Semi-Arid Food Grains Research And Development
S. A. F. G. R. A. D.

Farming Systems Unit (F. S. U.)

OAU/STRC - Joint Project 31
Contract AFR-C-1472 between
USAID and Purdue University

Document N°

MAJOR CROPPING PATTERNS - SAFGRAD COUNTRIES, UPPER VOLTA FACTS AND OBSERVATIONS RELEVANT TO FARMING SYSTEMS RESEARCH

(With Special Reference to three Regions in Upper Volta)

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AN INTRODUCTORY NOTE FROM THE AUTHOR

This document presents base line information and a brief discussion on crop production, yield, income and related demographic profile of SAFGRAD member countries. The discussion on Upper Volta and the sample regions in Upper Volta, is in greater detail. The data presented in this document have been drawn from several sources, and the author is deeply grateful to all of them.

Data from Farming Systems Research Unit's study regions were collected by survey methods, and the major focus of the document is on the sample regions. However, the author regrets that for lack of time and computer facilities no analytical work involving regression or programing could be undertaken. The data on yields and transactions etc. are still being completed by field staff in the seven sample villages. At this stage, therefore, only a rather descriptive view of the farming systems and household socio-economic characteristics is presented. In the next phase, the author will be conducting econometric and programing analyses of data with major focus on production economics, farm resource allocation and efficiency, constraints on small farms, and their relevance to farming systems research and development policies.

The author wishes to express his sincere thanks to Annie Bruyer, Dramane Konaté, Sawadogo Kimseyinga, Sawadogo Sibiri for their help and assistance in the conduct of survey and analysis of data. Dramane Konaté's participation in data tabulation and processing deserves special mention. Thanks are due to the field investigators : Bara Marou and Bonkoungou Larba, Dianou Kiri, Ouédraogo Seydou, Fofana Boureima, Dipama Etienne and Bouena Salifou.

The author records with a deep sense of appreciation the sincere and cooperative support given to him and other team staff by farmers in the seven villages, especially by those in the sample. Data collection and other activities of the team could have been impossible without their cooperation and support. Information was supplied by farmers and their families with full confidence and appreciation. The author is indeed proud to have the privilege of farmers' affection, friendship and their sincere collaboration at all stages of his work in the sample villages.

For typing and secretariat work, the author thanks Félicité Sawadogo who put in extra efforts to complete typing of the manuscript on time.

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Ouagadougou

February 16, 1981

MAJOR CEREAL CROPPING PATTERNS, YIELD AND PRODUCTION IN SAFGRAD[1] COUNTRIES

In most of the SAFGRAD member countries, farmers operate small holdings and produce, under low yield conditions, subsistance crops to satisfy family needs. Considering the present 25 SAFGRAD member countries (Table 1), per capita cropped land ranges from 0.1 hectare (Cape Verde) to 3.2 hectares (Niger), although the majority (60 %) of these countries have less than one hectare of cropped land area per person. Countries with less than half a hectare per person are Senegal, Nigeria, Ghana, Sudan, Mauritania, Tanzania, Cape Verde, and Somalia. Those with 0.5 to 1.0 hectare of cropped land per person are Guinea, Benin, Gambia, Guinea Bissau, Ethiopia and Upper Volta. The remaining 10 countries (or 40 %) i.e., Ivory Coast, Zambia, Botswana, Cameroun, Togo, Central African Republic, Sierra Leone, Niger, Chad and Mali have on an average a per capita cropped land of one hectare and above. Overall, however, the average size of operational holdings per household is small, and in majority of the cases farms are not economically viable.

The main cereals produced in the 23 out of the 25 SAFGRAD countries consist of sorghum, millet and corn with the exception of Guinea and Gambia where the principal cereal is rice with 57 percent to 60 percent of the total cereal area under this crop (Table 2). In terms of the relative importance of the three major cereal crops in the total cereal cropping systems, corn occupies the first position in Benin (79 %), Kenya (73 %) and Ghana (56.5 %), while the second position in Cameroun (49 %), Tanzania (44 %), Guinea (28 %) and Ethiopia (25 %).

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[1] Semi-arid Foodgrain Research and Development created under OAU/STRC Joint Project 31 and approved by heads of state of the OAU member countries. The participating institutions in the SAFGRAD effort are Purdue University (USA) with Farming Systems Research, IITA (Nigeria) with Maize-Cowpea research and ICRISAT with sorghum (and soil fertility).

TABLE 1

MAJOR SOCIO-ECONOMIC PROFILE OF SAFGRAD COUNTRIES IN AFRICA

SAFGRAD countries (Africa)	GNP/CAPUT 1976 (US $)	Population (millions) 1979	Density/SQ.km of ag. land	Rate of natural increase % per year	% population in agricul. 1977	Cropped land/caput (ha) 1976	Adult literacy %	Radio/popu./100	PQLI[1]
Ivory Coast	650	7.7	-	2.9	81	1.3	-	-	28
Zambia	450	5.6	-	3.0	69	1.0	43	1.8	-
Senegal	410	5.5	34	2.6	76	0.5	10	6.9	22
Nigeria	400	75.0	-	3.2	56	0.4	-	-	-
Botswana	390	0.7	-	3.4	82	1.9	-	-	38
Ghana	370	11.0	61	3.1	53	0.3	-	7.8	31
Cameroun	310	8.3	37	2.3	82	1.1	-	-	28
Sudan	270[2]	18.0	-	2.7	79	0.4	-	-	33
Togo	270	2.5	-	3.0	70	1.0	-	-	-
Kenya	250	15.0	-	3.8	79	0.2	30	4.8	40
Mauritania	250	1.6	-	2.8	84	0.8	-	4.7	15
Centr. Afr. Republic	240[2]	2.4	-	2.3	89	3.3	-	-	18
Guinea	210	4.9	-	2.5	82	0.9	-	-	20
Sierra Leone	190	3.7	-	2.6	67	1.3	-	-	29
Benin	180	3.5	-	3.0	47	0.9	-	-	23
Gambia	180	0.6	-	2.4	79	0.5	-	-	22
Tanzania	180	17.0	23	3.0	83	0.4	-	1.5	28
Niger	150	5.1	22	2.9	90	3.2	-	3.6	14
Cap Verde	140[2]	0.3	-	1.8	58	0.1	-	-	46
Guinea Bissau	140[2]	0.6	-	1.8	84	0.6	-	-	10
Chad	120	4.4	7	2.3	86	1.7	7	1.6	20
Somalia	110[2]	3.5	-	2.8	82	0.3	-	-	19
Ethiopia	100	32.0	31	2.5	81	0.5	7	0.6	17
Upper Volta	100	6.7	28	2.6	83	0.9	5	1.6	17
Mali	100	6.5	12	2.7	88	1.7	10	1.2	15

Source : World Bank, FAO, Overseas Development Council (U.K) and Government publications

1 = PQLI = Physical Quality of Life Index

2 = provisional

Millet is the most dominant crop in Mauritania (91 %), Chad (91 %), Senegal (81 %), Mali (70 %), Niger (65 %), Tanzania (57 %) and Cameroun (little on 49 %). Sorghum occupies the first position in Sudan (70 %), Upper Volta (59 %) and Botswana (43 %). Taking sorghum and millet together however, 10 (40 %) out of the 25 SAFGRAD countries for which data was available have relatively greater land area devoted to these crops than the others.

It is also clear from the data (Table 3) that the main cereals used for consumption in the majority of the SAFGRAD countries are sorghum, millet and corn. Per capita annual consumption of cereals (1975-77) ranges from as low as 57 kg in Central African Republic and 73 kg in Ghana to 271 in Niger and 223 kg in Guinea Bissau. The relatively low income countries show higher level of consumption of food grains as compared to high income countries.

Cereal yields (Table 3) per unit of land area under cultivation are extremely low, among the lowest in the world. Except for one or two countries, all the twenty five SAFGRAD countries are net importers of cereals in one form or the other. Data on production, per hectare yield and imports as presented in Table 3 amply demonstrate that one of the major problems facing agriculture in the semi-arid zone is how to increase crop yields on small farms from the present levels of 300 to 500 kg of grains per hectare. Low farm productivity in these countries is not the result of any single factor. It reflects a combined effect of physical, technological, human and institutional factors.

Poor soils and unfavorable and often unpredictable climatic conditions in the semi-arid parts of the world make farming risky and uncertain. Most of the technological innovations and investments in agricultural research made so far in the less developed countries have been confined to crops grown under conditions of assured water supply, and

TABLE 2

IMPORTANT AGRICULTURAL ECONOMIC INDICATORS
IN SAFGRAD COUNTRIES (AFRICA)

SAFGRAD countries (Africa)	Arable land as % total land	Cereal area (million ha 1975-77)	Cereal area as % arable land	% area under				
				Corn	Sorghum	Millet	Rice	Wheat
Ivory Coast	-	0.7	-	-	-	-	-	-
Zambia	6.6[1]	1.3	11.9	-	-	-	-	-
Senegal	11.7[1]	1.1	-	5.0	-	81.2	13.8	-
Nigeria	-	13.0	50.1[1]	16.5	42.8	34.3	16.4	-
Botswana	-	0.2	-	-	-	-	-	-
Ghana	4.4	0.8	88.5[1]	56.5	19.6	14.3	9.6	-
Cameroun	14.2	0.8	12.6	49.1	-	19.1	1.8	-
Sudan	2.8	4.1	53.6	0.6	70.4	17.9	-	11.0
Togo	-	0.3	-	-	-	-	-	-
Kenya	2.7	1.7	111.3	73.5	-	16.5	1.6	6.8
Mauritania	1.0	0.2	16.7	9.1	-	90.9	-	-
Centr. Afr. Republic	-	0.2	-	-	-	-	-	-
Guinea	16.9[1]	1.0	24.7[1]	27.7	-	12.2	60.1	-
Sierra Leone	-	0.4	-	-	-	-	-	-
Benin	-	0.4	-	79.1	17.8	3.1	-	-
Gambia	-	0.1	-	-	-	42.9	57.1	-
Tanzania	11,8	2.0	7.5	33.3	-	57.0	9.2	0.8
Niger	11.8[1]	2.9	18.6[1]	0.3	28.7	65.4	5.6	-
Cap Verde	-	*	-	-	-	-	-	-
Guinea Bissau	-	0.1	-	-	-	-	-	-
Chad	5.4[1]	1.1	13.0	1.2	-	91.4	6.4	1.0
Somalia	1.6	0.4	54.5	-	-	-	-	-
Ethiopia	10.6	5.1	45.5	25.1	17.6	3.9	-	16.5
Upper Volta	19.4	2.2	41.9	7.1	58.8	30.8	3.3	-
Mali	9.4[1]	1.5	12.6[1]	6.9	-	69.8	23.3	-

Source : World Bank, FAO, Overseas Development Council, (U.K) and Government publications

1 Includes permanent crops

* Less than 0.1

TABLE 3

IMPORTANT AGRICULTURAL ECONOMIC INDICATORS IN SAFGRAD COUNTRIES (AFRICA)

SAFGRAD Countries (Africa)	Cereal yield (ton/ha) 1975-77	Cereal output (million tons) 1975-77	Cereal consumption/caput (kg/year) 1975-77	Fertilizer consumption NPK kg/ha 1976	Tractor density (No./ 1 000 ha) 1976	Import content in cereal consumption % 75-77
Ivory Coast	0.9	0.7	119	5	0.3	20
Zambia	0.9	1.2	252	13	0.8	10
Senegal	0.6	0.7	210	16	0.2	28
Nigeria	0.6	8.4	145	5	0.3	10
Botswana	0.6	0.1	186	2	1.4	32
Ghana	0.7	0.6	73	8	1.2	21
Cameroun	0.9	0.8	128	2	*	8
Sudan	0.6	2.6	145	14	1.2	2
Togo	0.8	0.3	131	1	0.1	6
Kenya	1.3	2.2	160	25	2.8	E
Mauritania	0.3	*	135	1	n.a.	69
Centr. Afr. Republic	0.5	0.1	57	**	*	10
Guinea	0.7	0.7	177	**	*	7
Sierra Leone	1.4	0.6	206	**	0.1	6
Benin	0.7	0.3	110	1	*	11
Gambia	0.8	0.1	198	10	0.3	28
Tanzania	0.8	1.5	113	5	1.2	13
Niger	0.4	1.2	271	**	*	3
Cap Verde	0.5	*	131	4	0.8	90
Guinea Bissau	1.0	0.1	223	1	*	25
Chad	0.5	0.6	145	1	*	3
Somalia	0.6	0.2	110	n.a.	1.2	34
Ethiopia	1.0	4.9	174	2	0.3	1
Upper Volta	0.5	1.1	186	1	*	2
Mali	0.7	1.1	203	1	0.1	6

Source : World Bank, FAO, Overseas Development Council, (U.K) and Government publications

* Les than 0.1 ** Less than 0.5 n.a. : not available

E : net exporter

on better quality soils. Rain-fed crops have lagged behind in the game of growth and development in science and technology, and whatever new technology is considered to be available and perhaps can be transferred to farmers, its adoption has been slow and almost nonsignificant. In some cases the relative performance of new technology vis-a-vis the existing technology followed especially by better-off farmers has raised questions and doubts about the former. Perhaps, we do not know enough about the existing or traditional production systems that we want to modify. Also, we need to study and evaluate the socio-economic feasibilities of improved or new technological package or packages, their appropriateness, and implications for physical research, development and public policies. Similarly sources of adoption gaps need to be identified. This would indicate the need for carefully designed pre-extension studies and testings under real farming conditions, and follow-up studies in homogenious agro-climatic zones.

Low yields from agriculture would by and large account for low rural income levels. As revealed by the data in Table 1, rural income per person in most of these countries varies from US $ 50 to $ 100, half the national averages. At such low income levels, we know that the marginal propensity to consume is high, and consequently, saving margins are low. Investment in land or in anything else that is conducive to increase in productivity is low. Additionally, with distortions in input and output markets, inadequate infrastructures, and serious imperfections in the flow of production related informations, the incentive system in several of these countries is extremely weak and often counter-productive. Compare the average fertilizer consumption (NPK) per hectare in the countries listed in Table 3. In the majority of the cases it is 1 to 5 kg per hectare ! Of course, besides distortions in the incentive systems, there are other obstacles to the use of chemical fertilizers and other improved practices that involve investment by farmers. Physical and climatic constraints are hard to tackle through public policy interventions, but those related to incentive structures are definitely amenable to policy manupulation.

The use of capital, new technology, improved seeds, chemical fertilizers and pesticides etc are closely linked with the knowledge and skill of farmers. In a dynamic agriculture, the need and incentive for acquiring knowledge and skill will increase because of higher returns to investment under changing conditions of production technology. Public policy will have an important role to play in the process.

In addition to improvement in production technology and infrastructures, another important factor that will need to be upgraded to achieve higher production better income prospects is the human factor -the skill and knowledge embodied in this factor. The key to any sustained improvement in production systems on small farms will ultimately lie in our ability to improve the skill and capability of human factor. This is often not realized. I am tempted at this point to quote Prof. T. W. Schultz who while delivering his nobel Prize lecture (1979) said : "What we have learned in recent decades about the economics of agriculture is that agriculture in many low income countries has the potential economic capacity to produce enough food... The decisive factor in improving the welfare of poor people are not space, energy and cropland, the decisive factor is the improvement in population quality".

It may be pertinent to draw attention the data pertaining to literacy and physical quality of life index as presented in Table 1. In countries like Upper Volta, Chad and Ethiopia, for example, not more than 5 to 7 percent of the total adult population is literate ! Based on the availability of basic needs, infant mortality and literacy, the Physical Quality of Life Index (PQLI) as worked out by the British Overseas Development Council is much lower in semi-arid countries, especially in northern and western parts of Africa, than in other parts of the LDC'S. It is as low as 10 for Guinea Bissau, 15 for Mali and 17 for Upper Volta, to take a few examples (Table 1).

II

RECENT DEVELOPMENT IN CROP IMPROVEMENT EFFORTS IN SAFGRAD COUNTRIES

Of late efforts both at the national and the international levels are being made to alleviate food deficits in these countries through technological innovations. An important part of such efforts has been the investment made in research in cereal crops like sorghum, millet, maize and cowpea by regional and international institutions such as ICRISAT, IITA, IRAT, and SAFGRAD[1]. It is gradually being recognized that research and development efforts aimed at finding ways and means to increase production and productivity on small farms will not succeed without understanding the existing farming systems, and the constraints under which farmers in these regions operate. Varietal improvement program must integrate with it some of the charactristics of the better local crop varieties already grown by farmers. Similarly, a research in improved agronomic practices, insect, disease and weed control measures can benefit from some of the local practices already followed by better farmers. This implies that along with our search for better agricultural technology, the scientific community will need to acquire information related to production systems as followed by farmers, and the constraints they face in regard to the adoption of new technology. Understanding the traditional farming systems both from socio-economic and agronomic points of view, and identifying the factors that either limit or promote production will indeed be vital to our efforts in the

[1] see footnote 1, page 1. Also see Table 1 for list of member countries up to date.

development and transfer of technology, appropriate to the needs and resources of small producers in the semi-arid regions.

Farming Systems Research

Lately, there has been a growing interest in farming systems research in several developing countries. In fact, the term farming systems has become a catch word for many agricultural scientists whether agronomists, soil scientists, plant breeders, irrigation engineers, economists, sociologists and anthropologists. The concept has been used and defined differently by different people depending upon their disciplines. If one were to review some of the works and writings, one will find a plethora of definitions and notions used to explain farming system. This ranges from a single crop approach to a complete farm and household approach. However, the purpose here is not to go into any review of such works but to provide a frame of reference in regard to the concept and meaning of farming systems in the SAFGRAD context.

Farming System approach provides a framework that integrates farm production systems with consumption and other socio-economic components of the household for studying the interrelationships among various components. A single crop or any other economic activity is only a part of the farm operated by the household. Likewise the farm in a wholistic sense is only a part of the overall household economic structure.

It therefore becomes necessary to understand the system as a whole so as to be able to study the individual parts. Anything that influences one component of the production system is bound to influence the system as a whole. Household's overall resource constraints, be it land or labor or capital, may put serious limitations on switching to a new crop variety even though the new crop variety has higher yield potential as compared to the traditional variety. The same may hold for any other kind of change or modification introduced or suggested in the existing cropping system. The nature and extent of such interactions among household and farm production systems, and their implications need to be understood and analysed.

The cost-benefit calculations of new production technology alone will not go far unless these are related to the existing farming and household economic system as a whole. Similarly, it would be important to know which attributes or characteristics of the existing systems can be advantageously used by scientists in developing yield-increasing technologies. There has got to be a two-way traffic in this process-information must flow from farmers to scientists, and from scientists to farmers. Farming Systems Research can and must provide an important source of linkage in such a two-way flow of information.

Farming Systems Research under SAFGRAD

Farming Systems Research Unit created under the SAFGRAD scheme is intended to provide a vital linkage between farmers and agricultural scientists. Its major role has been defined to cover the following objectives or functions :

a) analysis of small farm conditions and the application of new technologies to these conditions. In doing this, we not only hope to develop a research methodology appropriate to the study of farming systems, but to create a list of criteria for the description and classification of farming system domains in Semi-Arid Africa.

b) formulation of strategies for the development and implementation of small farm technology.

c) developing recommendations regarding physical research priorities.

d) the design, organization and analysis of farmer field trials and studies.

e) training host country professionals in farming systems research.

Being located in Upper Volta with other SAFGRAD researchers, the Farming Systems Research was started during 1979 in three regions of the country. This research involved a multidisciplinary approach with three major disciplines ie. anthropology, economics and agronomy. The major focus of this effort is on understanding of traditional production systems as practised by farmers ; evaluating the performance of some of the improved technologies by conducting agro-economic trials in farmers fields ; providing the necessary feed-back between farmers and scientists ; and identifying major constraints and their relevance to a) physical research priorities, and b) policy implications.

III

SAMPLING PROCEDURES FOLLOWED BY FARMING SYSTEMS RESEARCH UNIT FOR AGRO-ECONOMIC AND ANTHROPOLOGICAL STUDIES

A three-stage selection procedure was followed to chose the villages for socio-economic and agronomic studies and fields trials. This comprised of 1) the region within the ORD, 2) the villages within the region, and 3) the farm households within the village(s). The three regions selected for study are Ouahigouya in Yatenga ORD (rainfall, 500-600 mm per annum), Ouagadougou in the Ouagadougou ORD (rainfall, 800-850 mm), and Zorgho in Koupela ORD (rainfall, 800-900 mm). The selection of the regions was based upon three principal criteria : rainfall, soil type, cropping patterns, and relative potential for yield increasing technology. A brief description of the study regions is provided in the next section.

Sampling of villages within the selected regions was made purposive. However, broady three major considerations determined their selection : size of the village in terms of households and population, cropping patterns, levels of production technology, and the extent of farmers' cooperation and responsiveness. Preliminary visits to the villages were planned with the local ORDS, village chiefs and rural schools with a view to acquiring on-the-spot understanding of local conditions and characteristics pertaining to the broad criteria laid down for selecting the villages. Extremely large or extremely small villages were deliberately left out of the sample for the purpose of our study.

In all, seven villages* (Table 4) were selected from the three regions (see map). Their locations and population size are presented in Table 4.

TABLE 4

HOUSEHOLD AND POPULATION IN SAMPLE VILLAGES*

Regions (ORD)	Villages	No. of households (menages)	Present population as on the date of enumeration (1979)	Persons living outside	Total population
Ouagadougou	Nedogo	208	1 855	263	2 118
Ouahigouya	Sodin	137	983	351	1 334
	Aorema	89	1 020	208	1 228
	Tougou	141	913	284	1 197
Zorgho	Digre + Bissiga	151	1 014	351	1 365
	Tanghin	214	1 809	413	2 222
	Gandaogo	200	1 184	454	1 638

* Of the seven villages (which are "administrative" units) only two villages (Nedogo and Digre) were enumerated completely (ie. all the hamlets, (quarters) were included), while in the five villages, some of the hamlets were left out for sake of convenience.

The term village is used as per the administrative definition, and includes several hamlets or quarters scattered around the main or central village where the village chief resides. The quarters have their own individual names with their sub-chiefs. How closely or loosely the quarters are related to, and integrated with the main village depends in most cases upon the socio-political status and economic power of the chief. The chief or as locally called "Nabha", is the administrative head of the village under his jurisdiction, and normally provides the link between the local administration and the people he represents.

The third stage of sampling, selecting households was preceded by a carefully drawn plan of introductory work by the team's field staff in the villages. After the necessary formalities were completed to seek the approval of the village chief and farmers through several visits and meetings with them, the project' field staff was stationed in the villages. Field investigators and supervisors, all mooré (local language) speaking, spent a couple of months in the assigned villages, meeting and talking to farmers about the Farming Systems research projects, the kinds of data that would be collected, their purpose and relevance to improvement in farm production, agronomic field trials etc. This person-to-person visit in the village provided the field staff a close and good understanding of farmers, and farmers got opportunities to know about the project and its investigators.

During this period, the investigators and supervisors enumerated all the households (menages) covering broad demographic and crop information. All the houses were individually visited. This provided a complete list of households for drawing the sample. Thus the final stage was set in to select farmers, and from each village a sample of 15 farmers households was drawn.

An important point to note in this sampling procedure was the full participation of the village chiefs and a select group of villagers in drawing the sample. Villagers wanted to know why only a small number of households was being chosen for socio-economic and others studies, and how (and why) the fifteen were to be selected. This was explained in simple understandable language by the survey supervisor and the rural school teacher in the joint meetings held in each village before drawing the sample. Once understood, farmers provided full cooperation and participation in the entire sampling proceedings. Sample thus having been drawn, the selected fifteen heads of households came forward and promised full support in front of the chief and other fellow farmers. It was a rare experience of working and developing contacts with the mossi farmers in Upper Volta. The methods adopted by the Farming Systems Unit has come to be highly commended among the villagers who no longer took us as strangers, and who since volunteered to work with field staff without reservations. Except for five to seven cases, all the sample households have stayed over for the entire investigation period. The households which were dropped from the sample were those which had very elderly and physically weak chiefs who were not in a position to respond to questions.

Each investigator was assigned 15 farmers, out of which 10 were finally selected for detailed intensive investigation. Each household was visited once a week for the purpose of interviews through structured questionnaires. Such personal visits and interviews were carried out continuously for the entire production period covering the 1980 agricultural year. The major components of the questionnaire comprised of farm production systems, household socio-economic structures, labor time allocation, input use, and transactions. Interviews were conducted either close to farmers' compounds, or their crop fields.

MAP SHOWING STUDY REGIONS/VILLAGES
UNDER FSU/SAFGRAD

Selection of farmers for carrying agronomic field trials followed more or less the same methodology ie. an intensive pre-survey or pre-trial contact and confidence building work by field staff before initiating the actual trial work. The group of farmers selected for trials in their fields consisted of both the sample farmers chosen for socio-economic investigation and others outside the sample.

Agronomic trials in farmers fields consisted of three major components : 1) productivity of soil's plant nutrient minerals-use of rock phosphate to maximize farmers resource productivity ; 2) planting date for sorghum and millet as related to crop associations (cowpea association in particular) ; and 3) patterns of fallowing for different soil types to examine where the current agronomic techniques may change fallowing practices.

SOURCES OF DATA

Data for the Farming Systems research have been collected from two sources. First, and the most important is the primary source through survey method, and field trials which enabled to gather information directly from sample farms.

Besides the primary source ie. the sample households in the selected villages, secondary sources were also used for obtaining the required data on population, production, consumption, income levels, and, prices etc. The latter included such sources as the FAO, World Bank, International Fertilizer Development Centre (IFDC), Directorate of Agricultural Services in Upper Volta, and other government publications of the countries concerned.

ANALYTICAL TOOLS AND METHODS OF ESTIMATES

The data will be analyzed and presented through a number of methods. This will include simple tabular and graphic presentation of data, correlation and regression analysis, and farm modeling. In the present paper, however, the summary data has been presented and discussed in tabular forms. The data could not be subjected to rigorous econometric and programming analyses for lack of computer facilities in Upper Volta, besides time constraint. The data for the 1980 crop year were still in the collection process. The results presented in this paper are provisional and in certain cases not complete.

ORGANIZATION OF WORK

The work in the remaining section of this paper will cover broadly four areas :

a) a descriptive view of crop production system in Upper Volta, highlighting current cereal cropping systems, levels of production, yield, supply and demand conditions ;

b) some salient socio-economic features of FSU's sample regions including inferences relevant to farming systems ;

c) some of the preliminary results of socio-economic surveys covering cropping patterns, input use, estimates of labor supply and critical labor demand across the major agricultural operations during the crop production cycle.

IV

AGRICULTURE IN UPPER VOLTA : AN OVERVIEW OF MAJOR CHARACTERISTICS AND THEIR RELEVANCE TO FARMING SYSTEMS RESEARCH

Upper Volta -one of the 25 SAFGRAD countries in Africa- is located between 6° W and 2°E longitude and 10° and 15° N latitude. It is landlocked by Mali on the North and West ; Ivory Coast, Ghana, and Togo on the South ; and Benin and Niger on the East. The hand area is 274.200 km2 (106.500 mi^2) with an estimated population of 6.7 million (1979). Agriculture accounts for 83 percent of the country's total population. The latest population growth rate is estimated at 2.6. percent per annum.

Most of Upper Volta lies in the Sudan vegetative zone. Annual rainfall varies from 500mm (northeast) to 1 500 mm (southwest). More than 100 mm of rainfall per month occurs in 4-5 months of the year with maximum occuring in August. Most of the soils are classified as ferruginous tropical. Sands covered by laterite crusts are extensive in the Northeast, southwest, and central retions. Soils of southern and eastern Upper Volta were developed from granite, gneisses, and schists. Soil are generally very poor in fertility, and in scanty rainfall areas very hard to plough.

Upper Volta is among the poorest of the low income countries with a per capita income of $ 100 per annum (Table 1). Among the SAFGRAD countries, this country, along with Mali, Ethiopia, Somalia and Chad, stands at the bottom in terms of per capita income which ranges between 100 and 120 US dollars, and literacy rate which is not more than 5 to 10 percent of the total adult population. By most major economic and agricultural indicators (Table 2 and 3), the country can be rated as the least developed and chronically food deficit among the low income countries.

According to the 1975-1977 data, Upper Volta has 2.2 million hectares of land under cereals which accounts for about 42 percent of the country's total arable land. Arable land, however, is only 19.4 percent of the total available land. In terms of per capita cropped land, it is 0.9 hectare (Table 1).

The major cereal crops produced in Upper Volta are sorghum, millet and maize. The percentage area devoted to major cereal and other crops per farm estimated by the Directorate of Agricultural Services (Upper Volta, 1974-1975) is as follows : sorghum 36 percent ; millet 29 percent ; maize 5 percent ; rice 3 percent ; cowpea 3 percent ; peanut 7 percent ; and cotton 7 percent.

Cereal yields average not more than 500 kg per hectare. On an average, per capita availability of cereals for consumption varies for 170 to 186 kg per annum. Of the total cereal consumption, food imports accounted for 2 percent of country's total consumption during 1975-1977 (this was 7 percent during 1973-1974). It is estimated that the country would need to import about 100,000 metric tons of food grains this year (1981) to feed the population at its current level of consumption. This is mainly because the last year drough conditions in the northern part of the country.

The country's status on the food front is better explained by the available information on levels of cereal production and per hectare yields, (Table 5) ; consumption (Table 6 and 7) ; and the extent of overall food deficits to be met by imports and/or grain relief aid (Table 8).

TABLE 5

PRODUCTION LEVELS AND TRENDS IN UPPER VOLTA

(in 1 000 m. tons)

Years	Sorghum	Millet	Maize	Paddy rice	Cowpea (dry)	Peanut (shell)
1961-65	514	300	100	34	71	58
1970	563	378	55	34	65	68
1971	493	27[illegible]	66	37	60	66
1972	512	266	59	30	60	60
1973	481	253	58	32	50	63
1974	400	220	50	25	55	40
1976	534	347	60	36	NA	72
1977	634	354	73	37	NA	57

Source : Ministry Rural Development, Government of Upper Volta

TABLE 6

ESTIMATED LEVELS OR CEREAL CONSUMPTION IN UPPER VOLTA (kg/capita/year)1

Crop	1970	1980	1985	1990
Millet/Sorghum	130	131	131	130
Maize	11	11	12	12
Rice	4	4.5	5	5
Wheat	4	5	5	5.5
Cowpeas	20	21	21.5	22
Peanut	6	6	6	6

1 Estimation for 1970 are based on actual consumption and others upon FAO projections considering elasticity of demand. Taken from International Fertilizer Development Center (IFDC), Vol. IV, Upper Volta.

Note : Range of per capita supply for 1970-79 - 148 kg-181 kg. Average for the period = 167 kg/person. When adjusted for milling and other losses, the average supply will be 150 kg/person.

TABLE 7

ESTIMATED FOOD REQUIREMENTS IN UPPER VOLTA

(1 000 m. tons)

Crop	1970[1] Low - High	1980 Low - High	1985 Low - High	1990 Low - High
Millet/Sorghum	699 - 786	893 - 902	1019-1026	1166-1168
Maize	58 - 65	74 - 78	85- 91	97- 106
Rice	22 - 25	28 - 31	32- 37	37- 44
Wheat	23 - 26	29 - 33	33- 41	38- 50
Cowpea	109 - 123	139 - 145	159- 168	182- 196
Peanut	31 - 34	40 - 41	45- 47	52- 55

1 For 1970, estimation based on actual consumption. "Low" is based upon per capita consumption at estimated level of 1970 and "High" based upon elasticity of demand (as per FAO projections). Taken from International Fertilizer Development Center (IFDC), Volume IV, Upper Volta.

TABLE 8

CEREAL IMPORTS IN UPPER VOLTA

(1 000 m. tons)

Crop	1960-65	1970-71	1972	1973	1974
Wheat	8	22	34	14	21
Rice	3	2	11	11	-
Maize	1	1	6	22	24
Other	2	-	1	22	30
Grain relief Aid	-	-	-	50	95
Total	14	25	41	108	170

Source : Government of Upper Volta (Ministry of Rural Development)

The data presented in Tables 5 through 7 demonstrate the gap between supply and demand. The question is how to augment supply so as to meet the growing demand for food by an increasing number of people. With the current average yield level of 500 kg per hectare under cereal crops, the task at hand is undoubtedly difficult. That how to increa- production levels raises a whole set of questions. For example, whether it can and should be expanded by extensive farming, if additional land is available for cereal production ; or by intensive cultivation practices, if the necessary inputs are, or can be made available to farmers ? There is no easy answer to these questions. However, it appears that combination of the two methods may provide some kind of a via-media for increasing production.

In the final analysis however it will come to the farmer -the principal actor in the production- consumption process. It is true he is influenced by a number of exogeneous factors over which he has no control, and which may constrain his production efforts. The primary concern for policy intervention is not with such exogeneous factors, but with the endogeneous factors which could be influenced by several policy measures. An important variable that is of crucial concern of Farming Systems research is that of appropriate technological innovation that raises productivity per unit of farmers resources, and the diffusion of such an innovation. This innovation could take several forms : improved seeds which are disease resistant and high yielding ; use of fertilizers, insecticides and pesticides ; introduction of better management practices under existing production systems ; and substitution of capital equipment, machinery, and animal traction for labor, for example.

Without going into any detailed discussion about the importance of the individual innovation, it may be useful to quote some statistics pertaining to one component of technological package, ie. the use of chemical fertilizer. The International Fertilizer Development Center (IFDC) made an estimate about three years ago in regard to the potentialities for fertilizer use in Voltaic agriculture. Basing its estimates on FAO's projections for production, consumption and population growth (and with the underlying assumptions), the IFDC came out with a very attractive proposition showing a big saving in foreign exchange if the country imported fertilizers instead of food grains. The arithmatics of the estimates were as follows. Average cereal demand was projected to increase annually by 25 000 m. tons between 1975 and 1980, and 27 000 m. tons between 1985 and 1990 (urban demand will account for 25 percent). If domestic production is not increased, potential cereal deficits could reach 125 000 m. tons in 1980 to 270 000 m. tons in 1985. Assuming a grain : yield response of 10 kg of grain per kg of nutrient (but not without change in cultural practices) Upper Volta can save 4.3 CFA in foreign exchange for 1 CFA spent for fertilizer. The estimated c.i.f. cost of imported sorghum at Ouagadougou was 43 000 CFA/mt, or 12.5 billion CFA for 250 000 mt, whereas the cost of 27 000 mt nutrient (101,000 CFA/mt) required to obtain the 290 000 mt of grains will be only 2.9 billion CFA, indeed a big saving (12.5 billion versus 2.9 billion CFA !) and a very attractive proposition.

There could be some other equally attractive propositions, say with regard to new crop varieties. ICRISAT's new sorghum variety, E-35-1, has an yield potential of 3.5 to 4.0 m. tons of grains per hectare, maize (IRAT 100 and BDS III) 3.0 tons per hectare, and cowpea (KN1), 1.5 m. tons of grains per hectare on experimental plots (see Tables 11 and 12). Even if one were to reduce these yield levels to 50 to 60 percent, realizable under farmer conditions, one may expect big shifts in production levels, and consequently in farming systems.

The propositions stated above are not that easy to realize however. Questions can and will be raised by several people including agronomists, economists, and policy makers with respect to technological relationships and assumptions, economic feasibilities and implications including the distributional systems to translate the various yield into realities under real farm conditions and constraints. The intention is not to enter any lenghty discussion of these aspects, at least in this paper.

Two specific conclusions will however emerge from the data presented above. First, Upper Volta cannot in the absence of all-round concerted efforts, produce enough food to meet its growing demand. Second, agricultural scientists have a challenging task to evolve technologies that raise production and productivity on small farms, and such technologies fit well in the system.

Evidence suggests that there is scope for varietal improvements, more efficient agronomic practices, changing farming methods from hand tool to animal traction, and upgrading the skill of farmers in the use of modern farming practices. That whether we find an appropriate technology that can modify existing farming systems and thereby increase farm production for the majority of small producers will, although not easy in semi-arid regions, determine whether or not we will succeed in improving the lot of the poorer among the poor farmers in the third world.

V

THE SAMPLE REGIONS

The three areas, Ouagadougou, Ouahigouya and Zorgho selected for study in the first phase of the Farming Systems Research during 1979 and 1980, are in the Central region of the country. In terms of agricultural potential, the Ouagadougou and Zorgho regions have been categorized as "poor" while the Ouahigouya as "very poor" region1/. The three study areas in the central region have much higher population density in the country2/, the pressure of population on cultivable land is accordingly the highest (Table 9).

TABLE 9

AREAS AND POPULATION OF THREE SAMPLE REGION, UPPER VOLTA

Study Region/ORD	Total area km^2	Total population (1000)	Density km^2
Ouagadougou	24,179	847.6	35.1
Zorgho/Koupela	9,039	272.6	30.2
Ouahigouya/Yatenga	12,239	531.5	43.2
National average	-	-	17.9[2]

Source : Ministry of Planning and Rural Development

1/ There are in all 11 ORD's (Regional Development Organizations) which are geographic units covering the country. These are autonomous organizations responsible for extension services, credit, marketing and rural infrastructures. The ORDs in the Western Region (Bobo, Banfora and Diébougou and Dédougou) are "Good" (Dédougou is "Fair") and have IBRD sponsored development projects. In Eastern region, Fada N'Gourma is "Mediocre", and it has an USAID sponsored development project (and also UNDP).

2/ Population density in other regions is : Koudougou 27.9 ; Diébougou 20.6 ; Banfora 9.8 ; Bobo 11.5 ; Dédougou 16.2 ; Kaya 27.8 ; Fada 6.

The data in Table 10 reveal that cereal crops occupy the major land area under cultivation in all the regions, although in the lower rainfall regions, the relative area under cereals is larger than the high rainfall areas. For example, cereals occupy 92 to 93 percent of cultivated land in Dori and Yatenga regions as compared to 70 percent in the Western regions of Bobo, Diébougou and Banfora. Similarly, in the Central regions of Ouagadougou, Yatenga and Koupèla sorghum and millets are comparately more important in cropping patterns than the Western and the Eastern regions. In the latter, maize, peanut and cotton occupy more important place than in the former. The distribution of crops across the major regions of the country does indicate the relative potentialities of different crops for future expansion in production. While sorghum and millet are grown universally all over the country, a crop like maize will have better prospects for increasing production in areas like Bobo, Diébougou and Fada where per farm area under maize is between 0.30 to 0.42 hectare as compared to 0.005 to 0.13 hectare in the ORDs of the Central region.

The data presented in Table 10 provide a comparative view of the cropping systems and levels of productivity in the three study regions vis-a-vis some of the country's selected ORD's.

The data on per hectare yields of cereal crops (Table 10) reveal significant differences in productivity levels among the regions. Per hectare yield of sorghum is as low as 148 kg in Dori, 368 kg in Ouahigouya (Yatenga), 495 kg in Ouagadougou region as compared to 844 kg in Bobo and 848 kg in Fada.

TABLE 10

LAND USE, CROPPING SYSTEMS AND YIELD LEVELS IN THE THREE SAMPLE REGIONS VIS-A-VIS SOME SELECTED REGIONS OF UPPER VOLTA

Area/Prod/ Rainfall	Sample Regions/ORDS			Other selected Regions				
	Ouaga	Yatenga	Koupela	Bobo	Dié-bougou	Banfora	Fada	Dori
Total cultivated land area 1977 (1000 h)	490	220	130	150	200	90	190	140
Area under cereals (ha) (1000 h)	390	205	100	105	140	70	155	130
Cotton (1000 h)	4	-	-	20	4	-	-	-
Legumes (1000 h)	15	9	18	11	16	8	17	-
Cultivated surface per active person	0.96	0.80	1.0	1.02	1.10	-	1.02	0.74
<u>Per Farm area under</u>								
Sorghum (h)	3.64	1.80	2.7	2.46	1.80	-	2.95	2.30
Millet (h)	3.64	1.20	2.7	1.26	1.90	-	1.48	2.30
Maize (h)	-	0.005	0.13	0.30	0.30	-	0.42	-
Peanut (h)	0.15	0.15	0.56	0.42	0.45	-	0.77	-
Cowpea (h)	-	0.20	0.15	0.24	0.65	-	-	0.07
Cotton (h)	0.09	0.03	0.03	0.72	0.11	-	0.30	-
<u>Per hectare yields (1977-1978)</u>								
Sorghum (kg)	495	368	650	844	545	560	848	148
Millet (kg)	408	300	360	690	434	520	618	229
Maize (kg)	263	206	350	1045	651	850	1230	-
Peanut (kg)	315	313	500	620	402	780	718	250
Cotton (kg)	365	201	229	866	249	140	700	200
Average	750	600	700	1100	1100	1200	700	400
Rainfall mm	1000	700	1000	1200	1200	1400	1000	700

Source : Ministry of Rural Development, Government of Upper Volta

As evident from the data in Table 10, per hectare millet yield is 229 kg in Dori, 300 kg to 408 kg in the Central region, and 434 kg to 690 kg in the Western region.

For maize, yield differentials are equally marked. In the Central region of Ouaga and Zorgho, per hectare yield of maize is 263 kg to 350 kg as compared to 1 045 kg in Bobo, 850 kg in Banfora, and 1 230 kg in Fada.

Differences in yield reflect among other things conditions of rainfall, soil fertility, and management practices, and the overall resource endowments of the various regions. Equally important, they indicate future possibilities and prospects for productivity-increasing efforts through technological changes, and developmental policies with regard to infrastructures, credit and fertilizer distribution, and farmers training and skill formation programs.

It is interesting to compare at this stage the existing yield levels with those realized at the experiment stations, research managed trials, and model farms (Table 11). Take the case of sorghum and maize for which data are available. The ICRISAT's sorghum variety E-35-1 has the potential for giving an average yield of 3.5 m. tons to 4 m. tons or even more per hectare with the recommended fertilizer applications and management practices. Such yield levels can of course be realized under ideally controlled conditions, which would be difficult to insure under farmer's conditions.

The FSU/SAFGRAD research managed farmer fieldtrials have yielded 1.8 m. tons of rains per hectare of E-35-1 and 1.3 m. tons of SV 35 (Table 12). If the farmers were to manage their crops, the yield levels would be less. It is clear that evidence under more varied conditions than at present need to be collected in regard to these varieties.

On IRAT's experimental plots and SARIA model farms, the average per hectare yield of sorghum ranges between 2 to 2.5 metric tons of grains. The model farm technology was highly controlled and subsidized. The recepients of this technology were the employees of the institute diffusing technology. The spread-over effect under real farm conditions was negligible, if any.

Maize yields reported by maize agronomists and breeders (IITA, IRAT) vary from over 2 metric tons to over 3 metric tons per hectare. Such yield levels are related to different levels of fertilizer applications, management practices, and varietal changes under West African farming conditions (Table 11).

Two points need to be emphasized while comparing the existing crop yields and those realized under modified farming conditions (varietal change, or improved management practices including use of fertilizers etc.). First, it is not possible under farmer's conditions to realize the ideal or potential yield levels of 3.5 to 4 m. tons of grains per hectare, be it for sorghum or maize. To be realistic, perhaps 1.2 to 2.0 m. tons of yields can be realized in farmers' fields, provided the recommended practices are followed by farmers.

It is also true that there could be identified areas and farmers that would have conditions conducive to realizing higher yields than 1 to 2 m. tons per hectare. This brings us to another question. If we consider the national average yield statistics for cereals, it is about 500 kg per hectare. This average however hides some very important facts about yield potentialities in the regional and subregional contexts. For example, as shown by the data in Table 10, the average yield for sorghum ranges from as low as 148 kg in Dori region and 368 kg in Yatenga region to as high as 844 kg in Bobo region and

and 848 kg in Fada region. Likewise for maize, it ranges from 206 kg in Yatenga to 1 230 kg in Fada and 1 045 kg in Bobo (Table 10). For AVV farms, it is over 1 000 kg per hectare. For other crops also almost the same pattern of yield differentials holds.

Such productivity differences in the existing farming systems that we observe in the country would give us some useful guidelines for comparing the experiment station's experimental plots yields with the existing yields already realized by farmers in different regions, especially by those who are already obtaining yields around 1 m. ton or more per hectare. In one of the FSU's seven villages (ie. Nedogo), mean yield of E-35-1 (sorghum) on 4 farmers plots (4 paired observations) was estimated at 1 120 kg as compared with the local sorghum yield of 1 690 kg per hectare. Two other observations of E-35-1 in the same area with no local checks showed and average yield of 1 720 kg per hectare. The two varieties were planted on relatively high quality village fields.

Therefore, for valid comparisons and meaningful extrapolations, the macro level average yields will not represent a true picture. It is necessary that scientists, policy makers and development agencies compares yields in the regional and subregional context. This will help in identifying regions with different potentialities in respect of different cropping systems and crop improvement programs. In countries like Upper Volta, if the objective is to realize maximum results in cereal production in as short period as possible, scarce research and developmental resources will need to be allocated on a selective basis with relatively higher priorities to areas which have greater potentialities for yield-increasing technologies and higher economic returns to investment.

The same will hold in the regional and subregional context. Priorities need to be assigned within the region either for allocating resources for agricultural research and development, or for increasing farm production through the provision of credit, input supplies and building up infrastructures. Within the major areas, an important question to ask is as to how to place the relative emphases on individual crops and/or regions while making decisions about investment in agricultural research, irrespective of the source or sources of funding for such research. Should not the relative economic return per dollar spent be a key factor to determine the order of priorities for investment in research and development efforts ?

TABLE 11

PER HECTARE YIELDS OF SORGHUM AND MAIZE REALIZED AT EXPERIMENT STATIONS AND MODEL FARMS, UPPER VOLTA

Variety	Average yield in kg/hec	Observations
Sorghum E-35-1	3 500 to 4 000	Reported by scientists of ICRISAT on the basis of experimental results.
Red Sorghum		
SARIA MODEL FARM(IRAT) 1969-74	2 551	IRAT's model farm in SARIA (HV) with 4.4 hectares of cropland since 1969, with 6 persons (3 active), was phased to bring 1 hectare a year under improved technology. Yield figures arrived in fifth year.
IRAT P & K Experiments for sorghum 1964 & 1974	975	0 level
	1 806	50 kg of P205/H (16.6 kg grain/kg of P205)
	1 958	100 kg P205/h (3 kg grain/kg)
	1 228	0 level
	1 679	50 kg K20/h (9 kg of grain/kg K20)
	1 848	100 kg K20/h (3.4 /kg)
Maize IRAT 100	3 023	Mean yield based on IITA's trials in Upper Volta, Senegal, Mali, Ivory Coast & Benin (1979)
B D S III	2 970	" " " " "
Jaune de Fo	2 328	
Massayomba	2 286	
Cowpea KN1	1 500	3 years average based on IITA SAFGRAD trials

Source : ICRISAT, IITA/SAFGRAD and IRAT, Reports.

TABLE 12

PER HECTARE YIELDS OF NEW SORGHUM AND COWPEA VARIETIES
ON FSU/SAFGRAD RESEARCH MANAGED FIELDS
IN SAMPLE VILLAGES, UV 1980

Crop variety	Yield in kg	Observations
E-35-1 (Sorghum)	1 800	Village fields with preplanting cultivation and 100 kg RP + 20 kg Urea per hectare 1980 research-managed trial
	1 500	Village fields without preplanting cultivation ; no fertilizer. 1980 research-managed trial
	750	Bush fields with preplanting cultivation and 100 kg RP + 20 kg Urea per hectare. 1980 research managed trial
	150	Bush fields without preplanting cultivation ; no fertilizer. 1980 research managed trial
SVP 35 (Sorghum)	1 300	Sandy valley soils Ouahigouya 1980 with preplanting cultivation and 100 kg rock phosphorous and 20 kg Urea per hectare research-managed trial
	600	Sandy valley soils Ouahigouya 1980 without preplanting cultivation, no fertilizer research-managed trial

Source : FSU Field Trials in Sample Villages, 1979-1980, (Paul Christensen's Report)

VI

SAMPLE FARMS IN THE THREE REGIONS OF UPPER VOLTA : STUDY OF HOUSEHOLD AND PRODUCTION SYSTEM

Land and Labor are two most important resources that small farm households in African agriculture command. Land distribution has generally been governed by local tribal customs and traditions. Individual rights and ownerships do not follow any legally defined system as is the case in the Western legal system, or in several other anglophone countries of third world. Land distribution system will not be discussed in this paper because it is complicated, and this subject was not covered in the objectives of the study. Therefore distributional aspects although important will not appear in the present discussion.

Small farmers' capital consists in most parts of small hand tools and implements used for planting and weeding operations. Animal traction is not universal. In Upper Volta, its use is limited.

Human Resources in the Sample Households

A household in mossi villages generally consists of the chief or head of the household, his wife or wives, and their young children. Sometimes married sons and other relatives also stay in the household. The data presented in Table 13 shows the size distribution of sample households by age and sex. Since labor supply comes mainly from the household and farm production is carried out mostly by family labor, it is important to consider household's manpower resource in both its quantitative and qualitative dimensions. This is important because of two things. First, farm production is heavily dependant upon labor supply because most of the production activities are carried out by hand. Second, under changing production technology and disequilibrium conditions the quality aspect of population becomes critical. Some qualitative change in the human agent of production must occur to cope up with the changing economic and technological relationship s.

TABLE 13

MEAN NUMBER OF PERSONS PER SAMPLE HOUSEHOLD*
BY AGE AND SEX - THREE REGIONS, UPPER VOLTA

Age (Years)	Ouaga		Zorgho				Ouahigouya			
	Nedogo		Digre		Tanghin		Aorema		Sodin	
	M	F	M	F	M	F	M	F	M	F
0 - 6	1.5	1.4	1.1	1.6	1.0	1.4	1.8	1.6	1.2	1.8
7 - 9	1.3	0.4	0.4	0.7	1.0	0.7	0.4	0.6	0.8	0.7
10 - 14	0.9	1.0	0.4	0.5	0.8	0.3	0.6	0.3	0.9	1.0
15 - 18	0.5	0.8	0.1	0.4	0.6	0.4	0.7	0.8	0.5	0.7
19 - 21	0.6	0.6	0.2	0.2	0.3	0.2	0.1	1.0	0.5	0.5
22 - 55	2.4	2.5	2.1	2.4	1.9	2.0	1.7	2.2	2.5	2.7
56 - 59	0.2	0.1	-	-	0.1	-	-	0.1	-	0.4
60 - 64	0.1	0.2	0.2	-	-	0.1	0.2	0.3	0.1	0.1
65 - 69	0.1	0.1	0.1	-	0.1	-	0.3	-	0.2	-
70 +	0.2	0.3	-	0.1	0.2	-	0.4	0.3	0.6	-

Source : FSU sample survey, 1979- 1980

* Includes all members present and absent.

M = Male

F = Female

On an average there are in all the sample over 10 persons present per household. If however one were to include also the absent members, this will come to over 13 persons per household. The sample villages in the Ouahigouya region have relatively large sized households than the other two regions. The average size of sample households estimated on the basis of the present members in the household is as presented in Table 14.

TABLE 14

NUMBER OF PERSONS (PRESENT) PER SAMPLE HOUSEHOLD

Village	No. of persons
Nedogo (Ouagadougou)	11.3
Sodin (Ouahigouya)	12.7
Aorema (Ouahigouya)	11.2
Digre (Zorgho)	8.6
Tanghin (Zorgho)	8.0

Data on literacy and education among the sample heads of households show that except for one household head in Nedogo all the heads of sample households are illiterate. In the two villages of Zorgho, the illiteracy rate among the heads of households is one hundred percent. The same is true in the case of the sample households in the Ouahigouya region. This indeed speaks of the low quality of population in terms of literacy and education.

Migration in Sample Population

Migrant members constitute an important part of household's socio-economic structure in mossi villages where out-migration is probably of the highest order in the country. This is because of acute population pressure on land, and lack of alternative economic opportunities in the region.

As evident from the data in Table 15, eighty one percent of all the sample households had migrant members living outside the village permanently, but with links with their families. On an average, there were 3 persons or one 33 percent of household total population who live outside. The sample villages in Zorgho region have relatively higher out-migration (3.5 persons per household) than the Ouagadougou village (2.1 persons). The majority of the migrants, about 70 percent of all, went to Ivory Coast (Table 16). Ouagadougou the capital city of Upper Volta accounts for about 24 percent of all the migrants ; of the rest 6 percent, 5 percent migrated to Bobo and Pô regions, and about 1 percent to Ghana.

The major contribution of migrants to village farm households is through remittances of money, and gifts in kind that they bring with them which augment household's economic resource base. Of course, to the extent adult members of households leave for outside employment, there is reduction in households labor force. But, the question is that of the relative gain and/or loss from such migration. Economic theory would suggest that labor moves out from a given region for better earnings and higher living standards. In the present case, the gain to households from migrant members earning outside is estimated to range from 2 000 CFA to 5 000 CFA of money income per annum, besides gifts in kind (Table 17). Considering the low level of income, this is a substantial contribution.

In addition to the tangible income contribution, the migrant members provide useful sources of information to households about the outside world, and sometimes can prove to be important vehicle of qualitative changes in household's human resource base through investment in education and training., or in production systems. Contacts with urban industrial centers through migrants widen household's outlook and attitudes towards technological changes and their adoption.

TABLE 15

DISTRIBUTION OF SAMPLE HOUSEHOLDS BY NUMBER OF PERMANENT MIGRANTS IN ZORGHO AND OUAGADOUGOU VILLAGES UNDER STUDY

Number of migrants	PERCENTAGE OF SAMPLE HOUSEHOLDS		
	Ouagadougou region	Zorgho region	
	Nedogo	Digre	Tanghin
1	28.7	23.1	25.0
2	28.7	23.1	25.0
3	14.3	15.3	8.3
4	4.8	7.7	16.7
5	14.3	7.7	-
6	4.8	7.7	-
7	-	-	-
8	-	-	-
9	-	7.7	-
10	4.8	7.7	-
11	-	-	16.7
12	-	-	-
13	-	-	-
15	-	-	18.3
Total	100.0	100.0	100.0
Average number of migrants per household with migrants	3.0	3.8	4.7
Average for the whole sample	2.1	3.3	3.8

Source : FSU sample survey, 1979-1980

TABLE 16

PERCENTAGE DISTRIBUTION OF MIGRANTS BY DESTINATIONS

Destination	Nedogo	Digre	Tanghin
Ouagadougou	15.5	22.9	33.3
Zorgho	-	-	3.5
Ouahigouya	-	-	-
Bobo	1.7	-	-
Leo	-	-	-
Pô	8.6	-	-
Suntanga	1.7	-	-
Dori	-	-	-
Moapa	-	-	1.7
Ghana	1.7	2.0	-
Ivory Coast	70.6	75.0	61.4
Total	100.0	100.0	100.0

Source : FSU sample survey, 1979-1980

TABLE 17

MONETARY AND NON-MONETARY BENEFITS OF MIGRATION

Type of Benefit	Nedogo	Digre	Tanghin
Money Remittance			
% of households receiving	33	67	53
% of migrants remitting	23	31	21
Average amount received per receiving household (CFA)	6 600	7 800	6 312
Average amount received per sample household (CFA)	2 000	5 200	3 367
Non-monetary (Kind gifts)			
% of households receiving	33	40	20
% of migrants sending	18	20	14
% of households receiving clothes/dresses	30	27	20
% of migrants sending clothes/dresses	16	18	14
% of households receiving foodgrains (millet, rice and sorghum)	-	13	7
% of migrants sending	-	8	7
% of households receiving bicycles	7	13.3	-
% of migrants sending bicycles	1.6	4	-

Source : FSU sample survey, 1979-1980

Role of wives in household and production systems

Wives play a crucial role in the mossi family's socio-economic structure. Normally, the chief of a household has more than one wife, and as he rises in the socio-economic status in life cycle, the number of women he marries tends to increase. Women provide a very important source of labor, first by their own work, and second by producing children who later augment household labor supply.

The data in Table 18 indicate that on an average there are two wives per chief of household in the sample. There are however inter-village differences in the number of wives per household. Nedogo has relative greater percentage of households with three and more wives than the villages in the Zorgho region.

TABLE 18

PERCENTAGE DISTRIBUTION OF SAMPLE HOUSEHOLDS BY NUMBER OF WIVES PER HEAD OF HOUSEHOLD : SMALL FARMS IN TWO REGIONS, UPPER VOLTA (1980)

Number of wives	Ouaga region	Zorgho region		Total	All total
	Nedogo	Digré	Tanghin	Zorgho	Zorgho & Ouaga
1	25.9	20	33.4	31.9	29.6
2	37.1	73.4	26.7	40.9	39.4
3	25.9	6.6	6.6	6.8	14
4	7.4	0	26.7	18.2	14
5	0	0	6.6	2.2	1.5
6	3.7	0	0	0	1.5
7	0	0	0	0	0
7	0	0	0	0	0
Total	100.0	100.0	100.0	100.0	100.0
Average per head	2.3	1.9	2.5	2.2	2.2

Source : FSU sample survey, 1979-1980

Fertility and Mortality Rates

The data on the number of children born and dead among sample households (Table 19) show interesting and the same time disturbing trends. As one would expect the number of children born per household increases with number of wives. But so does the number of deaths among young children (0-4 years). The average number of children born per household is estimated at 12 (6.4 male + 5.6 female) ; of these four, or 33 percent of the total die while young. Six children are born per wife, and of these about one-third do not survive. A mortality rate of 33 percent is indeed very high, and this would reflect among other things the health and nutritional status of women among poor small farm households, and medicare facilities in rural areas.

A high fertility-mortality rate may seem a puzzle, but it is not. The households under study are poor households operating small farms all with the help of family labor. Under the present production technology, labor is a major input in production ; more hands generally would mean more land under cultivation, more fields to farm (Table 20), more timely seeding and weeding operations, and also freeing the chief of the household for other off-farm activities. Therefore, there is greater tendency among household chiefs to have more wives, and with more wives there would be greater tendency to produce more children, other things contant. But, with more children born, under the present health and nutritional standards, the chances of mortality also increase, and then follows a peculiar but unfortunate vicious circle.

Women's Role in Crop Production Systems

It needs however to be recognized that wives and children provide dominant sources of labor to poor farm households and hence their economic value to households

TABLE 19

CHILD MORTALITY RATES IN PERCENTAGE AMONG SAMPLE FARM HOUSEHOLDS

No. of wives/chief	Percentage of death among children						
	Male children			Female children			All children
	Ouaga	Zorgho	Total	Ouaga	Zorgho	Total	
1	25.0	38.1	33.3	40.0	26.2	30.6	32.0
2	30.6	37.5	29.6	36.5	34.1	35.0	32.0
3	27.3	42.3	32.1	30.8	28.0	29.9	31.0
4	46.2	31.2	34.9	29.2	38.0	36.3	35.6
5	-	23.5	23.5	37.5	33.3	33.3	27.6
6	33.3	-	33.3	-	-	37.5	35.3
7 +	-	-	-	-	-	-	-
Average (%)	31.4	35.4	31.7	34.1	33.3	33.7	32.6
Average No. of children born/household	6.4	6.5	6.4	6.1	5.3	5.6	12.0
Average No. of children who died while young/household	2.0	2.1	2.0	2.1	1.8	1.9	4.0
Average No. of children born/wife	2.8	3.0	3.0	2.6	2.4	2.5	5.8
Average No. of children died/wife	1.0	1.0	1.0	0.9	0.8	0.8	1.8

Source : FSU sample survey, 1979-1980

in low income countries. in the Voltaic context this is even more so. Besides social status, wives and children provide important sources of economic power to tradition bound farm households. Data on number of fields operated by households, number of wives per household chief, and number of children in the households (Table 20) shows positive association between the number of wives and children and the number of fields operated by households.

An interesting characteristic of the crop production system on small farms is the role of women in managing crop fields. For crops like peanut, earthbean (pois de terre), okra and roselle (bitto), the major production and sales responsibilities lie with women in the household, mainly chief's wife or wives (Table 21). Except in Digré village (Zorgho), in all other sample villages all the earthbean fields were operated by women. Eighty four to one hundred percent of okra fields, one hundred percent of roselle fields, and 48 to 76 percent of peanut fields were the responsibilities of women in the households. For cereal crops also, women' fields accounted for 23 to 36 percent of all the household fields under millet, and 12 to 40 percent of all fields under sorghum. It is true the size of these fields is relatively very small.

Land use and cropping system on sample farms

Tables 22 and 23 present the summary data on cropping systems followed on small farms in the three areas of Upper Volta. The two tables have more or less the same set of data. However, Table 22 gives a detailed account of all possible crop combinations practised by small farms, while Table 23 provides a summary with four major breakdowns of crop associations.

As shown by the data in Tables 22 and 23, millet is the most dominant constituent in the cropping system practised

TABLE 20

DISTRIBUTION OF SAMPLE HOUSEHOLDS BY NUMBER OF FIELDS, WIVES AND CHILDREN, SMALL FARMS, THREE REGIONS, UPPER VOLTA

Average No. of fields per household	Percentage of households	Average No. wives per chief	Average No. of other married women in the household	Average No. of all children in the household
Nedogo (Ouagadougou)				
9.0	(30.0)	1	1.2	5.3
10.0	(27.0)	2	1.0	8.0
14.0	(27.0)	3	2.0	16.6
20.5	(13.0)	4	1.2	15.0
25.0	(03.0)	6	5.0	22.0
Digre (Zorgho)				
16.0	(20.0)	1	3.3	4.3
19.8	(73.4)	2	0.9	8.6
35.0	(06.6)	3	5.0	22.0
Tanghin (Zorgho)				
11.4	(33.3)	1	0.2	5.2
11.7	(26.8)	2	0.75	8.5
19.0	(06.6)	3	4.0	17.0
16.5	(26.7)	4	2.5	20.5
18.0	(06.6)	5	1.0	21.0

Source : FSU sample survey, 1979-1980

TABLE 21

DISTRIBUTION OF CROP FIELDS BY HOUSEHOLDS MEMBERS
IN THREE REGIONS OF UPPER VOLTA (1980)

Crops	% of crop fields under each crop								
	Chief of household			Chief's wives and other females members			Chief's sons and other male members		
	Nedogo	Aorema	Digre	Nedogo	Aorema	Digre	Nedogo	Aorema	Digre
Millet	49	62	71	36	23	24	15	15	5
Red sorghum	79	-	40	12	-	40	9	-	20
White sorghum	75	60	81	20	30	11	5	10	8
Maize	98	89	80	-	-	7	2	11	13
Peanut	24	19	39	68	76	48	8	5	13
Okra	3	8	-	97	84	100	-	8	-
Earthbean	-	-	36	100	100	59	-	-	5
Roselle	-	-	-	100	-	100	-	-	-
Rice (paddy)	100	-	25	-	-	-	-	-	75
Cotton	-	-	-	-	-	-	-	-	-
Cowpea, earthbean	-	-	100	-	-	-	-	-	-
Other crop	-	-	-	-	-	-	-	-	-
Red pepper	-	-	100	-	-	-	-	-	-

Source : FSU sample survey, 1979-1980

by small farmers in the sample. The next important cereal crop grown is sorghum, followed by peanut and maize. In addition to these major cereals, the other crops that are commonly grown by farmers include earthpea, roselle (bitto), okra (gombo) and redpepper.

Millet : Millet fields account for 30 percent to 37.5 percent all the fields operated by households in the three sample villages in Nedogo, Aorema and Digre, for which field data has been computed up to date. There are as many as 10 different crop combinations ranging from one to three associated crops grown with millet as the principal crop. As indicated by the data in tables 22 and 23, the associated crops include cowpea, sorghum, roselle (bitto), earthbean, and to a very limited extent cotton.

However, the most common association is with cowpea in as much as 64 percent of all the millet fields in Nedogo, 69 percent in Aorema, and as high as 91 percent in Digre had millet cowpea association (Table 23). Millet-cereal association was in 5 to 7 percent of all millet fields.

Millet as a single crop is more common in Nedogo than in the other villages. About 7 percent of all millet fields had single millet crop as compared to none in Aorema (Ouahigouya) and 5.4 percent in Digre (Zorgho).

Sorghum : Farmers in two out of the three villages grow both the red and white varieties of sorghum. These are Digré (Zorgho) and Nedogo (Ouagadougou) which have had respectively 95 percent and 68 percent of all their sorghum fields under red sorghum. The sample farmers in Aorema (Ouahigouya) region did not grow any red variety at all. Preference for red sorghum in the two villages is explained by the fact that there is greater demand for red sorghum for local beer making in these regions, while in

Aorema where sorghum is used mostly as a food grain.

As with millet, the most common associated crop with sorghum whether red or white was cowpea consistently in all the study areas. However, as shown by the data in Table 21, there were eight to nine kinds of crop combination grown by sample farmers along with sorghum as the principal crop.

Fields with a single crop of sorghum formed 27.3 percent of all red sorghum fields, and 10 percent of all white sorghum fields in Nedogo. In Digre, this was 4.3 percent and 50 percent respectively. In Aorema none of the sample farmers grw sorghum (white) as a single crop ; all of them had white sorghum in association with cowpea in one way or another.

Maize : Maize is grown by every farmer with an average of one to two fields per household. In terms of its relative share in household's total cropped land it is very small. In Nedogo village, for example, for a subsample of 10 households maize area was estimated at 3.5 percent of total cropped land. For the country's average it ranges from 5 to 7 percent of the total cropped land. In terms of number of fields, maize fields account for about 12 percent of all fields in Nedogo, 8 percent in Aorema and 5.4 percent in Digre.

Aorema (Ouahigouya) has relatively much higher percentage of fields under single maize crop (22 percent), as compared to Nedogo (9.2 percent), as well as Digre (7.7 percent).

In most of the sample maize fields the associated crops were red or white sorghum. Percentage-wise, about 85 percent of all maize fields in Digre, 50 percent in Aorema and 37 percent in Nedogo had red or white sorghum as the main crop association.

It needs to be pointed out that in the three study regions maize is grown on land closest to the compound (champs des cases). Fields close to the compound are generally of better quality in terms of soil fertility. Farmers have over time taken care of such fields by supplying these fields with household wastes and other forms of organic manurial materials which have augmented the fertility status of soils.

In most cases two major cereal crops compete for such fertile soils, sorghum and maize. However, maize has not taken the larger share of such lands, sorghum on the other hand has, and farmers generally allocate relatively greater percentage of cultivated land to sorghum than maize. This can be explained by two factors primarily. First, sorghum is a staple food for the majority of farmers in the region, and hence a relatively much greater demand for this crop for domestic consumption. Second, maize is relatively a more sensitive crop and farmers run greater risks of loosing the crop when there is drought. As a rainfed crop sorghum has relatively greater probability of survival under drought conditions than the maize crop has, other things constant.

The relative cost-benefit perspective of the two crops can be altered by technological changes, such as by introducing drought resistant high yielding seed variety, or by modifying the existing management practices. If farmers find maize relatively more profitable, the chances for their allocating more land under this crop will increase. Profitability may be realized through reducing per unit cost of production, or increasing per hectare yield with the same input cost. Since maize occupies a relatively much smaller fraction of total cultivated land under the existing farming system, one would expect a relatively higher elasticity of substition for this crop than sorghum, the main competitor of maize, which occupies relatively a much larger land area. Therefore, an important

TABLE 22

CROP COMBINATIONS AND DISTRIBUTION OF FIELDS ON SMALL FARMS IN THREE REGIONS, UPPER-VOLTA (1980)

Crops & their combinations	% distribution of all fields operated by households		
	Nedogo	Aorema	Digre
Millet mono	5.0	2.7	0.4
Millet & cowpea	3.0	8.4	2.2
Millet + roselle	5.0	6.2	0.4
Millet + red sorghum	1.0	-	0.7
Millet + earthbean	0.3	-	-
Millet + cowpea + bitto	20.5	-	15.0
Millet + bitto + cotton	0.6	-	-
Millet + red sorghum + cowpea	0.6	-	14.0
Millet + white sorghum + roselle	0.6	-	0.4
Millet + cowpea + rice	0.3	-	-
Millet and other	0.8	11.7	0.7
Red sorghum mono	2.5	-	1.0
Red sorghum + maize	0.8	-	-
Red sorghum + white sorghum	0.6	-	-
Red sorghum + white sorghum + roselle	0.3	-	0.7
Red sorghum + cowpea	1.0	-	4.0
Red sorghum + cowpea + roselle	2.5	-	14.0
Red sorghum + cowpea + sesame	0.3	-	-
Red sorghum + roselle	1.0	-	1.0
Red sorghum and others	-	-	1.0
White sorghum mono	0.6	-	3.3
White sorghum + cowpea	0.8	-	-
White sorghum + cowpea + millet +roselle	0.3	4.0	-
Maize mono	1.0	2.0	0.4
Maize + red sorghum	0.8	-	0.7
Maize + white sorghum	1.3	-	-
Maize + roselle	1.3	2.2	0.4
Maize and other	7.0	4.0	4.0
Peanut mono	8.0	12.4	10.0
Peanut + roselle	9.0	2.7	5.2
Peanut and other	0.3	10.7	4.8
Okra mono	10.0	-	4.4
Okra and other	0.6	5.4	0.7
Rice mono	0.8	-	-
Earthbean mono	2.0	10.4	3.6
Earthbean & roselle	5.0	4.8	1.8
Earthbean and other	-	3.0	2.5
Others crops	0.3	-	2.5
Total	100.0	100.0	100.0

Source : FSU sample survey, 1979-1980

TABLE 23

CROPPING PATTERNS : PERCENTAGE DISTRIBUTION OF FIELDS BY CROPS IN THREE REGIONS, UPPER VOLTA

	Nedogo (Ouagadougou)		Aorema (Ouahigouya)		Digre (Zorgho)	
	Main fields	All fields	Main fields	All fields	Main fields	All fields
Millet mono	13.3	5.0	9.2	2.7	1.0	0.4
Millet cereal	6.6	2.5	-	-	5.4	1.8
Millet cowpea	63.9	24.0	69.3	20.0	91.4	29.5
Millet others	16.2	6.0	21.5	6.2	2.2	0.7
Red sorghum mono	27.3	2.5	-	-	4.3	1.0
Red sorghum cereal	15.2	1.7	-	-	2.9	0.7
Red sorghum cowpea	33.3	2.8	-	-	84.1	20.3
Red sorghum oghers	24.2	2.2	-	-	8.7	2.0
White sorghum mono	10.0	0.6	-	-	50.0	0.7
White sorghum cereal	5.0	0.3	-	-	-	-
White sorghum cowpea	85.0	4.7	190.0	13.0	25.0	0.4
White sorghum others	-	-	-	-	25.0	0.4
Maize mono	9.3	1.0	22.2	1.8	7.7	0.4
Maize cereals	37.2	4.4	50.0	4.0	84.6	4.6
Maize cowpea	-	-	-	-	7.7	0.4
Maize others	42.5	6.3	27.8	2.2	-	-
Peanut mono	46.0	8.0	48.3	12.4	50.0	9.5
Peanut cereal	-	-	-	-	-	-
Peanut cowpea	-	-	-	-	5.6	1.0
Peanut others	54.0	9.4	52.7	13.3	44.4	8.4
Okra	95.0	10.2	41.7	2.2	85.7	4.2
Okra others	5.0	0.5	48.3	3.2	14.3	0.6
Earthpea	28.0	2.0	57.1	10.7	45.5	3.5
Earthpea and others	72.0	5.0	42.9	8.0	54.5	4.2
Roselle and others	-	-	-	-	-	0.7
Rice (paddy)	-	0.8	-	-	-	1.4
Cowpea	-	-	-	-	-	0.4
Cowpea + others	-	-	-	-	-	-
Other crops	-	0.3	-	-	-	2.8
Red pepper	-	-	-	-	-	-

Source : FSU sample survey, 1979-1980

area of investigation in this regard will be to find out, under real farm conditions, the relative yield potential for maize in comparison to its competing crop(s) vis-a-vis the resource requirements and constraints of small farm households.

It is true that maize production cannot be expanded all over the country. Considering the agro-climatic requirements of this crop, certain areas like the southwest and Fada regions will have higher potentialities for production increase than the central and northern regions because of their comparative advantages in terms of soils, rainfall and other favorable resource endowments. Compare the average maize yields in the selected regions of the country as presented in Table 10. Therefore, relatively more concerted efforts need to be made in such areas of comparative advantages to promote yield increasing technology on a priority basis. This does not mean that other area should or could be ignored. The fact is that given scarce investment resources, economic rationality will suggest that one would allocate such resources where the comparative returns are high.

Cowpea : As stated earlier cowpea is grown universally as an associated crop with millet and sorghum, and to a limited extent with peanut. Cowpea as a single crop was found in only one field among all the sample households in Digre village (Table 22 and 23). Since cowpea production as a single crop is not common, it seems difficult to promote at this stage the idea of a single cowpea crop in the regions under study.

There is yet another important factor that need to be stressed. Cowpea will compete for land and other inputs with peanut if farmers were to plant it as a single crop. The improved cowpea variety KN1 will perform much better if grown as a single crop for that will allow for performing the necessary operations, particularly spraying which is a key element in influencing yield.

As indicated in Table 11, the yield potential for the cowpea variety KN1 is at least 1 500 kg per hectare with three to four sprayings of insecticides. Even if one assumes that in farmers field, the per hectare yield will be around 1 000 kg, this is much higher than the present yield levels of 200 to 250 kg per hectare. A rough and quick cost benefit calculation will yield the following figures.

	Cost Item/hectare	Amount (CFA)	Observations
on Cost side : (per hectare)	Labor cost	11 600	For 290 hrs of work required per hectare for plowing, planting, weeding & harvesting.
	cost on seed	3 200	30 kg of seeds
	Fertilizer	3 000	
	spraying	14 000	Includes both the variable costs and depreciation cost
	Total	31 800 CFA	

On Revenu side :

Total yield (assumed)	1 000 kg/ha
Additional yield	1 000 kg - 250 kg = 750 kg
Total revenue	750 x 60 CFA = 45 000 CFA
Net revenue	45 000 CFA - 31 800 CFA = 13 200 CFA/hectare

To realize this net revenue, the farmer will have to make an initial investment of approximately 24 000 CFA (15 000 CFA for the sprayer at a subsidized price plus the costs on spray, batteries etc). There are two questions before the farmer. First is how to get 24 000 CFA to undertake the initial investment. The next question will be : if he gets the money, is it more advantageous for him to invest this money on the sprayer, or he may invest this money elswhere, may be to buy a "hoemanga".

There are other questions as well. Will cowpea yield higher revenue per hectare of land than its competitor, other things being equal ? We don't know if this is so. Marketing and pricing of cowpea are other issues that will raise their head in the second generation of problem. Equally important will be the question regarding the infrastructures needed to promote cowpea production.

Farmers' knowledge and capabilities are essential elements in the whole process of spreading the new cowpea technology on small farms, knowledge about the use of sprayers to make them economical, money to buy the equipment, repair facilities and the like.

Therefore, the questions that need to be investigated are as follows :

1. Relative profitability or returns from cowpea vis-a-vis its competitors,
2. Extent of competition for land and other resources between cowpea and peanut,
3. Economic returns to sprayings ; estimates of yield in relation to the timing and number of sprayings ; and alternate uses of sprayers to make investment remunerative,
4. Relative economics of cowpea production as a single versus as associated crops.

USE OF MODERN INPUTS ON SMALL FARMS

The use of modern inputs such as chemical fertilizers is negligible. The data in Table 24 show one farmer out of 20 in Nedogo and 2 out of 10 in Aorema used phosphate. This fertilizer was however made available at cost price by the Farming Systems Research Unit as a part of its fields trials activities. Farmers allocated this fertilizer to millet, sorghum and peanut. Overall, the quantity used at the farm level is hardly of any significance on an average for the whole sample, 180 CFA worth of phosphate per farm was used in Nedogo, for Aorema it was 600 CFA per farm.

Organic fertilizer however was used by relatively larger percentage of farmers in the sample. The percentage of sample farmers applying organic fertilizer to millet fields was 25 for Nedogo (Ouagadougou region), 50 for Aorema (Ouahigouya), and 33 for Digre (Zorgho). None of the sample farmers in Nedogo applied organic fertilizers to sorghum, although in Aorema and Digre 20 percent of them gave some organic manures to this crop. In case of maize fields, 20 percent of farmers used these manures, whereas in the other two villages none of the farmers reported to have used such manures. In terms of value per sample farm, it is 324 CFA in Nedogo, 1 340 CFA in Aorema, no estimate was available for Digre farmers.

A small proportion of farmers reported to have used such chemicals as insecticides, fongicides and pesticides. Use of insecticide was confined to only one farmer (or 5 percent) in Nedogo for millet crop in one field, none else is reported to used it in the other villages. Fungicide was applied by 30 percent of the sample farmers in Nedogo, mostly for millet crop, and 10 percent each for sorghum and peanut crops in Aorema village. The value of such purchased inputs per farm in the sample was very small and non-significant.

Despite the small overall value of purchased inputs used on farms, it is however clear that there is awareness

TABLE 24

USE OF MODERN INPUTS AMONG THE SAMPLE FARMS, THREE REGIONS, UPPER VOLTA

Inputs	Nedogo				Aorema				Zorgho (Digre)			
	Sorghum	Millet	Maize	Peanut	Sorghum	Millet	Maize	Peanut	Sorghum	Millet	Maize	Peanut
Improved seeds	-	-	-	-	-	-	-	-	-	-	-	-
Phosphate												
No. of farmers	-	1	-	1	1	2	-	-	-	-	-	-
No. of fields	-	1	-	1	3	4	-	-	-	-	-	-
Val/CFA	-	2800	-	NA	3525	2555	-	-	-	-	-	-
Urea												
No. of farmers	-	-	-	1	-	-	-	-	-	-	-	-
No. of fields	-	-	-	1	-	-	-	-	-	-	-	-
Val/CFA	-	-	-	NA	-	-	-	-	-	-	-	-
Cotton Fertilizer												
No. of farmers	-	-	-	-	-	-	-	-	-	1	-	-
No. of fields	-	-	-	-	-	-	-	-	-	2	-	-
Val/CFA	-	-	-	-	-	-	-	-	-	1050	-	-
Organic manures												
No. of farmers	-	4	-	-	2	5	2	-	2	3	-	-
No. of fields	-	5	-	-	2	8	2	-	3	6	-	-
Val/CFA	-	6475	-	-	NA	5000	8040	-	NA	NA	-	-
Insecticide												
No. of farmers	-	1	-	-	-	-	-	-	-	-	-	-
No. of fields		1	-	-	-	-	-	-	-	-	-	-
Val/CFA	-	100	-	-	-	-	-	-	-	-	-	-
Fungicide												
No. of farmers	1	5	-	-	1	-	-	1	-	-	-	-
No. of fields	2	14	-	-	1	-	-	1	-	-	-	-
Val/CFA	120	1685	-	-	75	-	-	150	-	-	-	-
Pesticide												
No. of farmers		-	-	-	-	-	-	-	1	3	-	-
No. of fields		-	-	-	-	-	-	-	1	4	-	-
Val/CFA		-	-	-	-	-	-	-	50	525	-	-

Source : FSU sample survey, 1979-1980

among some farmers about the usefulness of the application of some of the modern inputs in production system. Identifying such farmers will be a very fruitful effort from the standpoint of extension of modern farming practices.

USE OF ANIMAL TRACTION ON SAMPLE FARMS

Data in Table 25 shows the use of animal traction on small farms by crop and operation. Among the three sample villages, the village in the Zorgho region use much less of animal traction than those in Ouagadougou and Ouahigouya regions. This is evident from the fact that in village Digre of Zorgho region only 10 percent of sample farmers used animal traction for weeding of millet and sorghum fields as compared to 53 to 63 percent in Nedogo (Ouagadougou) and 20 percent in Aorema (Ouahigouya). The use of animal traction by crop and operations shows certain interesting patterns.

Land Preparation

In both Nedogo and Digre villages of the four major crops, millet, sorghum, peanut and maize considered for animal traction, farmers did not use animal traction for land preparation of sorghum fields. In Aorema village, on the other hand, 40 percent of the sample farmers used animal traction for 27 percent of all their sorghum fields. seventy percent of the sample farmers ploughed their fields before planting in Aorema, while none in the two other villages used animal traction for such operations.

For maize and peanut fields, both in Nedogo and Aorema villages farmers used animall traction for land preparation. In Nedogo 32 percent of sample farmers used animal traction for 38 percent of their maize fields ; for Aorema it was 44 and 39 percent respectively. For no other operations farmers made use of animal traction in the two villages.

For peanut fields, the percentage of farmers using animal traction for land preparation ranged from 33 percent in Nedogo to 60 percent in Aorema, accounting for 17 percent of all the peanut fields in Nedogo and 50 percent in Aorema. In Digre farmers who had animal traction did not use it for any operations for maize and peanut fields.

Planting

The use of animal traction for planting is rather rare among farmers. In the entire sample, only one farmer (5 percent) in Nedogo used animal traction for planting operation for peanut, while another in Aorema used it for planting of millet. The entire planting is thus done by hand with the help of small tools, pioche (koutoaga)[1/] and calebasse (guinbga)[2/] It is time consuming and tedious.

Weeding

Animal traction was not used for weeding of maize crop in any of the villages. The utilization of animal traction for weeding is in more use for millet and sorghum, the two major crops grown by small farms in the study regions. Sorghum and millet fields are also generally much bigger in size than other crop fields. In Nedogo, 63 percent of the sample farmers used animal traction for 24 percent of their millet fields. For Aorema, 20 percent of sample farmers used animal traction covering only 5 percent of all millet fields, in Digré it was 10 percent of sample farmers and 10 percent of all millet fields that used animal traction. In the latter villages, the use of animal traction for sorghum fields also is much lower than the Nedogo village. Fifty three percent of the sample farmers in Nedogo used animal traction for 46 percent of their sorghum fields as against 16 percent and 10 percent farmers and 5 percent and 10 percent sorghum fields respectively in Aorema (Ouahigouya) and Digre (Zorgho).

1/ In English, pick, 2/ In English, Calabash. The words in parenthese are 'more' dquivalents.

Summary

It is clear from the data on animal traction that :

1. Overall animal traction is not used on the majority of farms.
2. It's not used by all farms owning animal traction for all farming operations.
3. Even for operations for which it is used, its use is on a rather limited scale for whatever constraints, may be the physical capacity of the animal which is mostly donkey, the soil type, wheather conditions, or even the traditional pattern of performing agricultural operations by human hand.

TABLE 25

USE OF ANIMAL TRACTION BY MAJOR CROPS AND OPERATIONS SAMPLE FARMS, THREE REGIONS? UPPER VOLTA

Crops/ operations	% of Farmers and Fields					
	Nedogo		Aorema		Digre	
	Farmers	Fields	Farmers	Fields	Farmers	Fields
Millet						
Land preparation	-	-	70	25	-	-
Planting	-	-	10	2	-	-
Weeding	63	24	20	5	10	10
Sorghum						
Land preparation	-	-	40	27	10	3
Planting	-	-	-	-	-	-
Weeding	53	46	-	-	10	3
Maize						
Land preparation	32	38	44	39	-	-
Planting	-	-	-	-	-	-
Weeding	-	-	-	-	-	-
Peanut						
Land preparation	33	17	60	50	-	-
Planting	6	2	-	-	-	-
Weeding	16	5	-	-	-	-

Source : FSU sample survey, 1979-1980

LABOR DEMAND PERIODS, AVAILABLE LABOR SUPPLY AND LABOR TIME USE ON SAMPLE FARMS

Labor demand periods

Under rain-fed farming systems the distribution of rainfall both over time and space plays a crucial role in determining production. Farmers in most of the time confront a niggardly and uncertain nature and find it hard to make the necessary adjustements to counter nature's moves. However, farmers in such harsh and unpredictable conditions have learnt through experience how best to respond to nature's fluctuating behavior. One form of such a response has been through farmers' decisions about planting strategies. Given the quantity and timing of rainfall, farmers try to plant their crops in such ways that they maximize their returns by planting different crops as quickly as they can. In a predominantly hand tool agriculture, labor becomes a major constraint. It is the timing and amount of rainfall that determine <u>when</u> and what to plant, but it is the quantity of labor available to households that determines <u>how</u> much of land can be planted within the given range of time with the required moisture conditions favorable to planting. The most limiting factor under existing farming practices with limited use of capital and animal traction then is household labor supply.

Critical labor demand periods by crops and operations are shown by farm survey data on labor time spent on major crop fields of small farms. These are presented in Table 26 through Table 28. Since land preparation is not very common, there is no peak period for labor time for this operation. Generally, land preparation activities such as cleaning, burning, and to a limited extent ploughing fields before planting, start in April and continue through May, June, and even some parts of July. For crops like maize and peanut, land preparation and planting were done on the same days during the week. For example, in Nedogo, land preparation and planting for these crops were performed between the second and the fourth week of June during which 80-90 percent of the fields were planted (Table 26). For sorghum and millet fields, land preparation continued during April and May at more or less constant rates in terms of proportion of fields for land preparation was done by farmers. The last week of May and the first week of June were the busiest weeks for which planting of both millet and sorghum in this village (for details, see Swanson).

The same pattern emerged in other villages, except for differences with regard to the time periods which were determined by the pattern of rainfall in the regions concerned. Land preparation in Aorema was done mostly in the months of June and July ; for maize and peanut, the major part of land preparation and planting was completed during the first and third week of July. For millet and sorghum these were the first and the last weeks of June (Table 27). Some planting also continued during July. The critical labor demand periods for Digre (Table 28) are comparable to those of Aorema.

From all the data presented in Tables 26 through 29, it is clear that the most busy periods for farm labor fall in the months of June and July during which one would expect labor shortages faced by small farmers. It is during these months that the three important operations, land preparation, planting and weeding overlap in terms of their demand for household labor. Timely planting, and timely and adequate weeding operations are key variables in determining production, other things constant.

TABLE 26.

CRITICAL LABOR DEMAND PERIODS BY CROPS AND OPERATIONS - SMALL FARMS, AOREMA (OUAHIGOUYA)

Months	Week	Land Preparation				1st Planting				2nd Planting				1st Weeding				2nd Weeding			
		SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN
April	1	x																			
	2																				
	3																				
	4																				
	5		x																		
May	1			x																	
	2	x																			
	3	x																			
	4	x																			
	5					xx		x													
June	1	x	xx			xxx	xxx							x							
	2		x	x		x	x	x		x				x	x	x					
	3		x	x		x	x				x			x	x						
	4	x	x			x					x			xx	x			x			
July	1	x	x	xxx	x	x	x	xxx	x		x			x	x						
	2	x	x	x	x	x	x	x	x	x	x			x	x	x		x			
	3		x	xx	xxxx	x		xx	xxxx		x			x	x						
	4	x	x	x	x	x		x	x					x	x	x		x			
	5													x	x	x					
August	1													x	x		xx	x	xx		
	2													x	x	xxx	x		x	x	
	3													x	x	x	xx	x	x	x	x
	4														x		x		x		
	5													x					x		
Sept.	1																x	x	x		x
	2															x		x	x		
	3													x					x	x	
	4																				

Source FSU sample survey 1979-1980

SR = Sorghum ; ML = Millet ; MZ = Maize ; PN = Peanut ; x = 20 % or less ; xx = 20-40 % ; xxx=40-60 %
xxxx = 60-80 %

These percentages are in relation to total number of fields under different crops of sample households. One field may be counted more than once if the concerned operation was done more than once different [illegible]

TABLE 27

CRITICAL LABOR DEMAND PERIODS BY CROPS AND OPERATIONS-SMALL FARMS, NEDOGO (OUAGADOUGOU), UPPER VOLTA, 1980

Month	Week	Land Preparation				Seeding I				Seeding II				Weeding I				Weeding II				Harvesting			
		SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN
April	1		x																						
	2		x																						
	3	x	x																						
	4	x	x																						
	5		x																						
May	1	x	x																						
	2	x	x			x																			
	3	x	x				x																		
	4	x	x			x	x																		
	5	x	x			xx	xx																		
June	1		x			xxx	xxx			xx	x														
	2				xxx	x	x		xxx	x	x			x	xx										
	3		x	xxx	xx	x	x	xxx	xx		x			xx	x										
	4			xxx	x			xxx	xx					xxx	xxx										
July	1		x		x										xx	x	x								
	2				x				x						xxx	x									
	3								x						xx	x	x								
	4					x									xx	x		x	x						
	5														x		x	x	x						
August	1																x		x						
	2																xx	xx	x						
	3																xx	xx	xx						
	4																x		xx						
	5																x		xx						
Sept.	1																x		xx					x	
	2																		x			x		x	
	3																								x
	4																				x				

Source : FSU sample survey, 1979-1980

SR = Sorghum ; ML = Millet ; MZ = Maize ; PN = Peanut ; x = 20 % or less ; xx = 20-40 % ; xxx = 40-60.

These percentages are in relationto total number of fields under different crops of sample households. One field may be counted morethan once if the concerned operation was done more than once different [illegible]

TABLE 28

CRITICAL LABOR DEMAND PERIODS BY CROPS AND OPERATIONS - SMALLFARMS, DIGRE (Zorgho), UPPER VOLTA, 1980

Month	Week	Land Preparation				1sr Pl nting				2nd Planting				1st Weeding				2nd Weeding				Harvesting			
		SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN	SR	ML	MZ	PN
April	1	x	x																						
	2		x																						
	3	x	x																						
	4	x	x																						
May	1	x	x																						
	2	xx	x	x																					
	3	x	xx	xx	x	x																			
	4	x		x			x																		
June	1	x	x			xxxx	xxx																		
	2	x	x	x	x	x	xx		x					x											
	3	x	x		x	x	xx	x	x	x	x			x											
	4			x	x	x	x	xx	x	x				x	xxx				x						
July	1	x			x	xx	xx	x		x	x			x	xxx			x							
	2				x	x				x	x			x	x			x							
	3	x	x	xxxx	xx	xx	xx	xxxx	xx	xx	xx			x	x			x							
	4	x			xx				xx	x	x					x	x	x							
	5								x	x	x	x		xx		x			x						
August	1				x				xx		x				x	x	x	xx	x						
	2								x								x	xx	x	xx					
	3								x								x	x	xx	xx					
	4								x									x	xx	x				x	
	5																xx		xx						
	1								x								xx	xx	xx					x	x
	2																xx	x	xx	x				x	x
	3								x								x		x	x	x			x	
	4								x								x		x					xxxx	

Source : FSU sample survey, 1979-1980

SR = Sorghim ; ML = Millet ; MZ = Maize ; PN = Peanut

x = 20 % or less ; xx = 20-40 % ; xxx= 40-60 % ; xxxx = 60-80 %

Available Labor Supply

Household labor supply available for farm and non farm activities has been estimated on the basis of the number of adult male and female members between 15 years and 65 years of age, and children 10-14 years olds present in the household during the production period (Table 29). Migrant members are not included in the estimated labor force. All labor was converted into labor units on the assumption that one male labor equals 1 labor unit, one female labor equals 0.75 labor unit, and one child (10-14 years olds) equals 0.5 labor unit. The term available labor supply indicates the quantity of labor force that households command and can be available for work. It does not however mean that all household members included in the estimate actually offer them for work.

As shown in the Table 29, labor force consists of 5.5 labor units per household in Nedogo (Ouagadougou region), 4.2 in Digre and 3.6 in Tanghin (Zorgho), and 5.3 in Aorema (Ouahigouya). Labor force thus estimated constitutes 49 percent of total household population in Nedogo, 47 percent in Digre, and 44 percent in Aorema.

Of the total available labor supply, female labor forms 51 percent in Nedogo, 46 percent in the two sample villages in Zorgho, and 43 percent in the two sample villages in Ouahigouya. Children as a source of labor form 8 to 16 percent of the total labor force. Adult male members constitute 33 to 52 percent of the total available labor force in the sample.

To what extent the available labor supply actually matches with demand for labor on the farm, or the extent of the utilization of the available labor force will be examined in the production section.

TABLE 29

ESTIMATE OF AVAILABLE LABOR FORCE 1/ IN SMALL FARM HOUSEHOLDS
THREE REGIONS, UPPER VOLTA

Category by age/sex	Nedogo		Digre		Tanghin		Aorema		Sodin	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male adult (per household)	1.8	33	1.7	41	1.5	42	1.8	41	3.2	52
Female adult (per household)	2.8	51	2.0	48	1.6	44	2.2	51	2.2	35
Male child (per household)	0.4	7	0.20	5	0.40	11	0.30	7	0.35	6
Female child per household)	0.5	9	0.25	6	0.10	3	0.05	1	0.45	7
Total male and female child (per household)	0.9	16	0.45	11	0.50	14	0.35	8	0.80	13
All labor force (per household)	5.5	100	4.2	100	3.6	100	4.4	100	6.2	100
Average size of household	11.3		11.0		11.0		13.4		15.2	

Source : FSU sample survey, 1979-1980

1/ This estimate is based on the following convertison ratios :

1 man labor = 1 labor unit
1 female labor = 0.75 labor unit
1 child labor = 0.50 labor unit
(10-14 years)

This excludes absentee members of households

Labor Time Allocation on Small Farms : Labor hours used per hectare of major crops

Labor is the most important input used in production on small farms. Since most of agricultural operations are carried out by hand, the amount of land a household can farm, and the extent to which it can perform on time and adequately important operations are a direct function of households labor supply. It is therefore important to know labor input used, or required per hectare of major crops grown on small farms.

The estimated per hectare utilization of labor input for major operations and crops are presented in Table 30. These estimates are based upon the actual number of man hours spent on various operations by different members of households. Labor days and/or hours have been estimated in the same way as of Table 29 (one adult male labor = 1 unit ; one adult female labor = 0.75 unit ; and one child 10-14 years old = 0.50 unit.

TABLE 30

PER HECTARE LABOR TIME USE ON SMALL FARMS : SAMPLE HOUSEHOLDS, NEDOGO, OUAGADOUGOU REGION

	Millet		Sorghum		Maize		Peanut	
	Hours	Man days	Hours	Man-days	Hours	Man-days	Hours	Man-days
Land Preparation by hand	19		18		197		95	
Land Preparation with animal traction	-		-		163		92	
Planting by hand	40 2/		35 2/		92		73	
Weeding by hand	179		180		211		215	
Weeding with animal traction	139		142		-		-	

Source : FSU sample survey, 1979-1980

1/ computed from a subsample of 10 households in village Nedogo for 10 fields under each crop. The estimates are provisional to be used more for illustrative purposes.

2/ These figures seem to be on the low side. Planting time estimated with the help of stop watches for a select number of fields indicated per hectare labor hours for millet and sorghum in the range of 55 to 60 hours.

The data presented in Table 27 gives some idea about labor demand per unit of land by the four major crops grown on small farms. Labor time estimated in this way will also help in estimating the input-output coefficient for labor required for programing model.

Labor Time Use for Land Preparation

As evident from the data (Table 30), maize and peanut crops for which ploughing and cleaning of land were normally done before planting, labor hours per hectare of land preparation are much higher than millet and sorghum. For the latter crops, it is mostly cleaning by cutting the bushes in the fields that normally farmers do before planting.

The difference in terms of labor time allocation between land preparation by hand and land preparation done with the help of animal traction shows a saving of 21 percent of labor as a result of the use of animal traction for maize. For peanut however the difference does not seem significant.

Labor Time Use for Planting

Invariably in all cases planting was done manually by hand, and hence labor becomes a key factor to determine the area planted by households during the critical periods which are governed by the pattern of rainfall. The most critical planting periods for millet and sorghum -the two dominant crops on small farms- were (for the crop year 1980) from the last week of May to the third and fourth week of June. This may however vary with rainfall. For maize and peanut planting is delayed for July. Meanwhile, there are a number of other small minor crops including associated crops like cowpea which are planted during the critical periods (May end till July end). Weeding operations also start during June-July for crops planted in early periods (May end to Middle of June).

Households want to plan quickly to cover as much land area as possible to get maximum advantage of moisture conditions following rainfall. Sometimes this period lasts for 3 to 4 days after the rains after which there may be a spell of dry conditions. Planting under uncertain and erratic rainfall conditions indeed becomes the most critical operation which demands judicious resource allocation by farmers.

That how much labor time is required for planting assumes special significance. On an average, farmers spent 35 labor hours to 40 labor hours for planting one hectare of millet and sorghum according to the information obtained from farmers, while it is 55 labor hours to 60 labor hours according to the estimates made by investigators with the help of stop watches used for measuring labor time by actually observing farmers time spent in some of their selected fields (Table 27). The latter estimate appears more reasonable and will be used as bases for estimating the per hectare labor utilization and requirement for these crops.

Maize and peanut take much more labor time for planting operations than the other crops. It was 73 hours of labor per hectare for peanut and 92 hours of labor per hectare for maize. However, there might have been some overestimation of labor time reported by farmers for these crops. More evidence is being collected to verify these results.

<u>Labor Time Use for Weeding</u>

Labor time spent for weeding varied from 180 hours per hectare of millet and sorghum to 211-215 hours per hectare of maize and peanut. The difference in labor time between hand weeding and weeding with the help of animal traction is worth noting. For example, an hectare of millet crop when weeded with animal traction took 139 hours as compared to 179 hours of handweeding ; for sorghum it was 142 hours as compared to 180 hours of handweeding. This implies that the use of animal traction can result in saving labor by 27 percent to 29 percent over hand-weeding. This also means that households with animal traction could weed fields faster, and hence perform weeding operations more adequately than those without animal traction. This in turn would have positive effect on yields.

1981

MAJOR CROPPING PATTERNS - SAFGRAD COUNTRIES, UPPER VOLTA FACTS AND OBSERVATIONS RELEVANT TO FARMING SYSTEMS RESEARCH

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