	557 fg	
M2S1FO	269	322	591 g	1.58
M1S2F1	332	260	592 g	1.17
M2S1F1	384	259	643 h	1.25
M2F1	759	-	759 i	
S.E			26.9	
C.V			12	

Means followed by different letters within a column are significantly different (P= 0.05) from each other.

.../...

TABLE 21. Grouped yields of maize from Ina, Sokka and Bensekou (D) (Data for the combined fertilized and unfertilized treatments (A, B, C) at the three sites are presented for case of reference).

(A) INA		(B) SOKKA		(C) BENSEKOU		(D) GROUPED YIELDS FOR MAIZE (INA, SOKKA, BENSEKOU	
Treatment	Yield	Treatment	Yield	Treatment	Yield	Treatment	Yield
S2	217 a	S2	841 a	S2	351 a	M1Fo	831 a
S1	432 a	M1	904 ab	S1	365 a	M2Fo	865 a
M2S2	1250 b	S1	943 ab	M1	431 b	M1F1	1199 b
M1S1	1527 c	M1S2	1042 bc	M1S1	473 c	M2F1	1778 c
M1S2	1594 c	M2S2	1169 cd	M1S2	475 c		
M2S1	1609 c	M1S1	1190 cd	M2S2	535 d		
M1	1710 c	M2	1321 de	M1S1	617 e		
M2	2091 d	M2S1	1424 e	M2	617 e		

2. Evaluation of the performance of maize and sorghum grown either in monoculture or in association on the ridge.

The varieties, treatments and agronomic details were exactly as described in the previous experiment with the exception that in this trial the crops were grown on the ridge.

The time it took for the plants to emerge and flower was similar as reported earlier where crops were grown on the flat The effects of treatments on the yield for Ina are presented in Tables 22 and 23. Results are reported as significant at P = 0.05. Fertilizer application increased overall yield by 65 % (1104 and 1827 kg) respectively for unfertilized and fertilized treatments. The lowest yields were obtained when both sorghum varieties were grown in monoculture and the highest when TZB maize was grown either in monoculture or in association with the local sorghum variety. Local maize in pure stand gave the same yield with TZB grown in association with improved sorghum. Similarly associating local maize either with local sorghum or improved sorghum gave the same yields.

The RYT values were all above one but again this was not necessarily due to the beneficial effects of intercropping.

Results for Sokka are presented in Tables 22. and 24. The superiority of TZB maize either in monoculture or when grown in association with any sorghum was clear. Improved sorghum yielde significantly better than the local sorghum. The yield of local maize in pure stand and in association with local sorghum was the same as that of the improved sorghum alone. The RYT were in genera lower at Sokka when compared to those attained at Ina.

The yields at Bensekou were characteristically low and their trend were less consistent. As at the other two sites the major finding here was the obvious resonse to fertilization. Fertilizers increased overall yield by 33 % (428 and 570 kg) for unfertilized and fertilized treatments respectively.

.../...

A unique feature for the Bensekou maize results were that the local maize performed slightly better than TZB maize Tables 22 and 25. It has yet to be examined whether this may be due to a greater tolerance of the local maize variety to striga or not.

TABLE 22. Effect of varieties on the yield (kg/ha) of the crops grown on the ridge.

I N A		SOKKA		BENSEKOU	
Treatment	Yield	Treatment	Yield	Treatment	Yield
S2	473 a	S1	738 a	S1	435 a
S1	623 a	S2	913 b	M1S1	449 ab
M1S1	1456 b	M1	930 b	M1S1	474 bc
M1S2	1622 bc	M1S1	961 bc	M2S2	496 c
M2S2	1762 bcd	M1S2	1045 bcd	S2	496 c
M1	1805 bcd	M2S1	1125 cd	M2	537 d
M2S1	1879 cd	M2S2	1128 cd	M1S2	551 d
M2	2108 d	M2	1205 d	M1	556 d

Means followed by different letters within a column differed significantly (P= 0.05) from each other.

TABLE 23.

Effect of treatments on the yield (kg/ha) and relative yield totals of crops grown on the ridge at Ina.

Treatment Combinations	Total Yield	R.Y.T.
S2Fo	389 a	
S1Fo	501 ab	
S1F1	747 bc	
S2F1	781 bc	
M1S1Fo	1119 cd	1.16
M1S2Fo	1231 cde	1.54
M2Fo	1277 cde	
M1S2Fo	1298 cde	1.46
M2S1Fo	1572 def	1.78
M1Fo	1676 defg	
M1S1F1	1792 efg	1.45
M1F1	1934 fg	
M1S2F1	2015 fg	1.56
M2S1F1	2185 g	1.22
M2S2F1	2227 g	1.22
M2F1	2938 h	
S.E	230.30	
C.V	15.7	

Means followed by different letters within a column differed significantly (P = 0.05) from each other.

TABLE 24.

Effect of treatments on the yield (kg/ha) and relative yield totals of crops grown on the ridge at Sokka.

Treatment Combinations	Total Yield	R.Y.T.
S2Fo	571 a	
M1S2Fo	644 ab	0.96
S1Fo	729 abc	
M2S2Fo	731 abc	0.97
S1F1	747 abc	
M1S1FO	828 abcd	1.31
M1Fo	855 abcd	
M2Fo	879 bcd	
M2S1Fo	957 cd	1.12
M1F1	1005 cd	
M1S1F1	1094 de	1.25
S2F1	1255 ef	
M2S1F1	1293 efg	1.08
M1S2F1	1447 fg	1.28
M2S2F1	1526 g	1.07
M2F1	1531 g	
S.E.	132.62	
C.V.	13.2 %	

Means followed by different letters within a column differed significantly (P = 0.05) from each other.

TABLE 25.

Effect of treatments on the yield (kg/ha) and relative yield totals of crops grown on the ridge at Bensekou.

Treatment Combination	Total Yield	R.Y.T.
M2S1Fo	374 a	0.86
M1S1Fo	419 ab	0.95
S1Fo	423 ab	
S2Fo	431 ab	
M2S2Fo	436 ab	0.99
M1S2Fo	439 ab	0.98
M2Fo	439 ab	
S1F1	448 b	
M1Fo	465 b	
M2S1F1	525 c	0.99
M1S1F1	529 c	0.97
M2S2F1	557 c	0.92
S2F1	562 c	
M2F1	636 d	
M1F1	647 d	
M1S2F1	664 d	1.10
S.E.	31.70	
C.V.	12.6 %	

Means followed by different letters within a column differed significantly (P =0.05) from each other.

3. Evaluation of the performance of local and improved maize and groundnut varieties in pure stand and in association.

The experiment was conducted at Ina. The treatment combinations were M1 = local maize, M2 = TZB maize variety, G1 = local groundnut G2 = Improved groundnut, M1G1 =local maize/local groundnut, M1G2 = local maize/improved groundnut M2G1 = TZB maize/ local groundnut, M2G2 = TZB maize/improved grounsnut. The treatment were arranged on the flat in a factorial design with four replications. The experimental details on plot size and fertilization were exactly as in Experiment one except that both crops were grown on the same day, and groundnuts in monoculture was sown at a spacing o 40 cm between rows and 20 cm within rows. The trial was sown on 11 July 1985. At havesting four central rows were harvested in monoculture maize, four maize and three groundnut rows in intercropping treatments and in monoculture groundnuts, the two outer rows on either side of the plot were left out.

The trial was repeated at Ina but the crops were grown on ridges which were 80 cm apart. When intercropped, the groundnuts were grown between maize plants.

A similar trial was planted on 19 July 1985 at Sokka utilizing both flat and ridge cultivation but all plots were fertilized.

Results from these three trials are grouped together and are presented in(Table 26).

Both maize varieties emerged four days after planting and groundnuts emerged after six days.

Local maize tasselled 5 days earlier than TZB maize (55 and 60 days, respectively). On the other hand the improved groundnut flowered 32 days after planting and the local one after 39 day

Data was transformed into RYT and also the yields were converted in their monetary values and then analysed. The current price of maize at Ina is 40 francs CFA per kilo and that of groundnut is 170 francs CFA per kilo.

.../...

TABLE 26. Effect of treatments on the monetary value and RYT values of maize and groundnuts.

LOCATION .	I N A		SOKKA	
Land preparation	Flat	Ridge	Flat	Ridge
Monetary value (CFA)				
Treatments				
M1Fo	57,980	55,660		
M1F1	75,950	64,900	48,160	64,120
M2Fo	63,260	62,980	-	-
M2F1	98,230	66,340	95,600	82,360
G1Fo	127,543	190,910	-	-
G1F1	235,280	179,690	199,835	188,828
G2Fo	128,945	127,330	-	-
G2F1	118,405	113,220	178,415	248,498
M1G1Fo	66,635	126,252		
M1G2Fo	72,985	99,153		
M1G1F1	94,730	126,770	126,550	64,855
M1G2F1	79,793	94,423	125,127	68,760
M2G1Fo	77,643	123,872		
M2G2Fo	68,513	89,088		
M2G1F1	98,580	119,345	183,940	107,185
M2G2F1	87,810	95,295	142,590	110,918
Relative Yield Total %				
Pure maize or groundnut.	100 %	100	100	100
M1G1Fo	97 %	109	-	-
M1G1F1	91 %	117	142	72
M1G2Fo	106	133	-	-
M1G2F1	87	122	142	77
M2G1Fo	105	135	-	-
M2G1F1	88	122	148	113
M2G1Fo	97	120	-	-
M2G2F1	87	124	126	112

Overall, application of fertilizer consistenlly increased the cash return when compared with the nonfertilized treatments. There existed little relationship between RYT and the monetary value of crops grown association (Table 26). Even with RYT of over 100 % pure groundnut brought in more cash. This appeared to be the case at all locations whetter the the crops were grown on the flat or ridge, and fertilized or without fertilization. The only exception to this generalization was with treatment M2G1 at Sokka when crops were grown on the flat. With this treatment the high RYT of crops was reflected in the monetary value as well. The lowest income was usually realized when maize was grown in pure stand, the lowest values being realized from local maize. The local groundnut variety was consistently superior to the improved variety. This may be associated with the longer crop growth duration of the local variety which matured one month after the improved variety.

At Sokka the crops grown on the flat cashed more than those grown on the ridge.

The fact that farmers use ridges despite low income may be due to the ease with which groundnuts can be uprooted at harvest when the crop is grown on the ridge.

4. Evaluation of the performance of maize and cotton in monoculture and in association.

Cotton is a major cash crop in the northern People's Rpublic of Benin. In comparison with with food crops cotton research is relatively more advanced and there are certain cultural recommendations which are practiced by the farmers, on this crop. Maize is one of the important food crops in this zone. Research findings on this crop are relatively scanty and the existing recommendations are not practised by the farmers. This experiment was initiated with the objective of evaluating the performance of these crops either in pure stand or in association utilizing the recommended fertilizer inputs for cotton, which farmers have accepted to use.

In order to avoid undue contradiction between this experiment and recommendations presently extended by the extension it was decided to limit this trial at the Ina Research Station.

Since it was not easy to establish during the reconnaissance trips which one of the two crops was more important than the other because of the two different roles that they play it was considered relevant to test these crops under 100 % monoculture for each then moving to associations of 50 % maize and 50 % cotton and thereafter to 75 % maize and 25 % cotton or 75 % cotton and 25 % maize respectively.

These treatments were designated as : MMMM and cccc for pure maize and pure cotton respectively, MMCC for 50 %; maize and 50 % cotton, MMMC for 75 % maize 25 % cotton and mccc for 25 % maize and 75 % cotton. In this experiment a replacement series technique was employed. The various proportions were achieved by replacing the entire row (or rows) of the pure crop with the other crop. A maize variety TZB and cotton variety 299 - 10 A was used.

A completely randomized block design was employed and the experiment was replicated four times, each plot measuring 5 x 4 m. Seeds were sown on the flat on 19 July 1985 and the crop spacings were 80 cm between rows and 40 cm with the rows leaving two plants per hill. NPK fertilizer at the rate of 150 kg/ha was applied after emergence and topdressed with 50 kg/ha of urea. The experiment was handweeded three times, and regular spraying with decis controlled the cotton pests.

.../...

Maize was harvested on 21 November 1985 and cotton was harvested from 16 December 1985.

TABLE 27.

Effect of treatments on yield (kg/ha) of maize and cotton, and the RYT values.

Ttreatment	Maize	Cotton	Total	RYT
MMMM	1632	-	-	-
MMMC	1093	157	1250	0.44
MMCC	873	354	1227	1.00
MCCC	358	517	875	0.90
CCCC	-	750	-	-
LSD P = 0.05			245	
C.V. = 14 %				

The highest yield of individual crops were obtained when they were grown in monoculture. Intercropping maize and cotton always reduced the yield of the individual crop (Table 27) and the total yield was not in any case higher than the monoculture maize. There seems to exist little advantage in growing these crops in association unless some other factors are taken into consideration as the RYT donot exceed one.

5. Evaluation of sunhemp (Crotolaria ssp) as green manure.

Sunhemp (Crotolaria ssp) is a leguminous herb which is grown mainly as a feed for livestock. Crotolaria can be used to ameliorate soil provided it is well nodulated. This trial was initiated with the objective of assessing the potential of sunhemp as a green manure for maize.

The experiment was carried out at Ina. The treatments were arranged in a completely randomized block : M1Co = local maize no fertilizer M2Co = TZB maize no fertilizer, M1C1 = local maize/Crotolaria, at planting and incorporated in the soil at weeding M2C1 = TZB maize/Crotolaria at planting, and incorporated in the soil at weeding, M1C2 = local maize/Crotolaria planted at weeding, M2C2 = TZB maize/crotolaria planted at weeding, M1F = local maize fertilized with NPK and urea and M2F = TZB maize fertilized with NPK and urea.

Seeds were sown on 17 July 1985 on the flat on plots measuring 5 x 4 mètres. Maize was grown at 80 cm between rows and 40 cm within the row leaving two plants per hill. Crotolaria where present was planted on the same row. Results are presented in (Table 28). Crotolaria didnot increase the yield of maize compared with the control. Application of fertilizer significantly increased the yield of maize. It was however observed that under Ina conditions crotolaria did not nodulate naturally. A freely nodulating species may be requered for future work.

TABLE 28. Effect of treatments on maize yield (kg/ha).

Treatment	Yield
M1Co	1430
M1C1	1253
M1C2	1343
M1F	2042
M2Co	1365
M2C1	1408
M2C2	1482
M2F	1670
L S D P = 0.05	515
C.V. =	23.2 %

6. Evaluation of the performance of Sorghum and cowpea in pure stand and in association.

This trial was carriedout at Ina, Bensekou and Karimama. The treatments, arranged in a factorial design were :- two soil preparations (Ridge and flat), two levels of fertilization (0 and fertilized with NPK at the rate of 150 kg/ha) and three planting pattern (pure sorghum, sorghum in association with cowpea and monoculture cowpea). Monoculture sorghum was planted at 80 cm between rows (or ridge) and the distance betwenn hills was 40 cm. Cowpea was planted at a spacing of 80 by 20 cm. Where intercropped cowpea was planted between sorghum plants. The sorghum planting dates were 19 July 1985 for Ina and 23 July 1985 for Bensekou and Karimama. Cowpeas were planted on 19 July 1985, 5 August 1985 and 16 July 1985 at Ina, BENSEKOU and Karimama, respectively. The plots measured 5 x 4 metres.

The treatments are donoted by the following letters :
Fo = Zero Fertilization,
F1 = Fertilized with NPK,
V1 = Sorghum,
V2 = Cowpea,
V3 = Sorghum/Cowpea
C1 = Flat Cultivation and
C2 = Ridge cultivation

Analysis of data was carried out on yield of individual crops, relative yield total and on the monetary value considering the prevailing prices of sorghum and cowpea at Ina are 50 and 170 CFA respectively.

Sorghum grown on the flat yielded more than sorghum grown on the ridge. Fertilization significantly increased the yield of sorghum, and intercropped sorghum yielded less than when it was grown in monoculture.(Table 29). On the other hand neither land preparation nor fertilization affected the yield of cowpea. Cowpea when intercropped with sorghum yielded more than when grown in monoculture. A relatively higher cash was obtained when crops were grown on the flat compared to the ridge. Similary higher values were achieved with fertilization. Overall the lowest income was realized when sorghum was grown in pure stand and highest income when cowpeas were grown in monoculture and when the crops were grown in association the cash income was higher than with sorghum alone.

.../...

TABLE 29.

Effect of treatments on yield of (kg/ha) of sorghum and cowpea RYT and the sorghum value of crops grown at Ina.

Sorghum			Cowpea	
V1C2	435 a	land	V2C1	642 a
V1C1	538 b	preparation	V2C2	603 a
V1Fo	436 a	Fertilization	V2Fo	600 a
V1F1	538 b		V2F1	645 a
V3	539 a	Varieties/culture	V3	1080 a
V1	922 b		V2	787 b
V3FoC2	342 a		V3C1	766 a
V3F1C1	587 b		V3C2	807 a
V3F1C2	595 b		V2C2	999 b
V3FoC1	630 b		V2C2	1161 b
V1FoC2	700 b			
V1FoC1	943 c			
V1F1C2	974 c			
V1F1C1	1069 c			

Relative yield Total
Pure Sorghum or Cowpea 100 %
Sorghum/Cowpea Intercropped 133 %

Monetary value :

C2 =	124 246 a	Fo	123 814 a	V1	46 087 a
C1 =	136 142 b	F1	136 574 b	V3	160 788 b
				V2	183 706 c

TABLE 30.

Effect of treatments on yield of sorghum and Cowpea at Bensekou.

Sorghum			Cowpea	
V1C1	176	Land	V2C1	511
V1C2	270	Preparation	V2C2	364
V1Fo	194	Fertilization	V2Fo	397
V1F1	251		V2F1	478
V3	331	Varieties/culture	V3	399
V1	337		V2	913
V1FoC1	207		V3F1C2	340
V3FoC1	239		V3FoC2	353
V3F1C1	255		V3FoC1	360
V1FoC2	340		V3F1C1	545
V1F1C1	352		V2FoC2	640
V3FoC2	378		V2F1C2	853
V1F1C2	447		V2FoC1	1028
V3F1C2	452		V2F1C1	1132

Relative Yield Total.

Pure sorghum or cowpea 100 %

Sorghum/Cowpea intercropped 145 %

TABLE 31

Effect of treatments on yield (kg/ha) of sorghum and Cowpea, grown at Karimama.

SORGHUM			COWPEA	
V1C1	319	Land	V2C1	116
V1C2	334	Preparation	V2C2	113
V1Fo	292	Fertilization	V2Fo	90
V1F1	360		V2F1	140
V3	450	Varieties/culture	V3	135
V1	529		V2	209
V3FoC1	430		V3FoC1	126
V1FoC2	430		V2FOC1	128
V1FoC1	444		V3F1C1	129
V3FoC2	450		V2FoC2	138
V3F2C2	457		V3F1C2	138
V3F2C1	463		V3FoC2	147
V1F2C1	573		V2F1C2	258
V1F2C2	670		V2F1C1	314

Results for Bensekou and Karimama are presented in Table 30 and 31, respectively. Crops were heavily attacked by striga at Bensekou and Karimama cowpea yields were very low. It was rather difficult to make any meaninful interpretations of these results.

7. Evaluation of local sorghum and millet in pure stand and in association.

Travelling northwards to the boarder with Niger, one notice changes in crops grown with sorghum and millet becoming more predominant the further north one goes. A trial was initiated at Birni - Lafia Karimama to evaluate the performance of the local sorghum and millet.

One local sorghum and one local millet variety bought in the local market was grown either in monoculture in association. These were either fertilized or no fertilizer was applied. Comparison were also made between ridge and flat cultivation.

The trial was plagued by poor germination and flooding and hence the data does not show any consistent trend.

CONCLUSION

An attempt has been made to assess the yield of what were considered to be important food crops in northern Benin with cultural practices that appeared common during the reconnaissance trips. The crops were grown late in the season and the yields so obtained are in general lower than expected. Certain preliminary useful information h been obtained and with the completion of socio economic studies the path along which to follow now appears clearer than was the case at the initiation of these trials.

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APPENDIX 1. a)

MECHANICAL AND CHEMICAL COMPOSITION OF SOILS AT THE SITES

SITE	Benseko	Ina	Birni Lafia	Boukoumbé	Ouake	Guilmaro
Size % (2 mm)	0.6	2.7	1.5	66.4	1.3	1.1
0 - 2 u %	6.32	9.44	17.44	9.64	8.40	10.02
2 - 20 u %	4.80	12.75	10.77	13.80	6.18	3.76
20 - 50 u %	8.49	15.18	25.61	29.69	19.69	5.01
50 -200 u %	49.74	38.03	26.52	23.87	41.77	37.11
200 -2000 u %	31.14	23.63	18.87	23.40	22.94	45.46
Humidity	0.6	0. 9	1.7	1.5	0.6	0.7
C %	0.75	0.77	1.49	0.59	0.83	0.61
N %	0.070	0.067	0.129	0.049	0.062	0.056
C/N	10.7	11.5	11.5	10.8	13.4	10.9
OM %	1.29	1.33	2.57	0.91	1.43	1.05
pH in water (1/2,5)	7.0	6.8	6.7	6.0	6.0	5.9
pH KCL (1/2,5)	6.2	6.0	5.8	5.3	5.5	5.0
Electrical conductivity umhos/cm 1/5						
Ca ++ meq/100g	3.40	4.40	4.75	4.55	2.80	2.20
Mg + meq/100g	1.55	1.60	2.75	1.20	0.80	1.30
K + meq/100g	0.32	039	0.50	0.44	0.23	0.18
Na^+ meq/100g	0.56	052	0.54	0.60	0.49	0.53
Total cations meq/100g	5.83	6.91	8.54	6.79	4.32	4.21
CEC meq/100g	6.90	7.70	9.50	9.60	5.35	7.10
% V = S/T x 100	84	88	90	71	81	59
P. ass. Bray I ppm	8	15	4	6	4	3

APPENDIX 1. b)

Rainfall (mm) 1986

	INA	SOKKA	BENSEKOU	BIRNI LAFIA
March	51		25	-
April	14		6	-
May	188		86.1	56
June	169.5		125.1	133
July	254.8		293.9	226
August	229.2		259.0	319
September	210.1		215.4	96
Ocotober	59.5		4.6	
TOTAL	1176.1		1015.1	830.0

Rainfall data for Sokka is not available. It can however be assumed that the figures for Ina are applicable at Sokka as the two sites are only 25 km apart.

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