PD-AAY-650

PROGRESS REPORT

ON

SOIL FERTILITY RESTORATION PROJECT (WEST AFRICA)

THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

BY

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

November, 1988

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PROGRESS REPORT
SOIL FERTILITY RESTORATION PROJECT (WEST AFRICA)

1.0 Introduction

Rapidly increasing populations coupled with declining per capita food production continue to place sub-Saharan Africa at the center of international concern in relation to food availability and production. The regions of West and Central Africa present some of the most complex problems in agricultural development during the latter quarter of this century.

The soils of West Africa are generally low in fertility, very fragile, readily exhausted through cropping, and prone to leaching of nutrients and erosion. Farmers have traditionally coped with these problems through shifting cultivation or "bush fallow rotations" where land is left fallow for long periods (5-10 years) to allow natural vegetation--including tree and forest cover--to restore soil fertility. These practices, combined with complex cropping systems have in the past permitted low but relatively stable levels of food production.

In recent years, however, with ever-increasing needs for additional food, more and more farmers are being pressurized to shorten the extended fallow periods which threatens the traditional stability and sustainability of the shifting cultivation systems. Marginal lands are also being brought into food crop production and there is increasing evidence that more frequent and even continuous cropping of already fragile, highly weathered

soils is causing serious depletion of soil organic matter and overall fertility levels.

The ecological diversity of West Africa further compounds these problems and poses a complex scientific challenge for agriculturists, especially soil scientists, agricultural and socioeconomists.

International development agencies and donors are rightfully concerned to support and implement initiatives that take due cognizance of the special problems now facing West African farmers.

1. There is an overriding need to manage and protect the natural resource base for agriculture in the region. Systems to improve production--whether they be improvements or amendments to existing systems or new alternative systems--must not threaten or irrevocably deplete the productive potential of the existing resource base for food production.

2. Basic and applied agricultural research is urgently needed in the ecologies of the region to obtain increased understanding and scientific explanation of the physical, chemical, biological, and socioeconomic elements of the natural resource base. It is especially important to identify and analyze the determinants of stability and degradation of the resource base in West African ecologies.

3. It is necessary to identify and test methods and systems of resource management especially in relation to soil fertility and cropping practices. In particular, it is necessary to design and pilot soil management systems that can stabilize

or increase output without permanent degradation of the resource base. A priority output area for such research is detailed information on the role and use of chemical fertilizers and associated soil amendments in stabilizing, increasing, and sustaining the productive potential of West African soils within prevailing circumstances as determined by agricultural policies, farming systems, and socioeconomic conditions.

Given a background of extremely low availability and use of chemical fertilizers in West Africa in comparison to other developing regions of the world, and the enormity of the challenge to farmers to increase food output, IFDC proposed a project to conduct an in-depth study to determine the scientific and social benefits of fertilizer and associated soil amendments in countries and villages of West Africa. The project would examine the difference that fertilizer availability and use could make at the village level in different countries and assess the potential of fertilizer to increase and sustain food crop production and farm incomes in various ecologies under different socioeconomic conditions and government policies.

The Soil Fertility Restoration Project (SFRP) is an applied agronomic and socioeconomic research program to evaluate various fertilizer investment options and assess their impact on soil productivity restoration and sustainability of soil fertility, evolution of farming systems, and on the economics of local communities.

Implementation over a 5-year period will center on pilot projects in selected villages in various agroecologies in West

Africa. These projects will provide benchmark data on the agronomic and economic benefits of chemical fertilizers and associated amendments for the major soils and ecologies in the region.

The pilot research areas are as of now in the humid zone of Ghana, in the savanna zone of Togo, and in the Sahel zone in Niger, where elimination of specific soil fertility constraints in potentially productive lands and the availability of markets for additional produce would make fertilizer use profitable and in the long run eliminate the need for government subsidies.

The specific objectives of the first few years are as follows:

1. Selection of four pilot regions in contrasting environments where crop production and soil fertility may be significantly increased and maintained through soil amendments and fertilizer use strategies.

2. Collection of ecological and socioeconomic base line data in the four selected pilot regions.

3. Establishment of pilot projects in the four selected pilot regions in collaboration with national programs to field test soil amendments and fertilizer use strategies. Emphasis will be given to the use of indigenously available resources in the soil amendments and fertilizer use strategies to be evaluated. Products obtained through low-cost processing of indigenous raw materials as well as con-

ventional fertilizer products will be considered in designing the strategies.

4. Training of the necessary national program personnel to implement and monitor the pilot projects and collect the necessary agronomic and socioeconomic data to evaluate the projects and their impact.

5. Determination of economically and socially effective strategies to restore soil fertility which could be recommended for adoption in selected regions through government-sponsored programs.

6. Sharing and dissemination of information generated in the projects and strengthening the capability of various national agricultural research organizations to conduct similar fertility restoration projects through scientific support and consultation, material support in the execution of the pilot projects and annual workshop.

The long term development objective of the project is to increase the availability of food, increase rural income, and promote agricultural and rural development in Africa through the reclamation and conservation of fertility depleted croplands.

2.0 Startup Phase and Staffing

2.1 Administration

The SFRP is being implemented by the IFDC's West Africa Division, which is located in Lomé, Togo. Startup operating funds for this division were provided by World Bank, United Na-

tions Development Programme (UNDP), the Rockefeller Foundation, W. K. Kellogg Foundation, and the International Aid Agencies of the United States, Canada, France, Netherlands, and the Federal Republic of Germany. IFDC opened it's West Africa Division offices in March 1987.

The day-to-day activities of SFRP are managed by a Soil Fertility Restoration Project team, made up of the following:

Dr. K. Acheampong, a Ghanaian Sociologist, who joined IFDC in August 1987, as visiting scientist from the Rockefeller Foundation.

Dr. E. R. Rhodes, a Sierra Leonean, who was hired in January 1988, as agronomist and team leader.

The third key position is that of agricultural economist. This position will be filled by a scientist seconded from the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières of the Département du Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD/IRAT). A short list of suitable candidates was compiled by CIRAD/IRAT in May 1988.

In addition to these core staff, the SFRP team receives technical support from the following from the following IFDC staff in Lome and Muscle Shoals. Drs. P.L.G. Vlek (soil science), A. U. Mokwunye (soil science), C. Baanante (economics), T. Thompson (sociology), and A. K. Pinto (research and associate-agronomist). Locally recruited research assistants in

agronomy (K. Alognikou) and sociology (Sakite) were appointed in April and May, respectively. Vacancies for a research associate and assistant have been identified but not filled.

2.2 Links with Organizations Promoting The Use of Phosphate Fertilizers

A protocol of agreement dated September 14, 1987, between the World Phosphate Institute (IMPHOS), American Phosphate Foundation (APF), and IFDC has been signed. It provides for annual meetings of a steering committee in which work plans, budgets, and progress reports of the SFRP are reviewed. The arrangement also makes for the provision of fertilizers by IMPHOS and APF for the field programs. The first meeting was held from November 1-3, 1987, at which the following participated:

*Dr. Donald L. McCune	-	IFDC
*Dr. P.L.G. Vlek	-	IFDC
*Dr. Ken A. Pretty	-	APF
*Dr. Jack A. Stewart	-	APF
*Mr. K. Benchekroun	-	IMPHOS
*Mr. A. Benjelloun	-	IMPHOS
*Mr. H. Fogt (Jr.)	-	IMPHOS/APF
Mr. M. Debbi	-	IMPHOS
Mr. A. Moraitis	-	Office Togolaise de Phosphate (OTP)
Mr. K. Agbadjan	-	OTP
Mr. N. Pere	-	OTP
Dr. A. U. Mokwunye	-	IFDC
Dr. E. R. Rhodes	-	IFDC
Dr. K. Acheampong	-	IFDC
Mr. T. M. Frederick	-	IFDC
Mr. A. K. Pinto	-	IFDC
Dr. T. Aithnard	-	DRA, Togo

*Members of the steering committee

A tentative field program for 1988 consisting of (a) exploratory and detailed baseline surveys on socioeconomic circumstances of farmers, soils, and cropping systems, and (b) on-farm trials/demonstrations was presented by IFDC. The plan was contingent upon the active cooperation of national collaborators. The committee acknowledged that it was imperative for IFDC to work in close collaboration with national counterparts and agreed that IFDC should proceed with initial discussions with Togo, Niger, and Ghana.

2.3 National Collaborating Institutions and Zones of Operation

The Ministry of Agricultural (MOA)/Soil Research Institute (SRI) in Ghana, the Ministere du Developpement Rural (DRA)/Institut National des Sols (INS) in Togo, the Ministere de l'Agriculture et de l'Environment/Institut National Recherches Agronomiques (INRAN) in Niger are the collaborating institutions. A Memoramdum of Understanding (MOU) was signed with the MOA in Ghana, and with INRAN in Niger in May and June, respectively. An MOU with Togo has been prepared and is being reviewed by the Ministry. It is hoped that the latter will be signed very soon.

All the in-country coordinators for the three countries have been appointed. Mr. S. Opoku of Ghana was appointed in March 1988, Mr. E. Melebou of Togo in late March 1988, and Mr. M. Goube of Niger in May. The coordinators are assisted in their various countries as follows by:

E. Acquaye (soil science)	Ghana
D. Boateng (economics)	Ghana
M. Kadi (economics)	Niger
Dali Fijiko (agronomy)	Togo

Figure 1 is organizational chart for the SFRP in Ghana, and the project is being implemented in the following ecological zones:

Humid zone	- Ashanti region, Ghana
Savanna zone-	Savane region, Togo
Sahel zone	- Maradi department, Niger

The SFRP is also to be implemented in irrigated lands in a savanna ecology, but the pilot area is yet to be selected. The possibility of the pilot area being located in any of the above three countries or a fourth country is being investigated.

2.4 Preparation and Adoption of Supplementary Technical Paper

A supplementary paper was prepared and adopted in January 1988. Among the essential features of the paper were:

a. The implication of the application of fertilizers and soil amendments to farm land in the light of the prevailing farming systems in the subregion.

b. The justification and methodology of the planned preliminary, exploratory, and verification surveys and on-farm trials (OFT).

3.0 Development of Work Plan

A draft activity and time chart for 1988 was prepared in January and finalized in April (Appendix 2). Detailed work plans covering the OFT, and exploratory and verification surveys were finalized individually with the in-country coordinators as follows:

Ghana - March 1988
Togo - April 1988
Nigcr - May 1988

4.0 Preliminary/Exploratory Surveys

As a first step towards the selection of sites for planned project activities, the Preliminary Survey form A (Appendix 3) was developed for national collaborators to collect basic information in several villages within the specified agroecological zones. The purpose of this exercise was to gauge the willingness of farmers to participate and to guide the SFRP team to narrow down the number of potential sites for the subsequent exploratory survey and OFT on the basis of a list of criteria. An Exploratory Survey Form B (Appendix 4) was also prepared to collect more detailed information through farm visits and interviews of a carefully selected sample of farmers. The document made provision for recording both farmers perceptions and researchers observations on the physical, biological, and socioeconomic environment, and on the farming systems, soils, and constraints to fertilizer use.

4.1 Ghana

The preliminary/exploratory surveys were conducted in March in the Ashanti region. Respondents included five men and five women farmers. The draft report was completed in June. The final version of the report will be published as Technical Report No. 1 of the SFRP. The survey involved interviews of male and female farmers in each of five villages in the Ashanti region (Adjamasu, Ayinasusuo, Hwidiem, Boamang, and Baworo). Soil samples were analyzed at INS for a range of soil chemical and physical properties. The field data was supplemented with information obtained from several secondary sources. Collection of published and unpublished materials on crop production, soils, climate, vegetation, and population began in November 1987. The exploratory survey report contains maps showing the location of pilot villages, road networks, and soil types. The draft report is Appendix 5. The major implications and conclusions of the findings of the SFRP were as follows:

a. Inadequate soil P levels is the major soil fertility constraint in the Ashanti region of Ghana. Emphasis should, therefore, be on the use of phosphatic materials.

b. Compounds versus single nutrient carriers of P should be compared as investment strategies in 1989.

c. The fact that continuous cropping is not practiced suggests that moderate annual applications of P rather than a single large dose to last for 3 to 5 years may be appropriate at the start of the project.

d. Maize and cassava are very important food/cash crops in the pilot villages. However, present yields are low. Fertilization of entire villages should be based on maize/cassava farms.

e. There is need to maintain close contact with the extension service, so that improved practices such as improved seed, correct plant populations, adequate weeding, etc., would be followed.

f. The verification survey should explore the extent of involvement of women in (1) decision-making, and (2) labor input in various farming and non-farming activities.

g. The villages of Adjamasu and Hwidiem belong to the same soil association, and they are within easy reach of markets and fertilizer depots; farmers are comparatively more market oriented; land tenure arrangements are not a problem in both villages; large responses to applied P fertilizers are highly probable in Adjamasu village. These two villages are, therefore, chosen as the villages in which the detailed survey will be conducted. The "fertilizer village" will be Adjamasu and the "control village" will be Hwidiem.

4.2 Niger

The preliminary/exploratory survey was conducted in June in Niger in Maradi department. It involved interviews with five men and five women in the villages of Nwallo, Tchizon,

Zaboua and Maiguero. Following the receipt of supplementary information in July, the report will be prepared. Soil samples are being analyzed at INRAN.

4.2.1 Prior to the selection of Maradi by INRAN/IFDC as the department in which the soil fertility restoration project is to be implemented, IFDC conducted a socioeconomic study of farm-level constraints to fertilizer use in Western Niger during the period June to August 1987. The survey provided an opportunity for IFDC to fine-tune its socioeconomics research techniques in departments of Niger with which its staff was familiar. The results of this survey (Appendix 6) showed that:

1. Dry-season migration to other West African countries averages about US $650 for as much as 9 months of work. These earnings were often the principle sources of household finances.

2. Lack of transportation is a serious constraint to fertilizer use. Distances to fields and markets can be relatively long and most farmers are dependent on foot transport.

3. Land may be owned or borrowed by household and individuals. Djerma farmers are reluctant to make capital investments in borrowed land and generally forego using fertilizer and manure. Therefore, the frequency of borrowed land is a constraint to fertilizer use.

4. Intercropping of millet and cowpea or millet and sorghum are common risk reduction strategies.

5. Virtually no household production is sold. Straw by-products are used in a variety of ways, and cowpea straw is a medium of exchange and is traded for goods and services.

6. Farm labor for weeding is frequently hired and wages are a significant cost. Few women and children labor on household plots; labor from non-household relatives were compensated with harvested grain or straw.

7. A major constraint is the lack of government supported credit. Farmers expressed virtually universal disappointment about the lack of credit to purchase fertilizers. The lack of credit in agricultural cooperatives is also a constraint to fertilizer use.

8. Farmers appeared to learn more about fertilizer use from each other than from cooperatives and/or extension services. Illiteracy is a constraint that prevents full realization of the contributions of agriculture.

4.3 Togo

Collection of secondary data on crop production, soils, climate, vegetation, and population began in November 1987. The preliminary/exploratory survey in the Savane region was conducted in July. It involved interviews with seven men and six women in the villages of Kampit Bong, Kpimboua, Dapri, Nakindalare-est Centre Ogaro, Bangu, and Boumbouka. The report is under preparation.

5.0 Verification Surveys and The Role of Women in The SFRP

The objective is to ascertain whether the information obtained from the rapid but less vigorous exploratory survey is representative of the overall population and to generate a body of agronomic and socioeconomic base line data for future monitoring and evaluation of project performance. It will be conducted in two villages in each of the three countries in which the project is being conducted. Appendix 7 is the basic questionnaire of the verification surveys. A suitable sample size will make possible the separation of data on a gender basis, so that the role of women in (a) decision-making, and (b) actual participation in the various farming and non farming activities will be properly assessed. The sample size of the exploratory survey was too small to permit statistical analysis of data. A status report on the role of women in the SFRP (Appendix 8) is attached.

6.0 On-Farm Trials

The general objective of the farmer/extension/researcher managed trials is to pretest on small scale some of the treatments which will form the basis of the treatments to be applied on large tracts of land in 1989.

6.1 Training for Collaborators in Ghana

As a prelude to the OFT a training course was conducted in two stages in March/April in Kumasi to familiarize participants with the objectives of IFDC and the SFRP and the conduct of the OFT. The first stage consisted of a lecture and discussion of the OFT with senior national research and extension workers from the SRI and MOA of Ghana, collaborating in the SFRP. The second stage emphasized the training of field assistants.

Topics covered in the second segment of the training were:

SFRP background and objective
On-farm trials 1988
Plot layout and soil sampling
On-farm trials and extension

The list of persons who participated in one or both of the training segments is shown in Appendix 9.

6.2 Design and Establishment of OFT in Ghana

The trials were planted in April/May. The specific objectives were to measure the effects of N (urea), P (single

superphosphate/partially acidulated Togo phosphate rock), and K (muriate of potash) on crop performance and soil properties and assess farmers' responses in terms of their management of fertilized plots and the way they dispose of any extra produce.

Location: Farmers fields in 5 districts in the Ashanti
Cropping system: Maize based with cassava intercrop
Plot size: 1,000M^2
Treatments:

	N	P_2O_5	K_2O	(Kg/Ha)
T1	100	60	0	(SSP)
T2	100	40	30	(SSP)
T3	100	60	30	(SSP)
T4	100	80	30	(SSP)
T5	100	60	0	(SSP)
T6	0	0	0	(Togo PAPR 50)

SSP = Single Superphosphate

Data are being collected on soil chemical and physical composition, crop stand, crop duration, seed/tuber yields, data of major management operations, and harvesting. A questionnaire has been completed after the basal fertilizer application to assess farmers' reactions to the fertilization practices. Questionnaires will again be completed at midseason and after the harvest. Records are being kept of participation of men, women, and children in the OFT.

6.3 Design and Establishment of OFT in Niger

The trials were planted in June in the villages of Nwallo, Zaboua, Tchizon, and Maiguero. The specific objectives are to measure the effects of N (urea), and P_2O_5 (SSP/Tahoua phosphate rock) on crop, soil, and farmers' response.

Location: Farmers fields in the Maradi department in Niger.

Cropping system: (a) Millet based with a groundnut or cowpea intercrop.
(b) Sole millet.

Plot size: 1,000M^2

Treatments:

	N	P_2O_5	(Kg/Ha)
T1	0	0	
T2	45	30	(SSP)
T3	45	30	(TPR)
T4	45	15	(SSP)
		60	(TPR)
T5	45	0	(SSP)

TPR = Tahoua phosphate rock
SSP = Single Superphosphate

7.0 Environmental Impact of Fertilizer Use

The SFRP project team will monitor the environmental impact of project activities. In preparation for this the literature on the effect of fertilizers on the environment is currently being reviewed and a plan of action will be prepared during the implementation phase.

8.0 Operating Problems During Phase One

For successful implementation of the project it is essential that there should be very close coordination with collaborators in Ghana, Togo, and Niger. There have been delays in the appointments of national coordinators and signing of an, especially in Niger and Togo. However, all participating countries readily welcomed the SFRP in principle, but, on the basis of past experience, African governments tend to be very cautious in accepting new projects these days, no matter how potentially useful the projects may be.

The late nomination of the coordinator for Niger gave very little time for finalizing the work plan and organizing training of field staff for the OFT. Farmers in two villages, which had been selected for these OFT, were dropped because they had gone ahead and planted. Even in Ghana, which was the first country to appoint coordinators and sign the MOU the exploratory survey had to be rushed through to ensure its completion before the start of the OFT.

In addition to the late appointment of the coordinator in Togo, the individual was requested by his Ministry to participate in a Farming Systems Research and Development course which ended on June 24. Although this course will prepare him well for the SFRP, it meant that there was insufficient time to select sites and organize farmers for the OFT. Hence, OFT are not being conducted in Togo in 1988.

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9.0 Project Monitoring/Management to Overcome Problems

1. The Director of IFDC's West Africa Division, members of the SFRP team, and other IFDC staff based at Lomé and Niger had meetings with the government officials in and out of Togo and sent several telexes, etc., to officials to get the MOUs signed and the coordinators appointed. See also list of trips made out of Lomé in connection with the implementation of the SFRP (Appendix 10).

2. The budgets drawn up with individual countries included a small "IFDC Direct In-Country Payment." This made it possible for IFDC staff on trips to use their expense accounts to take care of expenses incurred by the in-country coordinators before the MOUs were signed.

3. Data on crop response to fertilizers in the savanna region of Togo are to be reviewed to find out whether there is sufficient existing data on farmers' fields to bypass the OFT stage of the preparatory phase.

10.0 Plans for 1988/89

1. Two villages each in the Sahel of Niger, humid zone of Ghana, and savanna of Togo will have been identified for phase two implementation of the baseline surveys. In one village in each zone fertilizers and amendments will be applied. Acreage for fertilization will be equal to the total area of farm lands that were estimated to be under specific cropping systems in the

village in 1988. The cropping systems in the humid zone, savanna, and Sahel will be maize/cassava, sorghum/millet, and millet/groundnut, respectively. The other village will not receive fertilizers and amendments and will serve as control. Crop performance, soil properties, and socioeconomics parameters will be monitored in both villages.

2. OFT to support the large scale village-level fertilization will be established. They will help in upgrading the fertilizer and amendment treatments to be used in subsequent years.

3. The project will be implemented in irrigated lands in a savanna ecology.

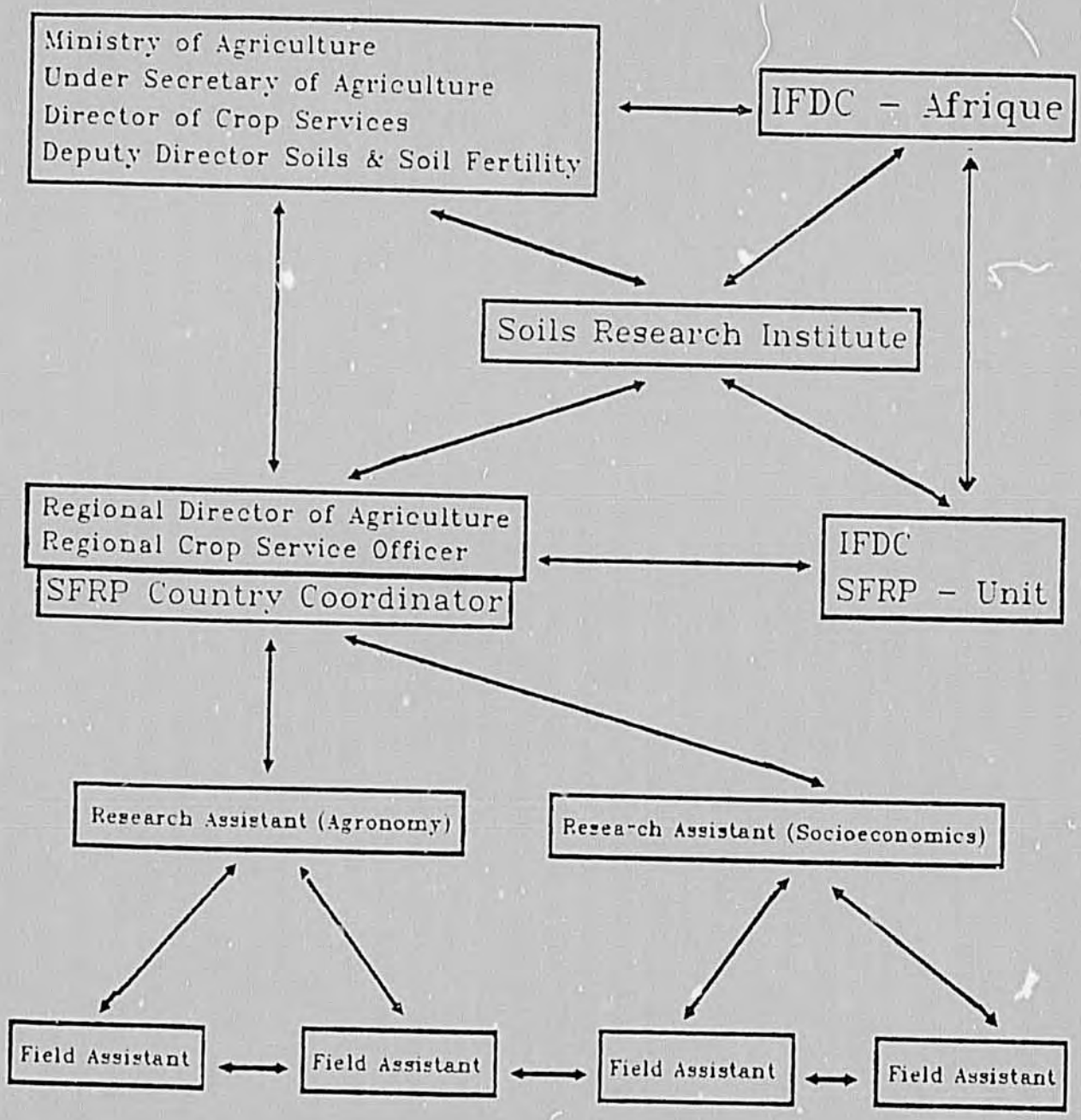
4. Reports of the surveys and OFT initiated in 1988 will be published.

LIST OF APPENDICES

Appendix 1	Organization Chart of Soil Fertility Restoration in Ghana.
Appendix 2	Work Plan April 1988 to February 1989.
Appendix 3	Soil Fertility Restoration Project Preliminary Survey Form A.
Appendix 4	Soil Fertilizer Restoration Project Exploratory Survey Form B.
Appendix 5	An Exploratory Survey of the Soil Fertility Restoration Project Pilot Area in the Ashanti Region of Ghana (draft).
Appendix 6	A Socioeconomic Study on Farm-Level Constraints to Fertilizer Use Among the Djerma of Niger.
Appendix 7	Draft Basic Questionnaire of Verification Survey.
Appendix 8	Status Report on the Participation of Women in the Soil Fertilizer Restoration Project.
Appendix 9	List of Trainees for the On-Farm Trials Program in Ghana.
Appendix 10	List of Trips Made to the Project Zones by IFDC Staff.
Appendix 11	Letter from Howard Fogt reporting on Fertilizer Investment for Soil Fertility Restoration Project in West Africa - Steering Committee Meeting, August 1988.

APPENDIX 1

SOIL FERTILITY RESTORATION PROJECT IN COUNTRY (GHANA) ORGANIZATION CHART



APPENDIX 2

SOIL RESTORATION PROJECT WORKPLAN

APRIL - DECEMBER 1988

Period		Activity	Personnel
April 15-May 30	(1)	Completion of report on exploratory survey (Ghana)	E. Rhodes and K. Acheampong will prepare drafts of report and questionnaire to be reviewed by C. Baanante and T.P. Thompson (headquarters)
	(2)	Design of verification survey questionnaire (Ghana)	
	(3)	Selection of two (2) villages for verification survey (Ghana)	E. Rhodes and K. Acheampong and S. Opoku, E. Melebou A. Bationo
	(4)	Selection of villages for exploratory survey (Togo)	
	(5)	Obtain approval and support for conducting field work (Niger)	
	(6)	Planting of 20 fertilizer field trials in 5 villages (Ghana)	
	(7)	Conduct the exploratory survey (Niger)	E. Rhodes, K. Acheampong, French Economist, and In-country coordinator, U. Mokwunye
	(8)	Design of on Farm Trials for Niger	
June 1-30	(1)	Conduct exploratory survey in Togo	E. Rhodes, K. Acheampong and E. Melebou, and S. Opoku
	(2)	Supervision of fertilizer field trials in Ghana	

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Period		Activity	Personnel
June 1-30	(3)	Establish fertilizer trials in Niger	E. Rhodes, K. Acheampong In-country Coordinator (Niger)
July 1-30	(1)	Completion of verification survey questionnaire and pre-test in Ghana	E. Rhodes, K. Acheampong and Staff
	(2)	Selection and training of interviewers in Ghana	K. Acheampong
	(3)	Prepare draft of exploratory survey report for Togo and Niger	E. Rhodes and K. Acheampong, French Economist, In-country Coordinators
August 1 - September 30	(1)	Verification surveys for Ghana, Niger and Togo (Ghana Aug. 1 - Sept. 7) (Togo Aug 1 - Sept. 15) (Niger Aug. 15 - Sept. 15)	E. Rhodes, K. Acheampong and In-country Coordinators, S. Opoku, E. Melebou, Niger Coordinator, French Economist, and T.P. Thompson
	(2)	Imphos Meeting, Niger	Committee members
October 1-30	(1)	Coding and data processing of verification surveys for Ghana, Togo, and Niger to be conducted in Lomé	E. Rhodes, K. Acheampong, Research Assistants, C.A. Baanante and T.P. Thompson
November 1 - December 30	(1)	Continue data processing and analysis. Initiate report writing	E. Rhodes, K. Acheampong, C.A. Baanante, and T.P. Thompson, U. Mokwunye, French Economist with National Coordinators and Research Assistants at Lomé and Headquarters
	(2)	Prepare work plan for 1989 phase	
January 1- February 28	(1)	Preparation and writing of final reports.	

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SCHEDULE OF WORK FOR THE SOIL RESTORATION PROJECT IN GHANA, TOGO, AND NIGER

November 1987 - October 1988 - Year 1

Activity	Time Period											
	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Exploratory Surveys												
Ghana (complete)												
Togo												
Niger												
Farm Trials												
Ghana												
Togo (none)												
Niger												
Reports on Exploratory Surveys												
Ghana												
Togo												
Niger												
Verification Surveys Baseline												
Ghana												
Togo												
Niger												
Data Processing and Analysis												
Report Writing												

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SCHEDULE OF WORK FOR THE SOIL RESTORATION PROJECT IN GHANA, TOGO, AND NIGER
November 1988 - October 1989 - Year 2

Activity	Time Period											
	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Exploratory Surveys												
Ghana (complete)												
Togo (complete)												
Niger (complete)												
Farm Trials (OFT & Village Scale Fertilization)												
Ghana												
Togo												
Niger												
Reports on Exploratory Surveys												
Ghana (complete)												
Togo (complete)												
Niger (complete)												
Verification Surveys												
Ghana (complete)												
Togo (complete)												
Niger (complete)												
Reports on Baseline Verification Surveys and OFT												
Ghana												
Togo												
Niger												
Agro & Socioeconomic Monitoring & Evaluation												
Ghana												
Togo												
Niger												
Identification & Exploratory Surveys of Irrigation Projects												
In-Country Appraisal of Crop Storage Facilities, Farmer Work Groups and Credit Schemes												
Data Processing and Analysis												
Report Writing												

APPENDIX 3

SOIL FERTILITY RESTORATION PROJECT PRELIMINARY SURVEY FORM A

COUNTRY _____

AGROCLIMATIC ZONE ----------

Location	Demographics		Accessibility				Crops Grown			
							Food		Cash	
Name of Village	Total Pop.	App # of H'holds	Nearest Market	Distance (km)	Rd. Type 1/ 1, 2,3	Md. of Transp. 2/ H, A, B, T	Prin.	Sec.	Prin.	Sec.

Sociocultural					Extension Services				Farm Credit 3/		
		Land Tenure							Source		
Ethnic Comp.	Local Auth.	Allocation	Control	Religion	Nearest Ext. Off. (km)	Freq. of Visit/m	Agric. Org.	Agric. Shows	Bank	Trad	Form C, K

Manure/Fert. Use 4/			Land Use Methods				Physical Environment						
							Rainfall (monthly)				Temp (c)		
Type	Source P, GA	Distance (km)	Method of Land Prep.	Typical Acreage	# of Years Cult.	Cropping System	Mn	Mx	Tot	Onset	Mn	Mx	$\bar{x}$

Physical Env. (Cont.d)

Soil				
Type	Status	Rec. Land Use	Relief	Comments

1. Food Path
2. Dirt Road
3. All-weather road

2. Md. of Transport (Trnasportatin of farm produce)

H = Head portage
A = Farm animals
B = Bicycle
T = Truck

3. Farm Credit
Form:

C = Cash
K = Kind

4. Fertiliser Use
Source:

P = Private Distributor
GA = Government Agency

APPENDIX 4

SOIL FERTILITY RESTORATION PROJECT

EXPLORATORY SURVEY

I Name of Recorder _____ Date _____

Agroclimatic zone _____ District _____ Village _____

Farmer's name _____ age ____ gender ___ Years of schooling _____

II Physical and Biological Environment

1. Rainfall: (a) Onset: from _____ (month) to _____ (month)

(b) Any dry spell? (Circle) NO YES --> from _____ (month) to _____ (month)

(c) Farmer's evaluation about last year's rainfall (circle) (a) good (b) ave. (c) poor and livestock/crop yields (check)

Crops / Livestock	Good	Ave.	Poor	Comments
Maize				
Cassava				
Plantain				
Cocoyam				
Vegetables				
Other (specify)				
Livestock:				

35

(d) Farmer's survival strategies — Comments

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

2. Topography, soil condition and vegetation:

(a) Topography

_____

_____

_____

(b) Farmer's evaluation of soil condition (check)

	High	Med.	Low
Erosion risk			
Drought risk			
Nutrient status			
H_2O holding capacity			

(c) Vegetation (type and status):

_____

_____

_____

_____

_____

26

III Human Environment

1. Institutional and other Support Services:

	Source	Access	Control / Cost	Comments
(a) Farm Credit				
(b) Extension				
(c) Farmer's Organ.				
(d) Farm Tools				
(e) Seeds / Cuttings				
(f) Fertilizers				
(g) Pesticides				
(h) Crop Residue				
(i) Manure				
(j) Consumer Durab.				

2. Social Environment.

(a) Land: Access and tenurial arrangements

_____

_____

(b) Labor: Sources, cost and form of compensation

_____

_____

(c) Health care services: Sources, type, accessibility and cost

_____

_____

(d) Religion/Festivals: Nature and time of occurance

(e) Migration: Pattern, selectivity, and destination.

3. Physical Infrastructure:

(a) Roads: Type, status, and typical distances to farms

(b) Transportation: Type and availability

(c) Markets: Location, distances from village/farms

38

IV Farming System:

1. Cropping patterns and land use:

(a) Length of fallow and cropping _____

(b) Criteria for farmland selection _____

(c) Farm size _____

(d) Method of land preparation _____

(e) Crop variety and characteristics _____

(f) Planting sequence _____

(g) Spacing and arrangement _____

(h) Weeds, time and methods of control _____

(i) Pest/disease identification and control _____

2. Post harvest activities and harvest utilization

(a) Activities during off-season _____

(b) Proportion of harvest:

	Consumed	Sold	Stored	Comments
Maize				
Cassava				
Plantain				
Cocoyam				
Vegetables				
Other (specify):				

(c) Storage:

(i) Methods and duration of storage

Crop	Method	Location	Duration	Comments
Maize				
Cassava				
Plantain				
Cocoyam				
Vegetables				
Other (specify):				

(d) Crop residues and by-products utilization

_____

_____

_____

_____

_____

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APPENDIX 5

AN EXPLORATORY SURVEY

OF THE

SOIL FERTILITY RESTORATION PROJECT

PILOT AREA

IN THE ASHANTI REGION OF GHANA

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SFRP TECHNICAL REPORT NO. I
August 1988

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ACKNOWLEDGMENTS

The contributions of several people made this study possible. It is, however, impossible to mention them all.

We wish to thank Dr. Paul L.G. Vlek, Dr. A. U. Mokwunye, Dr. C. A. Baanante, and Dr. T. P. Thompson for reviewing the initial draft report. Drs. Baanante and Thompson also reviewed drafts of the "checklist" of information to be collected in the exploratory survey and Mr. Mensah (Regional Economic Planning Officer, Kumasi) for information on population of some of the villages. Special gratitude is due to Mr. A. T. Halm and the staff of the Soil Research Institute, Kumasi, for their suggestions and collection of soil samples. To the farmers and the leaders of the pilot villages who patiently responded to our battery of questions, we owe a deep sense of gratitude. Without their cooperation the study would not have been possible.

We are grateful to the District Agricultural Officers in charge of the pilot villages for their support during the field work. The effort put in by our Research Assistants--Mr. E. Acquaye, Mr. D. Boateng, Mr. K. Alongnikou, and Mr. A. Sakite--during the surveys and the preparation of this report is very appreciated.

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INTRODUCTION

The aim of the Soil Fertility Restoration Project (SFRP) is to study means of facilitating the adoption of fertilizers in communities where the elimination of specific soil fertility constraints in potentially productive lands and the availability of markets for additional produce make fertilizer use profitable and attractive to small-scale farmers.

The project is being implemented in three agroecological zones--the Sahel, Savanna, and humid zones--of West Africa. The target area representing the humid zone was identified in the Ashanti Region of Ghana. As a prelude to embarking on large-scale fertilization of entire village farms, it was deemed necessary to conduct an exploratory survey to gain insight into farmers' socioeconomic circumstances as well as the climate, soils, and cropping systems within the target area.

This report concerns the exploratory survey in the humid zone of the Ashanti region of Ghana. The report is organized into six sections. An overview of Ghana, some general aspects of the region where the target area is located, and the methodology for the study are outlined in the first two sections. Sections three and four are descriptions of the physical, biological, and human environment. An analysis of the farming systems and the study's implications for the SFRP are provided in sections five and six.

The Republic of Ghana: An Overview

The Republic of Ghana, an Anglophone West African country, lies entirely within the tropics, i.e., between 4°44' and 11°11' north of the equator (see Figure 1). Bordered on the north, east, and west by the Republics of Burkina Faso, Togo, and Côte d'Ivoire, respectively, and on the south by the Gulf of Guinea, Ghana covers an area of 238,538 km^2. The country is considered as lowland because approximately 50% of the land is less than 150 meters above sea level.

The tropical climate of Ghana is characterized by high temperatures and a marked variations in the amount and distribution of rainfall. Except in the north, where the rainy seasons tend to merge, two rainy seasons are separated by a fairly short dry period in July and August and a relatively longer dry season from December to February.

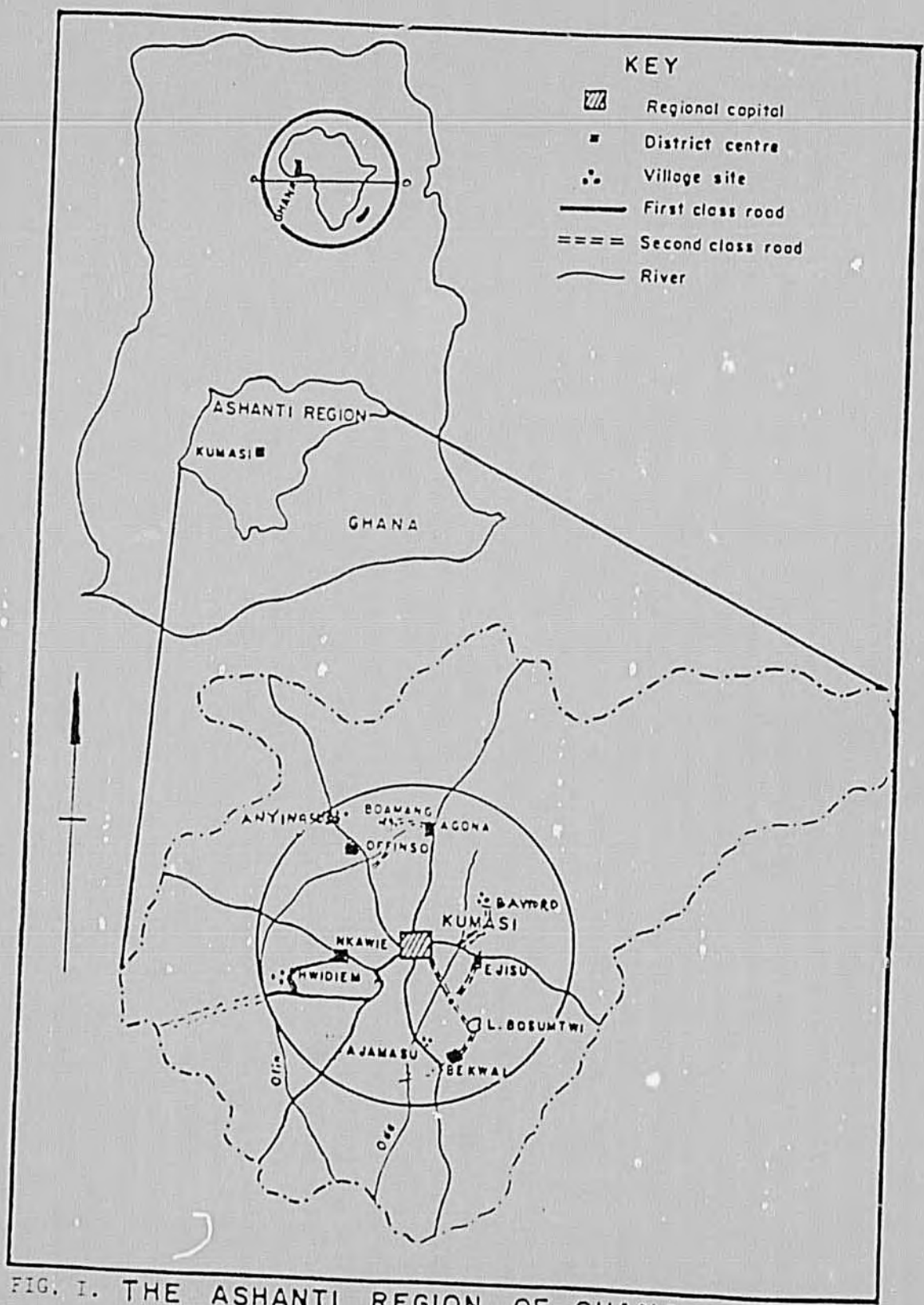


FIG. I. THE ASHANTI REGION OF GHANA

Although none of the original vegetation formations remain, there is a distinct banding of the natural vegetation as a result of the temperature/rainfall belts. With decreasing rainfall and increasing temperatures northward from the coast, vegetation gradually changes from tropical rain forests in the southwest to a moist semi-deciduous forest and the expansive guinea savanna woodland that covers about two-thirds of the country (see Figure 2).

The topography, drainage, climate, and vegetation have combined over time to produce a wide range of soils with varying levels of fertility. Soils in the rain forest and semi-deciduous zones have a greater accumulation of organic materials than those in the other zones and are relatively more fertile (Dickson and Benneh, 1970). They are considered to be suitable for food crops such as cocoyam, plantain, cassava, and maize, and for cash tree crops such as cocoa, coffee, oil palm, and citrus.

Preliminary estimates based on the most recent (1984) population census indicate that 68.7% of Ghana's 12.3 million people live in rural areas and are engaged in agriculture and other agro-based industries. Densities range between 17 persons per km^2 in the sparsely populated north and 438 persons per km^2 in the heavily urbanized south. There is a slight preponderance of females over males (i.e., 1.094 females:males ratio).

Ghana is divided into ten administrative regions each of which is headed by a Regional Secretary and supported by a team of officials representing the various ministries and other government agencies. Each region, in turn, is subdivided into districts headed by District Secretaries who, like the regional secretaries, are government appointees.

The Ashanti Region

Located in the central part of Ghana, the Ashanti Region exhibits most of the physical, biological, and other environmental factors required of a project such as the SFRP. About 2/3 of the region's 2.1 million people live in rural areas and are directly engaged in agriculture or in agro-based industries. With fairly well-distributed 1600 mm of annual rainfall, mean annual temperature of 27°C (see Figure 3), and potentially productive soil types, the region is considered potentially one of the most agriculturally productive in the nation.

GHANA: VEGETATION TYPES

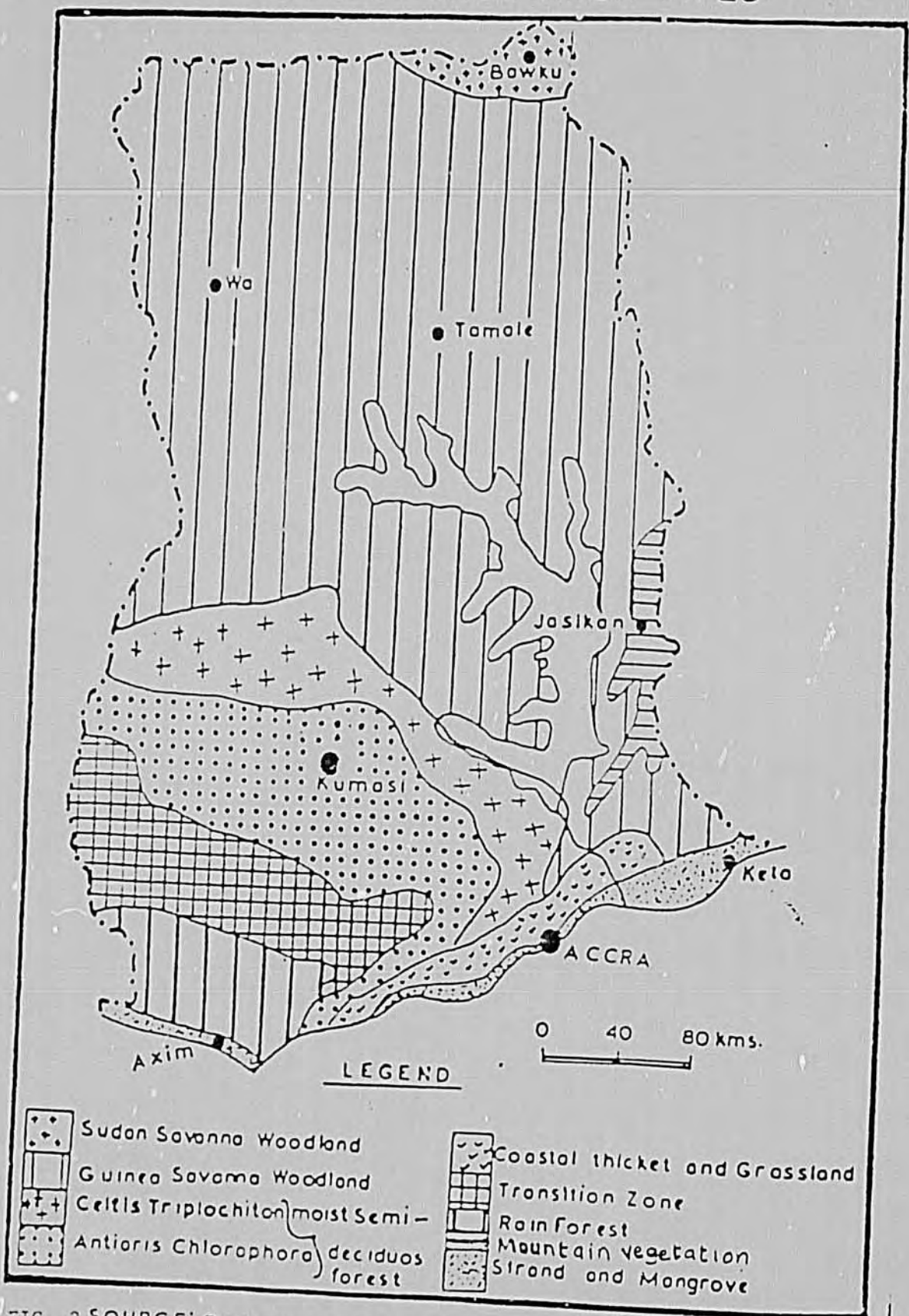


FIG. 2 SOURCE: Portfolio of Ghana maps. Survey of Ghana Accra

KUMASI: MEAN MONTHLY RAINFALL AND TEMPERATURE

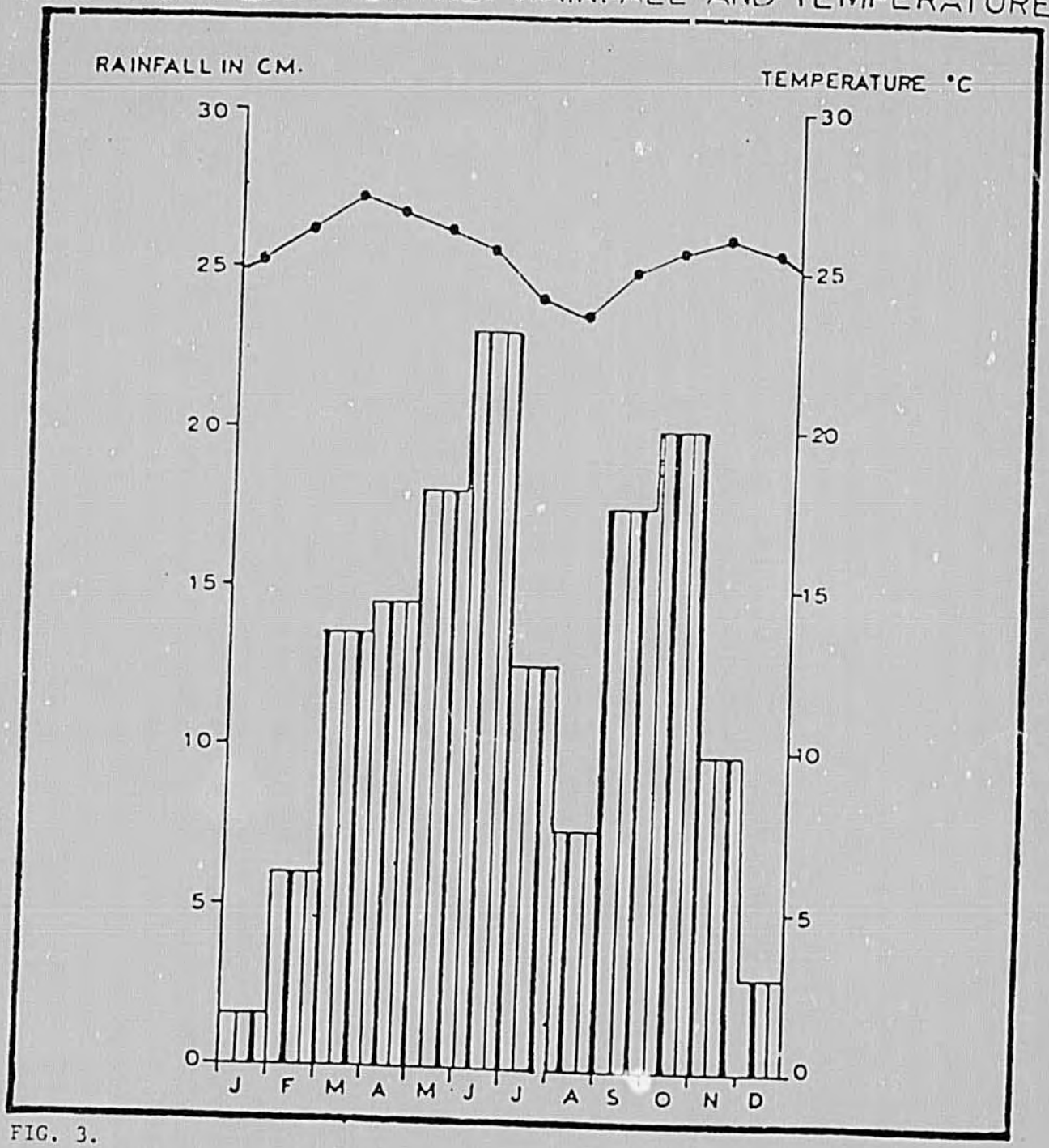


FIG. 3.

SOURCE: Meteorological Services Department, Kumasi

Kumasi, the regional capital, is the second largest city in Ghana with about a quarter of the estimated 2.1 million people in the region. Almost all the important north-south trading routes, connecting the northern and the southern parts of the country converge on the city. Kumasi is also the meeting point of the railway line from Accra in the southeast (the national capital) and that from the twin harbor cities, Sekondi-Takoradi in the southwest.

Within the Ashanti region settlements are urban and semi-urban[1] townships whose residents provide ready markets for a substantial proportion of the food crops grown in neighboring farming villages. Thus the ecological, socioeconomic, infrastructural, and institutional arrangements in the region provide an ideal environment for the SFRP whose ultimate goal is to improve the well-being of small-scale farmers through increased productivity.

METHODOLOGY

Information for the compilation of this report was derived from several sources including secondary data, village and farm visits, interviews with extension and research workers, a carefully selected small group of village leaders and farmers, and results of soil sample analysis.

Selection of Villages

The Ashanti Region appears homogeneous in several agro-climatic and socio-cultural factors. However, there exist slight variations in microclimates and cultural practices. Consequently to ensure representativeness and some degree of homogeneity, all villages located within 40 km radius of Kumasi with less than 2,500 people formed the population for the study.

In collaboration with regional extension service personnel, sixteen potentially productive villages were selected. After characterizing the sixteen villages in terms of population size, accessibility, soil/landscape,

---

1. According to the Census Office, all settlements with 5,000 or more population are classified as urban. Based on this classification 26 towns in the region are considered urbanized.

farming systems, credit and market availability; five villages were finally selected on the basis of the following criteria:

- Availability and access by farmers to large markets and fertilizer distribution centers.
- Experience of extension workers in the village.
- Location of villages to enhance the demonstration effect of field programs.

Interviews and Farm Visits

From each of the five selected villages 2 farmers (1 male and 1 female) who had earlier volunteered to participate in the on-farm trial (OFT) were selected for intensive interviewing. This yielded a total of 10 respondents (5 males and 5 females). The interviews and farm visits which lasted about four days covered farmers' perceptions about the physical and biological environments, socio-cultural and institutional services and farming systems. Also, soil samples at depths of 0-20 cm and 20-50 cm were collected from farmers' fields in collaboration with personnel from the Soil Research Institute (SRI) for analysis at the Institut National du Sols (INS) Lomé, Togo. The sites were also characterized with respect to slope and the presence or absence of gravel, and/or hardpan.

GENERAL ASPECTS OF THE PILOT AREA

The pilot villages, Anyinasuso, Adjamasu, Baworo, Boamang, and Hwidien are located within the Offinso, Amansie, Ejisu-Juaben-Bosomtwe, Kwabre Sekyere and Atwima Administrative Districts of the Ashanti Region, respectively (see Figure 4).

Residents of the five villages are predominantly small-scale farmers who are mainly engaged in food crop production. Some cash tree-crops (cocoa, coffee and oil palm) are also grown by farmers at Boamang, Anyinasuso and Adjamasu.

With the exception of Anyinasuso, where majority of residents appear to be Moslems, residents of the other villages are mostly orthodox and pentecostal Christians.

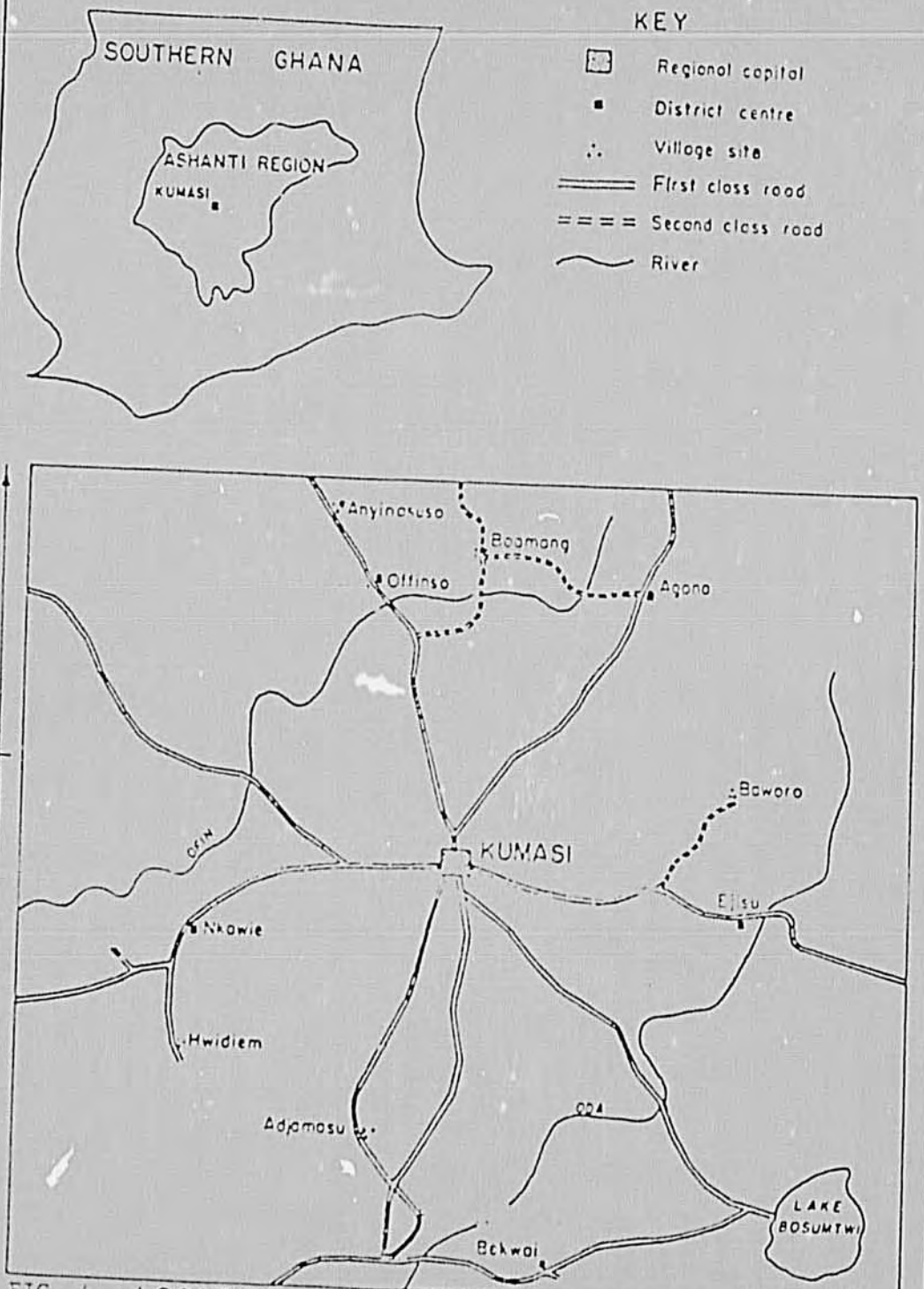


FIG. 4. LOCATION OF THE PILOT VILLAGES

Only Anyinasuso has a large regular market. However, the general layout of the other four villages provides for space in the village-center where residents buy and sell food crops and assorted items, perform funerals, public meetings, and other community rituals.

Transportation does not appear to be a problem in these villages. Consequently residents have relatively easy access to social and other essential services which are not obtainable in the villages. Table 1 provides a summary of population and highway distances between pilot villages and the location of essential services:

Table 1. Population and Highway Distances Between Pilot Villages and the Locations of Essential Services

Pilot Village	Total Population[a]	Service				
		Hospital	Commercial Bank	Secondary School	Large[c] Market	Agricultural Extension/ Fertilizer Depot
		(km)				
1. Anyinasuso	1,114[b]	9.6	9.6	7.0	43.2	9.6
2. Adjamasu	2,258[b]	16.0	16.0	16.0	16.0	16.0
3. Baworo	615	19.2	5.0	5.0	19.2	5.0
4. Boamang	1,983	16.0	0	13.0	33.0	16.0
5. Bwidies	998	25.0	4.5	3.2	25.0	5.0

a. 1984 Population Census of Ghana: Preliminary Report (unpublished), courtesy of the Statistical Service.
b. 1987 projection based on 1970 Population Census data (2.5% growth rate).
c. Large market implies centers where farmers make bulk sale of farm produce and procure farm inputs such as seeds, fertilizer, and tools. The large market as used here refers to Kumasi.

Incomes in all five villages appear to be generally low, and malnutrition, particularly among children, is very apparent. Considering the estimated six to seven children per family and the population growth rate of 2.5% (Ghana, 1984), the need to increase food production in the area becomes very imperative and the role of the SFRP is central in overcoming these problems.

PHYSICAL AND BIOLOGICAL ENVIRONMENT OF THE PILOT AREA

The use of fertilizer in sub-Saharan Africa depends on: (a) the desire and financial ability of farmers to use fertilizers and (b) the availability and cost of fertilizers. The first requirement, which depends on

crop response to fertilizer and socioeconomic factors, determines the demand of farmers for fertilizers and the second is determined by the supply of fertilizers (Baanante and Thompson, 1988). A set of factors associated with the climate, soil, and socio-economic environment determine crop production and thus the demand for fertilizers.

In the context of socio-economic research on farm level constraints to fertilizer use, climate and soil characteristics are used to identify relatively homogeneous domains which serve as a basis for selecting research areas and for the sampling of farmers.

Climate

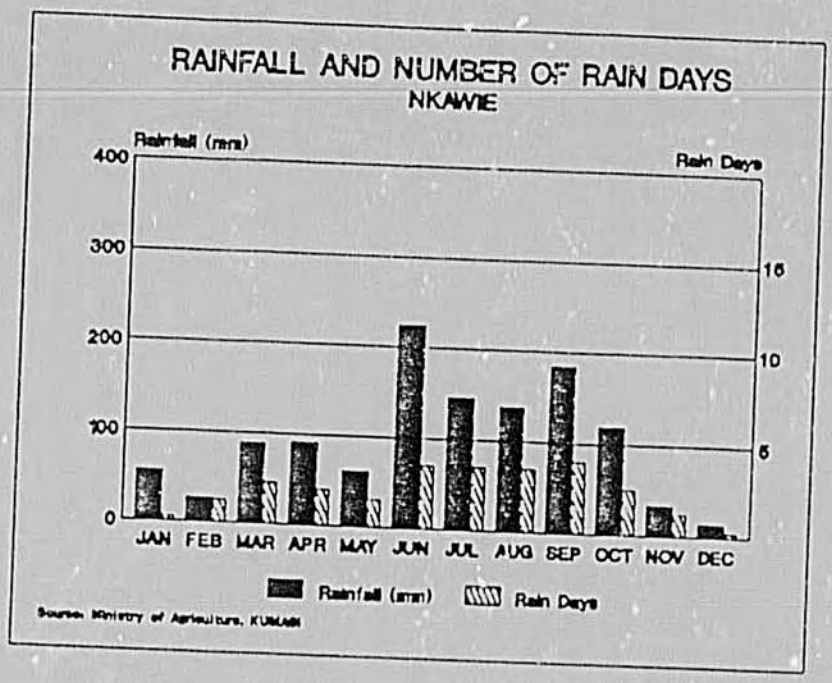
The pilot research area in Ghana is part of the Ashanti uplands that lie across the rain-bearing winds. Average annual rainfall in the Ashanti region ranges from 1400-1600 mm (Asiamah, 1986).

No rainfall and temperature data are available specifically for the pilot villages. However, rainfall data for nearby district centers (1987) provide some insight into the volume and monthly distribution pattern (see Figure 5 and Appendix Table 1). Due to their close proximity the climate around the pilot villages may not be significantly different from that of Kumasi. However, the comparatively higher elevation of the Offinso area, for example, may have a moderate effect on the rainfall and temperature.

Total rainfall in 1987 was slightly below the annual average for the region (Appendix Table 1) and farmers correctly perceived it as very insufficient. A summary of farmers' assessment of 1987 rainfall is provided in Table 2.

Table 2. Farmer Evaluation of 1987 Rainfall by Village (N = 10)

Pilot Village	Evaluation Category		
	Good	Average	Poor
Anyinasuso	-	xx	-
Adjamasu	-	-	xx
Baworo	-	-	xx
Boamang	-	x	x
Hwidiem	x	-	x



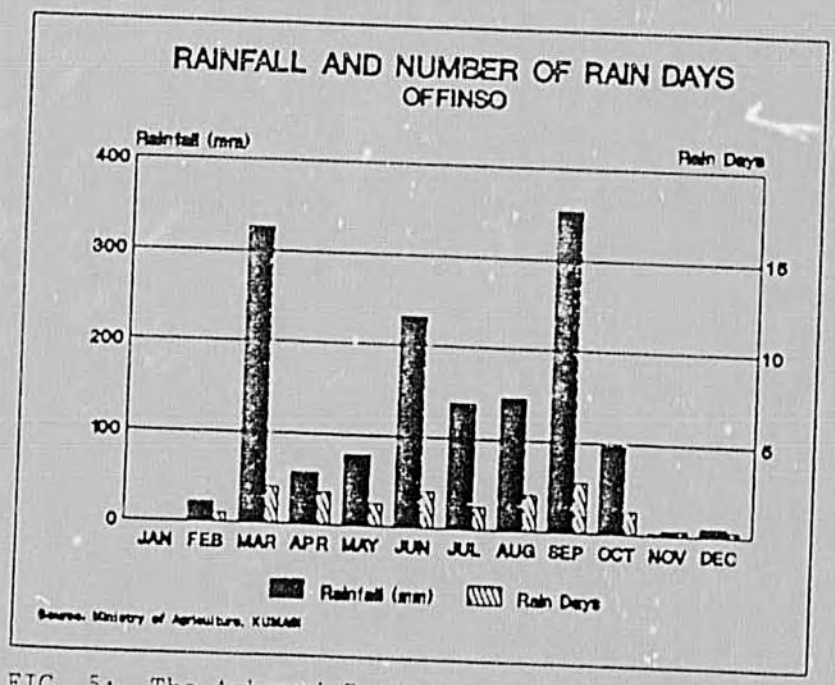
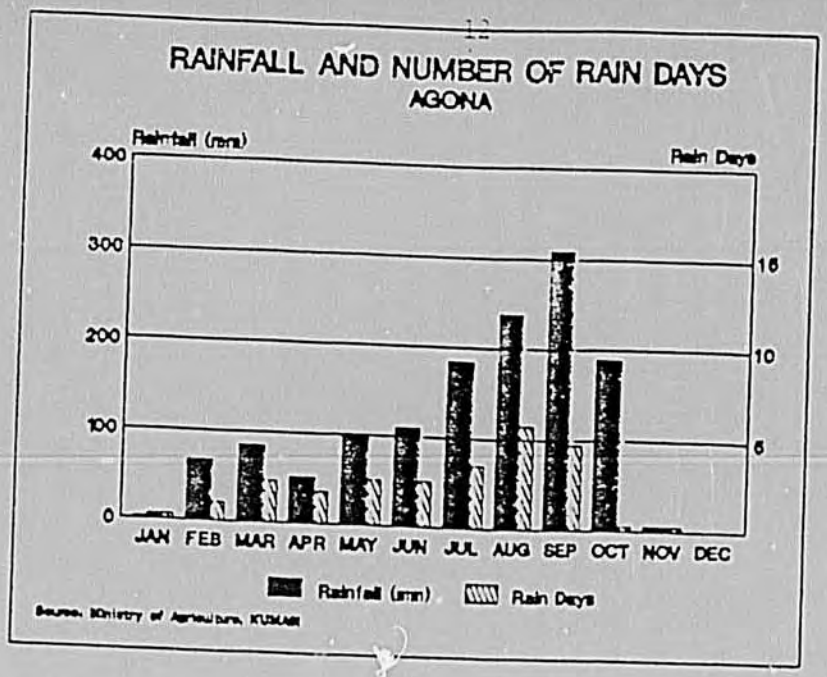
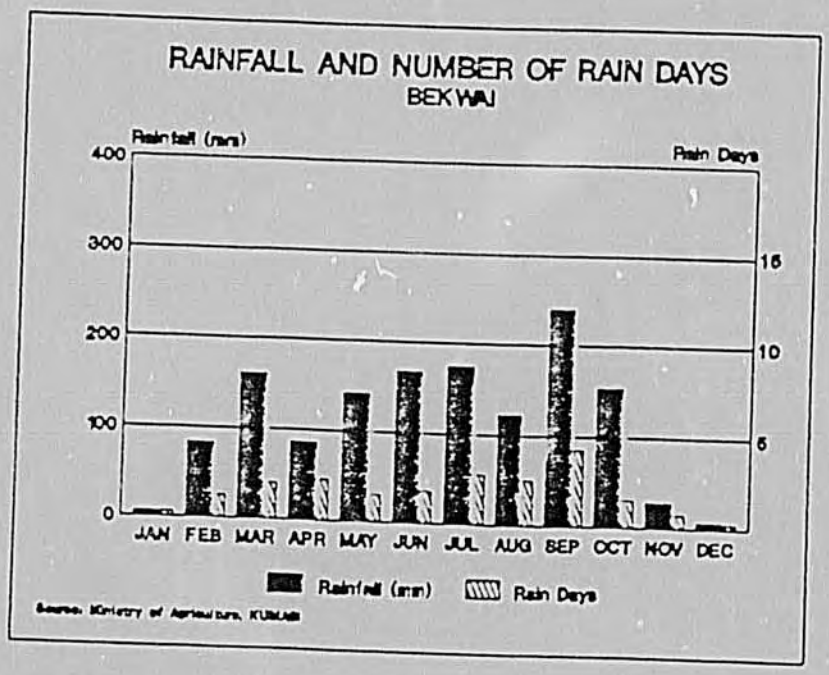


FIG. 5: The Ashanti Region: Monthly Rainfall and Numbers of Rain Days (1987) - Selected Stations.





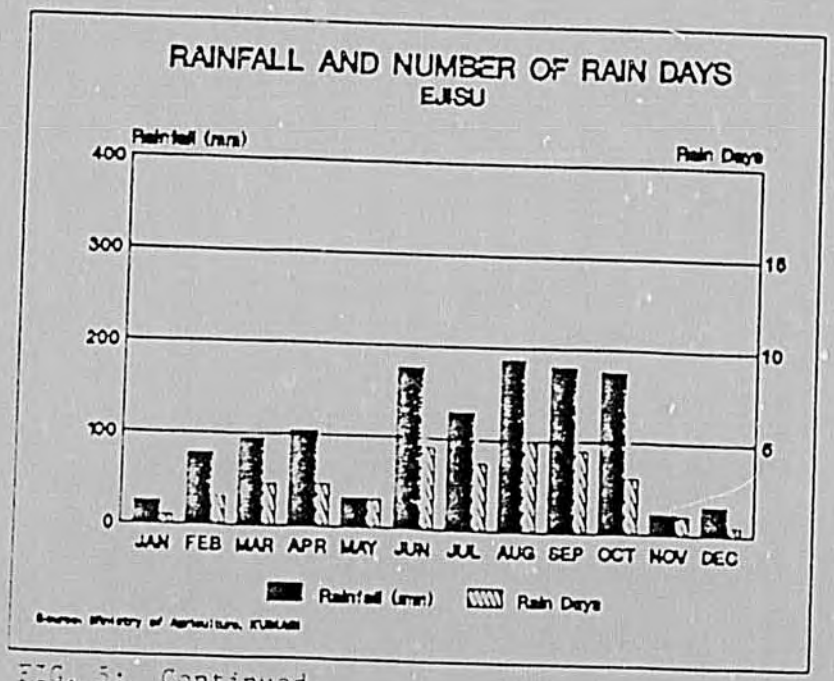


FIG. 3: Continued.

The farmers' survival strategies against poor rainfall distribution include to plant very early and, in many instances, to plant in lowlands near streams wherever possible.

Farmers' Perceptions of Site and Soil Conditions

Perceptions of farmers about site and soil conditions were as follows:

- Erosion risk was rated as low by 40% of respondents and moderate by 50%.
- Drought risk was rated by 30% of respondents as low, by 50% as moderate, and by 20% as high.
- Soil water holding capacity was rated as moderate by 40% of respondents and as high by 60%.
- Soil nutrient status was rated as moderate by 90% of respondents. A farmer in Baworo rated it as low.

Topography and Soil Properties

Soil fertility classification systems e.g., Buol and Couto (1981) utilize a number of soil characteristics and properties which can limit crop growth. Some of these characteristics and properties (Appendix Tables 2 and 3) are evaluated below, but no attempt is made to give classification notations.

Topography and Soil Physical Properties

The pilot area has an undulating topography made up of fairly level lands, slopes, and valleys. Slopes on the 10 surveyed farms ranged from 2 to 10% with an average of 5.8% (Appendix Table 2). Fifty percent of the farms were on slopes of 5% or less. Several small and medium sized streams drain the area. The major streams are the Offin and Oda and their tributaries.

In West Africa, there is a risk of erosion when slopes exceed 5% on sites where light textured topsoils overly heavy textured or compacted subsoils (Mutsaers et al., 1986). Textures were generally sandy loam in the topsoil changing to sandy loam, or sandy clay loam, or sandy clay in the subsoil. These textures are indicative of medium water holding capacity. The sites at

Adjamasu were of heavier texture (medium to high water holding capacity), i.e., clay or clay loam in the topsoil changing to clay in the subsoil. Gravels were present in the topsoil of site 1 at Ajamasu and site 11 at Anyinasuso, i.e., in only 20% of the topsoils examined, but there were no hard pan or rocks to impede root growth. Gravels reduce the available moisture holding capacity. Site 5 at Baworo and site 11 at Boamang were free of gravel in both the topsoil and subsoil. The soils at all sites examined were well to moderately well drained.

Soil Reaction, Exchange Acidity, Base Saturation, and C.E.C.

The pH (water) in topsoils ranged from 5.0 at site 7 (Baworo) to 6.8 at site 19 (Hwidiem) with an average of 5.8. In the subsoil, pH ranged from 4.40 in site 8 (Baworo) to 6.5 (Hwidiem) with an average of 5.2.

Exchange acidity (Al + H) in the topsoil was generally low, it ranged from 0.05 meq/100 g in sites 5 and 6 at Baworo and Boamang to 0.82 meq/100 g in site 15 at Anyinasuso. It averaged 0.14 meq/100 g. The highest level of exchange acidity and the lowest pH was recorded in site 15. In the subsoil exchange acidity ranged from 0.05 meq/100 g in sites 12, 18, and 20 at Hwidiem to 1.98 meq/100 g in site 8 at Baworo with an average of 0.65 meq/100 g.

Topsoil base saturation was generally above 60% when calculated on the basis of cation exchange capacity (C.E.C.) determined by NH_4 saturation and displacement. In site 19 (Hwidiem) it was >100%. This suggests that soluble salts together with exchangeable bases were being removed by the ammonium acetate extractant. The lowest base saturations of 32% and 40% were recorded at sites 15 and 7, respectively.

C.E.C. in the topsoil as determined by NH_4 saturation at pH 7 and displacement, ranged from 7.99 meq/100 g in site 11 at (Boamang) to 18.12 meq/100 g in site 3 at Ajamasu with an average of 11.12 meq/100 g. The sum of NH_4 OAc, exchangeable Ca + Mg + K + Na + KCl, and exchangeable Al + H is often referred to as effective C.E.C. In the highly weathered soils of the tropics (oxisols and ultisols) this parameter is of practical use in soil fertility management. However for the soil samples from the Kumasi area of Ghana, the use of an effective C.E.C. would suggest extremely high levels of base saturation in the topsoils.

Plant Nutrients

The plant available nutrients in the soils are assessed with respect to the level below which fertilization of a particular nutrient will be required. Interpretation of critical levels of plant nutrients is dependent on soil type, and crop species. Critical levels obtained from the literature on tropical African soils (IFDC, 1979; Roche et al., 1980; Munson, 1982; and Lindsay and Cox, 1985) are used when data for Ghanaian soils are unavailable).

Nitrogen--Soil organic carbon is used in the Soil Research Institute at Kumasi as an estimate of the N supplying power of soils. In the topsoils, organic carbon ranged from 0.76 in site 15 at Anyinasuso to 2.74% in site 3 at Adjamasu and it averaged 1.62%. Based on these levels the soil N supply is rated as high at the sites in Anyinasuso and Hwidiem and as low in site 15 at Anyinasuso. For 50% of the sites, the rating is considered as moderate.

Phosphorus--Bray P1 in topsoils ranged from 2.02 ppm in site 15 (Anyinasuso) to 7.95 ppm in site 9 at Boamang, averaging 5.05 ppm. Olsen-Dabin P ranged from 6.09 ppm in site 7 (Baworo) to 22.49 ppm in site 19 (Hwidiem), with an average of 12.13 ppm. Both extractants indicated low to extremely low levels of soil P supply in all sites. Acquaye (1986) reported that P deficiency is widespread in forest zone soils of Ghana and that crops grown in these soils are very responsive to phosphate fertilizers. P deficient maize plants were observed in a control plot not receiving P fertilizers in the on-farm trial of the SFRP at Adjamasu village.

Potassium--Exchangeable K in the topsoils ranged from 1.55 meq/100 g in site 15 to 0.42 meq/100 g in site 1 (Adjamasu). It averaged 0.24 meq/100 g. The K soil supply is rated as low in site 15 and as moderate to high in all the other sites.

Calcium--Exchangeable Ca in topsoils ranged from 1.55 meq/100 g in site 15 (at Anyinasuso) to 11.86 meq/100 g in site 19 (Hwidiem). It averaged 6.18 meq/100 g. With the exception of site 7 (Baworo), site 11 (Boamang), and site 15 (Anyinasuso), the levels are well above the critical level for exchangeable Ca. Acquaye (1986) reported that both Ca and Mg are usually present in adequate amounts in soils of Ghana except where the soils have been depleted during long periods of leaching and the continuous use of acid-forming fertilizers.

Magnesium--Exchangeable Mg in topsoils ranged from 0.93 meq/100 g in site 15 (Anyinasuso) to 2.74 meq/100 g in site 3 (Adjamasu) with an average of 1.58 meq/100 g. All sites were adequate in Mg supply.

Sulphur--Available S in the topsoils ranged from 8.26 ppm in site 15 to 41.71 ppm in site 1 (Adjamasu). It averaged 20.66 ppm. Thus, all sites were adequate in S supply. Acquaye (1986) reported that S deficiency is usually observed in the sandy savanna soils of Ghana.

Micronutrients--Levels of available Zn in topsoils are above the critical level in all sites. This is also true for Mn except perhaps in site 15 at Anyinasuso. Copper appears to be on the low side in all sites except Adjamasu. Iron appears to be low in sites 5 (Baworo), 9 (Boamang), and 17 (Hwidiem). Boron appears to be low in sites 15 and 9.

Soil Classification and Suitability

The soils of the Kumasi Region shown in Figure 6 have been surveyed (Asiamah, 1986). Three associations (a) Kumasi-Ofin compound, (b) Boso-Ofin compound, and (c) Boamang simple have been mapped. Their approximate equivalents in the FAO/UNESCO, USDA, and INRA/ORSTOM systems of soil classification are shown in Table 3. These associations are all developed over granitic rocks. The villages of Adjamasu and Hwidiem belong to the Kumasi-Ofin compound association, and the village of Baworo to a similar association. The villages of Boamang and Anyinasuso belong to the Boamang simple association.

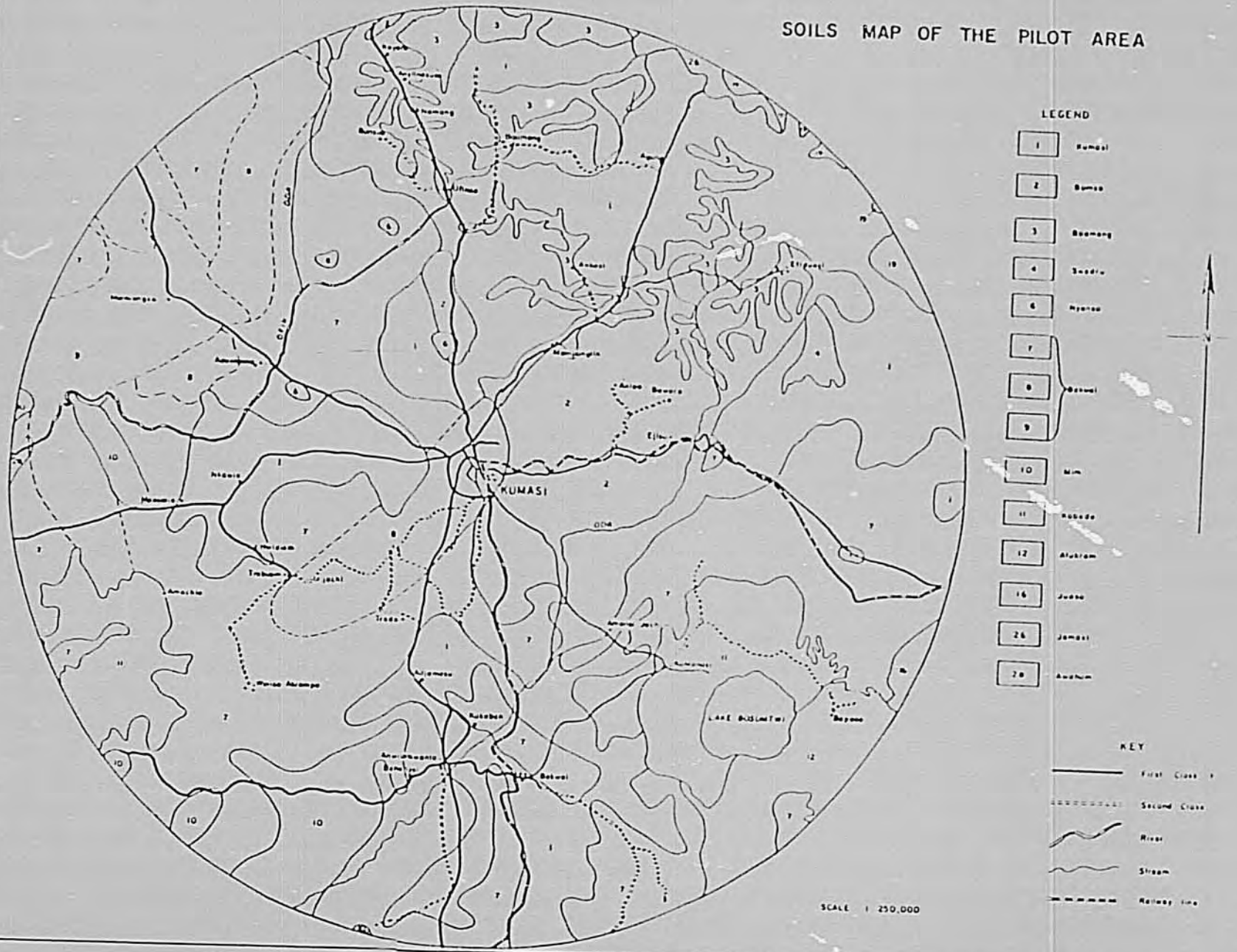
Sites that occur on the summits to middle slopes are suitable for the cultivation of maize, cassava, and other crops in all five villages (Asiamah, 1986).

Table 3. Classification of Well to Moderately Well Drained Soils of the Pilot Area[a]

Village	Local Soil Association	FAO/UNESCO	USDA	INRA/ORSTOM
Adjamasu	Kumasi-Ofin Compound	Orthhic Luvisol & Ferric Acrisol	Alfisol & Ultisol	Sols ferrugineux Tropicaux et Sols Fe.ralitiques Moyennement Désaturés
Hwidiem	Kumasi-Ofin Compound	Ditto	Ditto	Ditto
Baworo	Boaso-Ofin Compound	Ferric Luvisol & Ferric Acrisol	Ditto	Ditto
Anyinasuso	Boamang Simple	Orthic Luvisol	Alfisol	Sols Ferrugineux Tropicaux
Boamang	Boamang Simple	Ditto	Ditto	Ditto

a. Adapted from Asiaman (1986); Mutsaers et al. (1986)

FIG. 6


SOILS MAP OF THE PILOT AREA
LEGEND
KUMASI
LAKE BOSUMTWI
SCALE 1 250,000
KEY
First Class
Second Class
River
Stream
Railway line

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HUMAN ENVIRONMENT AND PHYSICAL INFRASTRUCTURE OF THE PILOT AREA

Sociocultural Environment

The Village Power Structure

With the exception of Anyinasuso where a substantial portion of the residents are settler farmers from the northern region of Ghana, residents of the remaining villages are of the Twi-speaking (Akan) ethnic group. Consequently, the basic ethnic unit of governmental authority is the village chief which in all cases is an adult male descendant of the first person that colonized the area (Rattary, 1962).

Aside from their judicial and religious functions, the chiefs, with the assistance of "a council of elders" (advisors) serve as custodians of their respective village lands and other natural resources. The performance of these roles confer on them a great deal of prestige and some aura of sacredness. Therefore involving the chiefs or at least notifying them about any program or activity in the villages, such as the SFRP, enhances legitimacy and also ensures residents' participation.

The Domestic Group

The matrilineal system of inheritance is practiced in all five villages. This makes the definition of a family or household difficult. Complications also arise in defining the family because of the progressive breaking up of the traditional family system especially among persons who have had some formal education.

A typical domestic group consists of a woman and her daughters and their children. However some couples live either alone, with maternal uncle, or with members of the wife's lineage. Also couples do not necessarily live together under the same roof.

It was observed during the survey that the head of the domestic group is usually a male, except in one location (Baworo) where the head happened to be a female. Whoever is the head of the group has authority over its members in domestic matters and is responsible for their upkeep.

Religion and Work Schedule

Aside from their regular church services, Moslem worship residents have to adhere to a few traditional beliefs and practices. As shown in Table 4, each of the villages has a special day of the week when, as custom demands, residents are obliged not to work on their farms. These "holidays" are reported to be observed in honour of either the earth deity and, in two cases, the major streams that drain the area. Thus a typical work week of a Christian or Moslem resident in any of the five villages may not exceed five days (i.e., a day each for the Christian/Moslem day of worship and the traditional holiday).

Table 4. Mandatory Holidays in Pilot Villages[a]

Pilot Village	Holiday
1. Anyinasuso	Tuesday
2. Adjamasu[b]	Tuesday and Friday
3. Baworo	Tuesday
4. Boamang	Tuesday
5. Awidiem	Thursday

a. In addition, every sixth Sunday (Akwasidae) and the Wednesday preceding it (Awukudae) are observed in all five villages.
b. Residents who farm around a specific location (southwestern side of the village) observe the Friday holiday.

Economic Environment

Recent policy measures including liberalization of "the mechanisms for determining agricultural prices and imports" (Dapaa and Otinkorang, 1987) as well as increased fiscal stringency have led to some increases in factor prices, particularly labor and capital and, to a small extent, rent paid by tenant farmers in the pilot villages.

Land Tenure and Access

Land tenure embodies the rules and procedures governing the rights and responsibilities of a group or an individual in the use and control of land (La-Anyane, 1985) and therefore exerts a great deal of influence on the economic organization and development of agriculture. As a rule land in the

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pilot villages, like elsewhere in the Ashanti Region in particular and Ghana in general, is considered as the property of the ancestors and is held in trust for them by the living. Every member of the lineage who is first to cultivate a tract of virgin land establishes for their direct descendants the right to use that land for cultivation. However, the field may be claimed by another member of the lineage if it is left abandoned such that traces of former use are obliterated (Benneh, 1972).

Outright sale of farmland is not permissible but leasing under varying tenurial arrangements, usually for short periods, is allowed. The systems of land tenure reported by farmers are provided in Table 5.

Table 5. Land Tenure Categories by Pilot Village (N = 10)

Village	Land Tenure Categories		
	Freehold	Sharecropping	Short-Term Leasing
Anyinasuso	-	xx	-
Adjamasu	xx	-	-
Baworo	xx	-	-
Boamang	xx	-	-
Hwidiem	x	-	x

Aside from the dominant traditional free-hold system, two other arrangements for land tenure prevail: namely, sharecropping and short-term leasing (Table 5).

Sharecropping seems to be very prevalent at Anyinasuso where, as stated earlier, the majority of the residents are settler farmers (migrants). Under the present arrangement, the landlord receives 50% of the cassava production and 33-1/3% of the maize harvested in return for use of the leased land. These costs represent a larger share of the prevailing costs of production in the case of maize than in cassava.

Under the present short-term leasing arrangements, land is usually leased to tenant farmers for one growing season (i.e., two years for maize/cassava intercrop) for varying sums of money. At Hwidiem, where this system was reported by a farmer, the rent for a hectare of farm land is about ¢6,000 (US $32). The prevailing sharecropping and leasing practices have important implications for the profitability of fertilizers and, thereby, for the implementation strategies of the SFRP. This is more so because one of the

ultimate objectives of the SFRP is to encourage the adoption and use of fertilizer as a long-term investment strategy. An analysis of these implications will be conducted using the verification farm survey data.

On the whole residents do not consider land to be scarce and settler farmers (migrants) have no difficulty in obtaining farm lands. The continuatin of this situation, particularly for farmers at Anyinasuso, is open to question, however. Total farm size as estimated by farmers ranged from 0.4 to 1.2 ha with a mean of 0.9 ha. Typical acreages estimated by extension workers was 0.8 ha. Farmers had 1 to 4 plots of land, usually located at less than 1.6 km from dwelling houses.

Labor

Three main types of labor were observed in the pilot villages, namely: family labor, hired labor, and a form of cooperative or pooled labor. The last seems very prevalent among the Moslem settler farmers at Anyinasuso.

Elsewhere, most farms are operated largely with family labor with occasional help from in-laws, nephews, and nieces. Some degree of division of labor by gender and age of children is practiced. Land preparation (brushing, tree felling, and burning) is considered to be the task for husbands and older male children, while the wives and daughters perform the relatively less arduous tasks of planting (seeding) and weed-clearing. This is the ideal but there appears to be frequent switch of roles depending upon the volume of work at hand, time limitation, and other circumstances. For example, during a farm visit at Anyinasuso it was observed that both husband and wife were planting cassava. Also, if children are enrolled in school, their labor may be available only on weekends and during school vacations.

Several farmers rely on hired labor which is not always available and, from the farmers' view, fairly expensive. A day's labor (usually 4½-5 hours) is paid a wage of between C300 (about US $2.00) and C350 depending on whether or not free lunch is provided on the farm. A summary of the estimated labor requirements and costs by type of activity for one hectare of maize in the Ashanti Region is provided in Table 6.

Table 6. Labor Requirements and Costs for a Hectare of Maize Farm (1987)

Activity	Amount of Labor	Cost (C)
1. Underbrushing	10 Mandays at C350/day	3,500
2. Tree Felling and Chopping	15 Mandays at C350/day	5,250
3. Burning	1 Manday at C350/day	350
4. Preparation for Planting	10 Mandays	3,500
5. Planting	3 Mandays	1,050
6. 1st Weeding	10 Mandays	3,500
7. 2nd Weeding	10 Mandays	3,500
8. Harvesting	4 Mandays at C300/day	1,200
9. Transport to Shed	4 Mandays	1,200
10. Dehusking	6 Mandays	1,800
11. Shelling	4 Mandays	1,200
TOTAL		26,050
Contingencies	10%	2,605
GRAND TOTAL		28,655

Source: Policy, Planning, Management, and Evaluation Unit, Ministry of Agriculture, Kumasi, Ghana.

Sources of Cash for Farm Activities

Farmers obtain cash from a variety of sources. The principal source is the sale of farm produce (food and cash crops) and occasionally livestock. As shown in Table 7, 60% of the farmers interviewed sold more than 50% of their previous year's harvest. Also it is important to note that farmers in Adjamasu appear to be more market-oriented than their counterparts in the other pilot villages.

Table 7. Proportion of 1987 Produce[a] Sold by Pilot Village

Village	Proportion Sold				
	<75%	50%-75%	25%-49%	<25%	% Total
Anyinasuso	-	x	-	x	20
Adjamasu	x	x	-	-	20
Baworo	x	-	-	x	20
Boamang	x	-	-	x	20
Hwidiem	-	x	x	-	20
% Farmers	30	30	10	30	100

a. Refers only to maize plots since most farmers reported that they have not finished harvesting their cassava plots.

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Farmers also supplement their farm incomes with occasional remittances from adult sons, daughters, and other relatives, who usually live in the cities. Table 8 shows the farmers' main sources of cash for their farm operations.

Table 8. Farmers' Sources of Cash for Farm Operations

Source	Number of Farmers	%
Own source/crop sales	5	50
Other family members	1	10
Friends/money lenders	3	30
Credit bank	1	10
TOTAL	10	100

Although a few institutionalized credit agencies (Commercial/Rural Banks) have branches in nearby towns, farmers are yet to take full advantage of the credit programs offered by the banks. As shown in Table 8 farmers seem to prefer credit from friends and relatives. According to farmers, such loans are generally small and sometimes carry high interest rates, depending upon the relationship between the two contracting parties. Two main reasons farmers gave for not taking bank loans were: (a) the volume of paper work involved and (b) the uncertainty, even after completing the paper work. A farmer who recently received bank credit reported that the farm-site plan requested by the bank cost him over C10,000 (US $54.00) to prepare.

Consequently very limited capital equipment such as hoes, cutlasses and axes and inputs such as fertilizers and pesticides are used by farmers.

Some farmers reported that although recent government policies of economic liberalization appear to have made some of the capital items more readily available on the market, but prices are higher than those that existed prior to the policy initiative. "A good cutlass," one farmer said, "sells between C500 and C600 compared to the previous controlled price of C60."

Physical Infrastructure

Roads

The area has a relatively well-maintained network of first class all weather roads as well as second class dirt roads. As shown on Figure 4 Adjamasu, Hwidiem, and Anyinususo are located on first class roads. Road maintenance is the responsibility of the Central Government. However, residents do some road maintenance in cases of emergency, such as removal of fallen trees after a rainstorm.

Private trucks, minibuses, and a few cars provide fairly regular transportation services. The Omnibus Services Authority, a para-statal commuter bus service, offers service between Boamang and Kumasi even though the service seems to be very irregular.

Farmers reported that transportation costs are generally not high but vary according to one's vehicle preference and whether or not one has accompanying luggage. Truck operators charge less but they usually prefer patrons who have pieces of luggage such as sacks of foodstuffs to be transported. While standard fares for passengers seem to exist in all villages, fares for luggage are decided by bargaining.

FARMING SYSTEMS AND AGRICULTURAL PRODUCTION

Cropping Patterns and Land Use

Farmers reported that the major food crops are cassava and plantain, while cassava and maize are the major cash crops. The following patterns of intercropping were reported: (1) maize/cassava, (2) maize/cassava/cowpea, (3) plantain/cocoyam, (4) maize/okra, (5) vegetables (tomatoes, pepper, etc.). The maize/cassava intercrop was most common. Plant populations were low; less than 25,000 and 7,000 plants/ha for maize and cassava, respectively. Planting was generally not in rows.

Land is also used for tree crop production, hunting, fuelwood, and religious purposes (sacred groves). However it was not possible to estimate the proportion of land under these uses in the survey.

Dates of Planting and Harvesting

In 1987, maize was planted between March and April and harvested between August and October. Most farmers planted in mid-March to early April and harvested in late August or early September. Cassava was planted between March and May and harvested the following year from January to March or later. Most farmers planted cassava in early to mid-April.

Crops Rotation

When the land was cropped for more than a year, in 50% of farms growing maize/cassava in the first year, this crop was followed by cassava or maize/cassava in the second year.

Fallow/Cropping Ratio

Farmers reported that the length of the fallow ranged from 4 to 5 years and the cropping period ranged from 1 to 2 years. Extension workers in the Kumasi area however estimated a cropping period of 2-3 years.

Crop Disorders

Diseases

Leaf spot, rust, and smut were reported by extension workers to be the common disease of maize. For cassava, mosaic virus was the most common disease. No control measures were taken by farmers against these plant diseases.

Pests

Farmers reported that grasshoppers and termites damaged cassava crops. The tubers were also damaged by wild pigs and rodents. A farmer in Boamang reported that he used a chemical as poison bait for rats. Stem borers and earworms were reported by extension workers to be common problems in fields of maize, while maize weevils and grain moths damaged maize grains, especially improved varieties, during storage. In general little or no control of field insect pests was practiced by farmers.

Weeds/Fallow Species

The following broadleaved species, grasses, shrubs and creepers were noted by extension workers - Leptaspics cochleata, Olyra latifolia, Crestis ferrugenea, Onchna kibbiensis, Chromelaena odorata, Alafia barteri, Strephantus sp.

Inputs and Yields

Fertilizers are mostly used in areas where maize and vegetables such as tomatoes are grown on a large scale in the Ashanti Region. The levels of supply are shown in Table 9.

Table 9. Fertilizer Allocation to Districts Where the Exploratory Survey Was Conducted (1987): Bags of 50 kg

Districts	Type of Fertilizer[a]		
	20^3	15^3	S/A
1. Kwabre-Sekyere	1,000	532	2,327
2. Offinso	5,599	756	2,500
3. Atwima	1,300	1,372	700
4. Amansie	3,983	1,338	6,859
5. Ejisu-Juaben Bosumtwi	300	400	1,700
TOTAL	12,182	4,398	14,086

a. 20^3 = 20-20-0; 15^3 = 15-15-15; S/A = Sulphate of Ammonia.

Source: Crops Services Division, Ministry of Agriculture, Kumasi, Ghana.

Compound fertilizers 20:20:0/15:15:15 were used by only 10% of the farmers interviewed at rates less than 15 kg of N or P_2O_5 or K_2O/ha. The official price for 20:20:0 and sulphate of ammonia are C1,380/50 kg and C870/50 kg, respectively. IFDC (1986) estimated subsidies of 37% and 44% for 20:20:0 and sulphate of ammonia, respectively. Farmers were aware that crop yields were declining as the fallow period declined. The reasons given for not using fertilizers were: (1) fertilizers are not affordable, (2) farmers were unaccustomed to fertilizer use, and (3) fertilizers encouraged weed growth. However, farmers were very keen to participate in the SFRP and try fertilizers. Based on value/cost ratio, the general fertilizer recommendation

(Acquaye, 1986) for maize and cassava grown in the major season in the forest zone of Ghana is 112:67:22 kg/ha and 67:45:90 kg/ha, respectively. The National Extension Service recommends a much lower dressing of 45:19:19 kg/ha (Dapaah and Otinkorang, 1988). The dressing consists of a basal application of 15:15:15 plus a side dressing of sulphate of ammonia. Twenty percent of the farmers interviewed reported the use of insecticides.

Eighty percent of the farmers interviewed reported that in 1987 they used improved maize varieties obtained from the extension service. Both male and female farmers in the Moslem village of Anyinasuso were using local maize varieties. All farmers reported the use of local cassava varieties. In 1987 intercropped maize was estimated by farmers to have yielded 600 kg/ha. The official price for seed maize is C42,000/tonne, but the average price is C58,000/tonne rising up to C85,000/tonne near planting time. The price of cassava is C37,000/tonne. Cassava yields per unit of area were difficult to estimate since it is harvested over a period of time and some plots were still not harvested.

Livestock

A few farmers keep small numbers of sheep and goats, but there was no conscious effort to integrate these animals into the raising of crops. The quantity of wastes produced by these animals is too small for manuring maize or cassava.

Post Harvest Activities and Harvest Utilization

Storage Facilities

There are no institutionalized storage facilities such as government or cooperative-sponsored silos in the villages. Farmers store produce in their homes for varying purposes.

Maize was stored for consumption, sale, or seed. The duration of storage ranged from 4 to 12 months. Methods of storage include hanging the unhusked cobs over a fireplace and chemical treatment of seed. Cassava is stored in the ground by delayed harvesting. Another method is for tubers to be peeled, cut, and dried (Kokonte) and stored. A better way of storage is to

process tubers into gari but it is not a main diet of people in the area. Crop residues were generally not used, although a few farmers mentioned that they sold maize husks for the preparation of balls of kenkey.

Marketing of Farm Produce

In the absence of long-term storage facilities, the majority of farmers sell a significant proportion of their produce soon after harvest to meet their cash needs. Maize is either harvested green and sold or left on the farm to dry before it is carried to markets in heaps, head loads, or bags of varying "weights" depending on the size of the market.

As shown in Figure 7 farmers' produce reaches consumers through two or three channels, namely, direct to consumers or through other intermediaries.

There are two categories of intermediaries: (a) the itinerant and (b) the sedentary intermediary. The former may be a resident or a non-resident who makes bulk purchases, sometimes total farm production, from farmers and retails to consumers in the urban centers. The sedentary intermediary is usually based in the urban center and buys either directly from the farmers, who go to the urban market with their produce, or from the itinerant intermediary for resale to consumers. In all cases transactions are made in cash terms. However, in the case of the purchase of total farm production sometimes full cash payment is made after the sale of the harvest.

CONCLUSIONS OF SURVEY AND IMPLICATIONS FOR THE SOIL FERTILITY RESTORATION PROJECT

1. Inadequate P levels is the major soil fertility constraint in the Ashanti Region of Ghana. It is well known that deficiency of P alone can drastically reduce maize yields, and responses exceeding 100% can result from P fertilization of West African soils that are deficient in P. Emphasis should therefore be placed on the use of phosphatic materials, with only small dressings of N and little or no potash application during the initial years of the project.

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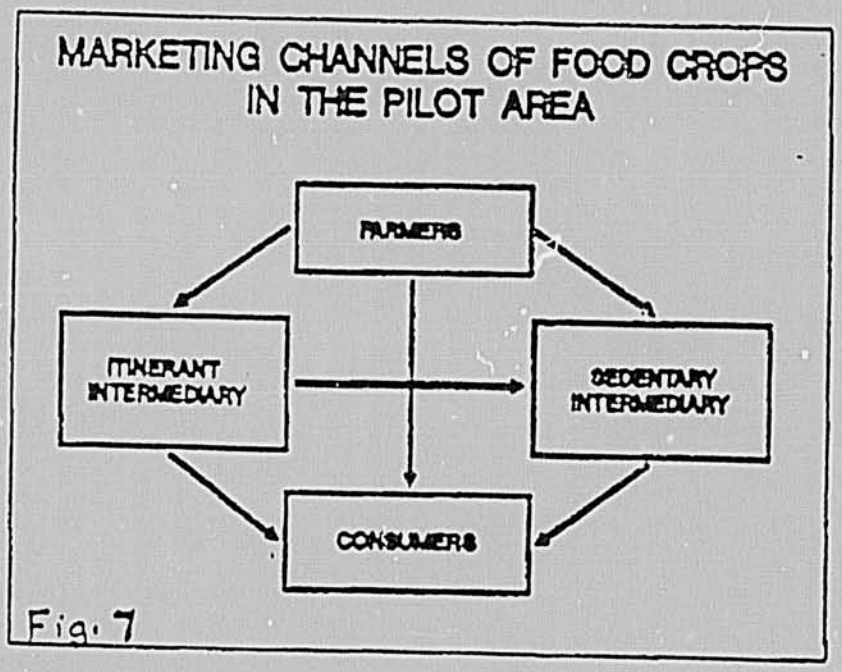
MARKETING CHANNELS OF FOOD CROPS
IN THE PILOT AREA
FARMERS
ITINERANT
INTERMEDIARY
SEDENTARY
INTERMEDIARY
CONSUMERS

Fig. 7

2. The soil tests were made on samples taken from newly cleared fields. Fertilization of entire villages may involve newly cleared lands and lands of lower nutrient status that have been cropped for more than 1 year after clearing.
3. The benefits of compounds and single nutrient carriers of P should be compared as investment strategies in 1989. Fertilization of maize on farmers' fields in Ghana is presently based on the use of compounds supplemented with N.
4. In the Ashanti Region, sulphur deficiency does not appear to be a problem. There is therefore need for economic and agronomic evaluations of high-analysis P fertilizers like DAP and TSP in on farm trials in this region. There has been an increase in the use of TSP and DAP by West African Countries because of savings in transportation costs (IFDC, 1987). However these materials have undergone only limited testing by IFDC in West Africa (IFDC, 1987).
5. The fact that continuous cropping is not practiced suggests that moderate annual applications of P rather than a single large dose to last for 3 or 5 years may be appropriate at the start of the project. However, as fertilizer use increases the length of the cropping period may also increase.
6. After initial application of "free" P fertilizers, resulting high maize yields will reduce soil reserves of other essential nutrients and the ability of farmers to cope with multinutrient deficiencies should be kept in mind.
7. The results of the ongoing on-farm trials should aid in determining efficient rates of P application.
8. There is a limited potential for the use of animal wastes in the manuring of maize/cassava in the Ashanti Region of Ghana.
9. Maize and cassava are very important food and cash crops in the pilot villages, but present yields are low. Fertilization of entire villages should be based on maize/cassava farms.
10. There is need to maintain close contacts with the extension service, so that improved practices such as improved seed, correct plant populations, and adequate weeding can be followed. Farmers evaluated soil fertility status as moderate in a situation in which they use low plant population densities.

11. The verification survey should, among other things, explore gender roles in detail especially the extent of women's involvement in (a) decision making, (b) labor input in various farming and nonfarming activities, and (c) farmers' income levels and consumption patterns.
12. The villages of Adjamasu and Hwidiem belong to the same soil associations and have easy access to markets and fertilizer depots. Arrangements for land tenure are not a problem in these villages. Farmers in both villages appear to be more market-oriented than their counterparts in the other villages: large responses to applied P fertilizers are highly probable in Adjamasu village. The two villages are therefore chosen as the villages in which the detailed survey will be conducted. The fertilized village will be Adjamasu and the control village will be Hwidiem.
13. After the first phase of the project there may be a need to expand the SFRP into the very high rainfall (>2000 mm) and leaching environments of West Africa, e.g, Cameroon, where several key nutrients are likely to be deficient.
14. Village chiefs have a great deal of influence on their people. Therefore their involvement in the project will enhance its success.

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APPENDIX .. TABLE 1: Ashanti Region: Rainfall and Number of Rain Days - Selected Stations 1997

District Capital		Months												TOTAL	
		J	F	M	A	M	J	J	A	S	O	N	D		
AGONA (Boamang)	Rain.mm	2	67	85	50	101	110	185	237	309	189	5	0	1230	102.5
	#Rain Days	1	4	9	7	10	10	14	23	19	10	1	0	18	
BEEKWAI (Adjamasu)	Rain. mm	5	83	160	86	14	167	174	122	239	153	28	7	1231	102.5
	#Rain. Days	1	5	8	9	6	7	11	10	17	6	3	1	84	
EJISU (Baworo)	Rain. mm	25	78	95	104	31	176	129	187	190	175	22	31	1233	102.7
	# Rain.Days	2	6	9	9	6	13	15	20	18	12	4	2	121	
NKAWIE (Ewidien)	Rain. mm	5	26	89	91	61	224	1454	137	184	118	33	14	1127	93.9
	# Rain Days	1	5	9	8	6	14	14	14	16	10	5	1	103	
OFFINSO (Anyinasuso)	Rain. mm	0	21	328	56	78	231	138	146	354	97	2	9	1458	121.5
	# Rain. Days	0	2	6	7	5	8	5	8	11	5	1	1	61	

Source: Ministry of Agriculture (Policy, Planning, Monitoring and Evaluation Unit) KUMASI

APPENDIX Table 2: Field Description of Sites

SITE	DEPTH (cm)	VILLAGE	FARMER'S NAME	GRAVEL PRESENCE	HARD PAN ROCK PRESENCE	TOPOGRAPHY	% SLOPE
1	0-20	Adjamasu	Madam Anna Twumwaah	Yes	No	Middle Slope	3.5
2	20-50	Adjamasu	Madam Anna Twumwaah	Yes	No	Middle Slope	3.5
3	0-20	Adjamasu	Mr. Nicholas Kwabena Nyame	No	No.	Middle Slope	10.0
4	20-50	Adjamasu	Mr. Nicholas Kwabena Nyame	Yes	No	Middle Slope	10.0
5	0-20	Baworo	Mr. Mohammed Kwaku Duah	No	No	Middle Slope	4.0
6	20-50	Baworo	Mr. Mohammed Kwaku Duah	No	No	Middle Slope	4.0
7	0-20	Baworo	Madam Adwoa Pepra	No	No	Upper Slope	7.0
8	20-50	Baworo	Madam Adwoa Pepra	Yes	No	Upper Slope	7.0
9	0-20	Boamang	Mr. Tabon Dagarti	No	No	Middle Slope	6.0
10	20-50	Boamang	Mr. Tabon Dagarti	Yes	No	Middle Slope	6.0
11	0-20	Boamang	Madam Anna Nsowaah	No	No	Middle Slope	5.0
12	20-50	Boamang	Madam Anna Nsowaah	No	No	Middle Slope	5.0

APPENDIX Table 2 (Cont.): Field Description of Sites

SITE	DEPTH (cm)	VILLAGE	FARMER'S NAME	GRAVEL PRESENCE	HARD PAN ROCK PRESENCE	TOPOGRAPHY	% SLOPE
13	0-20	Anyinasuso	Mr. Anadu Grunshie	No	No	Lower Slope	8.0
14	20-50	Anyinasuso	Mr. Anadu Grunshie	Yes	No	Lower Slope	8.0
15	0-20	Anyinasuso	Madam Fati Anadu	Yes	No.	Upper Slope	10.0
16	20-50	Anyinasusu	Madam Fati Anadu	Yes	No	Upper Slope	10.0
17	0-20	Ewidien	Mr. Samuel Kwarteng	No	No	Lower Slope	2.5
18	20-50	Ewidien	Mr. Samuel Kwarteng	Yes	No	Lower Slope	2.5
19	0-20	Ewidien	Madam Doris Amankwah	No	No	Middle Slope	2.0
20	20-50	Ewidien	Madam Doris Amankwah	Yes	No	Middle Slope	2.0

APPENDIX Table 3: Soil Analytical Data of Sites in the Pilot Area (Over dry weight basis)

Analysis	Depth (cm)	Sample No.	Amansie (Adjamasu)	Sample No.	Kjisu - Juaben - Bosumtwi (Baworo)	Sample No.	Kwabre - Sekyere (Boamang)	Sample No.	Offinso (Anyinasuso)	Sample No.	Atwima (Hwidiem)
Clay %	0-20	1	28.82	5	16.51	9	16.20	13	18.97	17	9.12
	20-50	2	47.84	6	40.85	10	36.49	14	34.55	18	18.13
	0-20	3	42.07	7	18.94	11	19.55	15	45.48	19	11.71
	20-50	4	47.07	8	40.68	12	7.57	16	24.42	20	11.66
Silt %	0-20	1	29.43	5	8.82	9	6.74	13	12.49	17	15.61
	20-50	2	16.73	6	9.47	10	7.50	14	12.63	18	12.37
	0-20	3	33.25	7	11.58	11	7.49	15	9.25	19	12.18
	20-50	4	18.13	8	11.94	12	19.27	16	19.62	20	18.24
Sand %	0-20	1	41.22	5	72.33	9	75.67	13	67.71	17	72.41
	20-50	2	34.71	6	49.54	10	55.43	14	52.12	18	68.61
	0-20	3	21.75	7	68.15	11	71.90	15	45.61	19	74.01
	20-50	4	33.98	8	46.45	12	73.40	16	56.19	20	71.28
Organic Carbon %	0-20	1	2.06	5	1.47	9	1.45	13	1.41	17	1.88
	20-50	2	0.89	6	0.63	10	0.59	14	0.47	18	0.96
	0-20	3	2.74	7	0.93	11	1.70	15	0.76	19	1.76
	20-50	4	0.82	8	0.63	12	0.31	16	0.35	20	0.31
Total N%	0-20	1	0.17	5	0.12	9	0.12	13	0.13	17	0.11
	20-50	2	0.07	6	0.06	10	0.05	14	0.04	18	0.12
	0-20	3	0.23	7	0.10	11	0.13	15	0.06	19	0.15
	20-50	4	0.07	8	0.06	12	0.03	16	0.04	20	0.03

APPENDIX Table 3: Soil Analytical Data of Sites in the Pilot Area (Over dry weight basis)

Analysis	Depth (cm)	Sample No.	Asante (Adjaadwo)	Sample No.	Ejisu - Juaben - Bosumtwi (Baworo)	Sample No.	Kwabre - Sekyere (Boamang)	Sample No.	Offinso (Anyinasuso)	Sample No.	Atwima (Bwidiem)
C/N	0-20	1	12.21	5	12.21	9	12.17	13	11.42	17	16.36
	20-50	2	12.25	6	10.28	10	12.26	14	11.12	18	5.09
	0-20	3	11.39	7	9.13	11	13.32	15	12.38	19	11.25
	20-50	4	11.24	8	11.32	12	11.07	16	8.11	20	9.10
Available P (ppm) (BRAY 1)	0-20	1	5.41	5	4.84	9	7.95	13	4.22	17	6.16
	20-50	2	2.71	6	2.01	10	2.00	14	1.93	18	6.51
	0-20	3	2.75	7	5.11	11	4.16	15	2.02	19	7.73
	20-50	4	2.00	8	3.03	12	1.97	16	3.55	20	2.97
Available P (ppm) (OLSEN [ABIN])	0-20	1	12.21	5	11.70	9	16.73	13	8.83	17	10.23
	20-50	2	6.12		5.65	10	5.11	14	5.07	18	10.11
	0-20	3	12.42	7	6.09	11	8.71	15	11.87	19	22.49
	20-50	4	3.06	8	5.14	12	5.03	16	6.08	20	5.56
NH4OAC pH7 Exchangeable K (eq/100g)	0-20	1	0.42	5	0.25	9	0.26	13	0.24	17	0.24
	20-50	2	0.23	6	0.09	10	0.09	14	0.11	18	0.32
	0-20	3	0.31	7	0.15	11	0.17	15	0.05	19	0.27
	20-50	4	0.26	8	0.06	12	0.13	16	0.24	20	0.10
Ca (meq/100g)	0-20	1	5.80	5	7.53	9	9.33	13	5.61	17	6.03
	20-50	2	1.43	6	2.06	10	2.86	14	1.31	18	5.66
	0-20	3	7.56	7	2.54	11	4.00	15	1.55	19	11.86
	20-50	4	1.33	8	1.03	12	1.81	16	1.52	20	2.33
Mg (meq/100g)	0-20	1	1.76	5	2.10	9	1.77	13	1.12	17	1.57
	20-50	2	0.78	6	1.28	10	1.19	14	0.50	18	1.35
	0-20	3	2.74	7	1.01	11	1.33	15	0.93	19	1.50
	20-50	4	0.71	8	0.48	12	0.50	16	0.64	20	0.49

APPENDIX Table 3: Soil Analytical Data of Sites in the Pilot Area (Over dry weight basis)

Analysis	Depth (cm)	Sample No.	Amonsie (Adjamanu)	Sample No.	Kjiau - Juaben - Bosumtwi (Bawoto)	Sample No.	Kwabre - Sekyere (Bosmang)	Sample No.	Offinso (Anyinasuso)	Sample No.	Atwima (Bwidiem)
Na (meq/100g)	0 20	1	0.10	5	0.09	9	0.06	13	0 06	17	0.05
	20 50	2	0 06	6	0 05	10	0 05	14	0.05	18	0 07
	0 20	3	0.08	7	0.05	11	0.05	15	0.05	19	0.08
	20-50	4	0.07	8	0.05	12	0.04	16	0.05	20	0.04
Sum of bases (meq/100g)	0-20	1	8.04	5	9 97	9	11.43	13	7.04	17	7.89
	20-50	2	2.56	6	3.49	10	4.20	14	1.99	18	7.40
	0-20	3	10.69	7	3.75	11	5,55	15	2.59	19	13.71
	20-50	4	2.37	8	1.62	12	2.49	16	2.45	20	2.96
Cation Exchange Capacity (meq/100g)	0-20	1	11.70	5	11.19	9	11.66	13	9.35	17	11.25
	20-50	2	6.38	6	7.71	10	7.97	14	5.76	18	9.61
	0-20	3	18.12	7	9.38	11	7.99	15	8.00	19	12.53
	20-50	4	11.23	8	9.77	12	3 22	16	6.33	20	5.05
Base Saturation (%)	0-20	1	70.19	5	90 54	9	39 39	13	77.88	17	71.58
	20-50	2	40.62	6	46 25	10	54.14	14	34.38	18	77.86
	0-20	3	61.08	7	40 57	11	70.70	15	32.35	19	102.25
	20-50	4	21.45	8	16.46	12	77.47	16	39.51	20	58.65
pH (H_2O)	0-20	1	5.5	5	6.2	9	6.5	13	5.6	17	6.1
	20-50	2	4.9	6	5.1	10	5.7	14	4.7	18	6.0
	0-20	3	5.3	7	5.0	11	5.6	15	5.5	19	6.8
	20-50	4	4.9	8	4.4	12	4.6	16	5.0	20	6.5

APPENDIX Table 3: Soil Analytical Data of Sites in the Pilot Area (Over dry weight basis)

Analysis	Depth (cm)	Sample No.	Amansie (Adiamasu)	Sample No.	Ejisu - Juaben - Bosumtwi (Baworo)	Sample No.	Kwabre - Sekyere (Boamang)	Sample No.	Offinso (Anyinasuso)	Sample No.	Atwima (Swidiem)
KH_2PO_4 Extractable S (ppm)	0-20	1	41.71	5	15.26	9	13.18	13	25.36	17	13.29
	20-50	2	33.71	6	13.36	10	8.17	14	6.09	18	17.19
	0-20	3	15.53	7	36.51	11	23.57	15	8.25	19	13.29
	20-50	4	22.47	8	23.66	12	9.56	16	8.11	20	12.13
O1N HCl Extratable Mn (ppm)	0-20	1	39.97	5	51.83	9	87.93	13	58.58	17	93.76
	20-50	2	3.27	6	5.34	10	19.00	14	11.39	18	80.37
	0-20	3	75.97	7	26.47	11	52.31	15	6.87	19	90.18
	20-50	4	3.52	8	4.89	12	21.23	16	16.99	20	14.76
Zn (ppm)	0-20	1	20.16	5	50.97	9	11.77	13	12.27	17	51.53
	20-50	2	24.69	6	13.00	10	18.39	14	9.57	18	15.18
	0-20	3	16.72	7	16.33	11	12.97	15	8.57	19	15.75
	20-50	4	11.54	8	10.30	12	13.88	16	16.63	20	8.54
Cu (ppm)	0-20	1	1.02	5	0.36	9	0.66	13	0.36	17	0.41
	20-50	2	1.28	6	0.46	10	0.82	14	0.96	18	0.56
	0-20	3	1.29	7	0.51	11	0.36	15	0.57	19	0.20
	20-50	4	1.48	8	0.36	12	0.65	16	1.01	20	0.35
Fe (ppm)	0-20	1	14.97	5	6.21	9	5.48	13	7.90	17	3.58
	20-50	2	21.74	6	12.54	10	7.25	14	18.67	18	11.74
	0-20	3	12.94	7	23.53	11	9.49	15	13.43	19	8.03
	20-50	4	28.70	8	19.77	12	10.92	16	14.66	20	10.72
B (Hot Water) (ppm)	0-20	1	0.57	5	0.67	9	0.26	13	0.31	17	0.31
	20-50	2	0.49	6	0.27	10	0.27	14	0.26	18	0.40
	0-20	3	0.79	7	0.39	11	0.43	15	0.25	19	0.43
	20-50	4	0.41	8	0.41	12	0.26	16	0.30	20	0.59

APPENDIX 6

A SOCIOECONOMIC STUDY OF FARM-LEVEL CONSTRAINTS TO FERTILIZER USE IN WESTERN NIGER*

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May 1988

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* This study was conducted as an IFDC initiative in collaboration and with the support of USAID/Niger. The study was not designed in the context of the Soil Fertility Restoration Project (SFRP), but it serves both as a report to USAID/Niger and as a background for the SFRP.

Preface

The lingering effects of the drought during the early 1980s and the decline of world uranium prices in the 1980s have exacerbated the human suffering in the Sahelian country of Niger. Declining food production per capita and limited use of fertilizer are critical problems that are becoming more evident in the 1980s. Farm-level socioeconomic research must be considered in evaluating the potential of the region to produce, market, and use fertilizer. Niger, at the geographical center of the Sahel, exemplifies the demographic, economic, and agricultural problems of the region. This exploratory study of farm-level constraints to fertilizer use in western Niger provides a basis for future socioeconomic research by IFDC in West Africa.

Acknowledgments

The support, guidance, and advice of Dr. Paul L.G. Vlek, Director of the IFDC West Africa Division in Lomé, Togo, and Dr. Andre Bationo, IFDC/Niger, are gratefully acknowledged.

The authors also acknowledge the support and assistance of Quincy Benbow and Ernest Gibson of the United States Agency for International Development (USAID) Mission in Niamey.

Ousseini Sidibe and Ibriham Magagi of the National Cereals Program of Niger are also acknowledged for their useful guidance and advice that were necessary for the successful completion of the project.

Charles Renard of the ICRISAT Mission in Niamey also provided timely support and advice and arranged for field transportation. Zakari Garba provided field assistance and shared his knowledge of Djerma agriculture and customs.

John Lamers is singularly acknowledged for sharing his 5 years of field experience in Niger with the authors and providing extraordinary insights into questionnaire construction and the cultural aspects of conducting interviews in western Niger.

Finally, the Village Chiefs of Goberi and Simari, Anabo Amadu, and Hassan Haruna are offered appreciation and gratitude for enthusiastically welcoming the research team into their villages and encouraging the farmers to discuss local agriculture and fertilizer use. Memories of them will not quickly fade.

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List of Abbreviations and Acronyms

Economic and Monetary

GDP	Gross Domestic Product
CFA	Currency of the West African Monetary Union--295 CFA = U.S. $1.00

Measures

ha	hectare (2.47 acres)
kg	kilogram (0.454 kg = 1 pound)
km	kilometer (1.61 km = 1 mile)
mt	metric ton (2.204 pounds = 1,000 kg)

Governmental and International Organizations

ALC	Associations Locales des Cooperatives
FAO	Food and Agriculture Organization of the United Nations
ICRISAT	International Crops Research Institute for the Semiarid Tropics
IFDC	International Fertilizer Development Center
GMV	Groupement Mutualistic Villageois
GON	Government of Niger
USAID	United States Agency for International Development

Fertilizer

CAN	Calcium ammonium nitrate
SSP	Single superphosphate
TSP	Triple superphosphate

A SOCIOECONOMIC STUDY OF FARM-LEVEL CONSTRAINTS TO FERTILIZER USE IN WESTERN NIGER

Introduction and Background

The Sahelian countries of West Africa may be described as a region of limited rainfall and frequent drought. Although diverse in many ways, the countries of Niger, Chad, Senegal, Mauritania, Burkina Faso, Sudan, and Mali have in common the problem of fragile agricultural sectors and demographic pressures. The Sahelian population counts its blessings by millimeters of rain and survives on a thin margin. Dust, wind, desertification, and a delicate ecological environment render life tenuous, harsh, and demanding.

The character of existence in the Sahel is well exemplified in Niger, a country sometimes described as "a land where the harvest is won with the soul's scythe." Niger is the largest country in West Africa and is the geographical center of the Sahelian region. Niger provides an excellent example of the demographic, economic, and agricultural problems confronting the region.

The Republic of Niger has a landlocked area of 1,186,408 km^2 or 458,075 mi^2 with a population that exceeds 7 million; it is the tenth largest country in Africa and sparsely populated. Although estimates vary, between 3% and 8% of the land is considered suitable for agricultural production.

The Demographic Character of Niger

Niger is in a period of explosive population growth caused by high birth rates, increasing life expectancies, declining infant mortality, and a generally declining death rate. The critical variables that describe that demographic transition are shown in Table 1. With an estimated midyear population of 7.1 million people in 1987 and one of the highest rates of natural increase in the world, Niger is confronting a rather dismal demographic horizon. One particular problem is the rapid 6% estimated annual growth of urban populations whose demands for sustenance will become increasingly difficult to satisfy.

Ironically, programs and interventions in health care will decrease the time in which the population doubles and make it more difficult to achieve progress in economic development. The social custom of polygamy contributes to high aggregate fertility. The total fertility rate shows that on the average each woman will have seven children during the childbearing period.

The demographic structure and character of Niger are greatly increasing the population density per square kilometer of agricultural land. The data shown in Table 2 indicate that such density has more than doubled during the last quarter century. The Nigerien people are increasingly dependent on a fragile and deteriorating economy in the midst of tremendous population pressure.

The Economic Situation

One particularly useful indicator to describe the situation of the Nigerien economy is the per capita gross domestic product (GDP). Those data shown in Table 3 indicate a constant downward trend since 1980.

The accelerated economic growth during the decade 1970-80 was attributable to soaring world prices for uranium and several years of adequate rainfall that temporarily bolstered agricultural production.

The factors that explain the deterioration of the economy in the 1980s are the decline in the world demand for uranium, which is mined in Niger, and the lack of growth in the agricultural sector.

The annual growth rates in real GDP per capita shown in Table 4 dramatically illustrate the deterioration of the economic situation of Niger. The rapid population growth and decline in other sectors of the economy have had profound consequences for the Nigerien agricultural sector.

The Agricultural Sector

A reliable and valid database is a necessity in planning an agricultural development strategy. Although essential data on key factors of agricultural production in Niger are lacking or often contradictory, the World Development Reports of the World Bank provide useful insight into the general condition of the Nigerien agricultural sector (Table 5).

The people of Niger are experiencing a decline in domestic production and a growing dependence on cereal imports and food aid. Because of the rapidly growing population and deteriorating agricultural production and economic growth, a high priority of the Government of Niger (GON) is to

increase grain production to meet domestic needs. Future expansion of agricultural production is to be realized from increased land productivity rather than expansion of the area of cultivated land. That strategy of intensive agriculture is predicated on developing and expanding the efficient use of appropriate fertilizer technology and other modern inputs.

Fertilizer Use in Niger

Central to the food and fiber production problems of Niger is the low level of fertilizer use, which was estimated by FAO in 1982 to average less than 10 kg/ha. Table 6 presents data on fertilizer deliveries for Niger by type for the period 1980-84.

The GON suspended credit for fertilizer in 1981. That decision had a depressing effect on sales and use of fertilizer and on agricultural production. The trend toward lower levels of fertilizer use has continued to the present. The lack of credit for fertilizer may have contributed to the expansion of the area under production and the use of smaller amounts of fertilizer.

Given the low levels of fertilizer use in Niger and the well-established contribution of fertilizers in increasing crop yields in other countries and regions of the world, it is apparent that in Niger there is a great potential to expand food production and promote economic development through increased use of fertilizers. Because 90% of the population of Niger is engaged in agricultural work, which is predominantly rural, economic development can only be realized through the rapid growth of the agricultural sector.

In order to design appropriate policies and enhance agricultural research and development, the Government of Niger needs a more elaborate and detailed understanding of farm-level constraints to fertilizer use. A study to provide this information, which at present is generally lacking, would clearly be useful and appropriate.

In general, farm-level constraints to fertilizer use may be classified in two general categories. First, there are those constraints that restrict the demand for fertilizer and are associated with agricultural production technology, the resource endowment of farmers, and socioeconomic factors affecting the attitudes and behavior of farmers. Second are those constraints that restrict the supply of fertilizer and are associated with the

imports, production, and marketing of fertilizers. The focus of this research project is on the identification of farm-level constraints to fertilizer use that are associated with agricultural production.

The Research Approach

Agricultural production theory is the basic framework used in this study of farm-level constraints to fertilizer use and demand. Agricultural production depends on decisions to use resources of land, labor, and capital for that purpose. Agricultural production is therefore a function of farmers' decisions about the use of the following:

1. A set of fixed factors of production such as factors that in the short run cannot be changed by farmers' decisions; these factors usually include land, family labor, and capital assets.
2. A set of variable inputs such as inputs whose use in the short run is determined by farmers' decisions: these inputs include fertilizer, pesticides, labor, and irrigation.

Farmers' decisions about the use of fertilizer are therefore affected by several factors, including the following:

1. The availability of fixed factors of production and a set of socioeconomic variables influencing the use of these resources for agricultural production. Thus, information is needed about land, land tenure, family labor, and capital assets as well as about socioeconomic variables such as use of agricultural output, crop prices and access to market, availability of financial resources, and access to credit.
2. Access to timely and adequate supplies of fertilizers and other variable inputs and their prices. In this respect, information is needed about farmers' access to and prices paid for variable inputs such as fertilizers, pesticides, seeds of improved varieties, organic manures, and labor.
3. Knowledge of and access to information about the use of fertilizers and agricultural production technology in general. In this respect, information is needed on the farmers' education, experience, contact with extension service, and access to different means and types of information.
4. Perception of and response to risk associated with uncertainty on crop yields and prices.

A preliminary questionnaire to collect data on some of the factors described above was designed and field tested in Niger during the first 2 weeks of March 1987. Following that test, the questionnaire was redesigned to make it more suitable to the situation of farmers in the survey areas.

Overview of Farm-Level Research in Niger

Socioeconomic research on farm-level constraints to fertilizer adoption and use in Niger is conducted rather infrequently. The few studies that have been conducted have concentrated on the departments of Maradi and Zinder in southeastern Niger, which are inhabited by the Hausa ethnic group. This geographical limitation has resulted in a bias in the research on Nigerien agriculture that has been widely disseminated among international research scientists and organizations.

The departments of Maradi and Zinder represent a distinct agroclimatic region; more extensive use of modern agricultural inputs and animal traction, and higher levels of agricultural productivity are found in Maradi and Zinder than in other departments in Niger. In the departments of Niamey and Dosso, the use of animal traction is virtually nil, and the agroclimatic and soil conditions are quite different from those in Maradi and Zinder. Because of these factors, research distinctions between western and eastern Niger must be a continuing consideration and feature of future farm-level research.

This study offers an initial contribution to the literature by focusing on farm-level constraints to fertilizer adoption and use among the Djerma ethnic group of western Niger.

Farm Survey

The farm survey was conducted during the period June 10-August 6, 1987, and 48 interviews were completed. The interviews were primarily conducted in western Niger in the departments of Niamey, Dosso, and Tahoua. The specific villages visited were Bambey, Galmi, and Dan Gona in Tahoua; Sokorbey, Falmey, and Goberi in Dosso; and Torodi, Karma, Gotheye, and Simari in Niamey. Department names are used in the text and tables to refer to these villages. Figure 1 shows the locations of these villages. The remoteness of many of these villages mitigates the biases that are often associated with socioeconomic studies conducted in villages located near major highways.

Data Analysis

The questionnaire was designed to collect and analyze data on 11 main factors related to farm-level adoption and use of fertilizer. These factors included the demographic characteristics of farmers and household composition, patterns of dry-season migration, distances from households to commercial locations and fields, and land tenure and use.

The factors related to agricultural production and fertilizer use included cropping systems on household plots, fertilizer use on household plots, farm production and byproduct use, farm-level labor, benefits of agricultural cooperatives, and the characteristics of users and nonusers of fertilizer.

Household Composition

The sociodemographic characteristics of the households during the cropping season, shown in Table 7, have several important implications. The average number of persons per household is 8 and indicates a high level of dependency of children. The average number of wives per household is 2, and polygamy is a critical factor contributing to population growth. The typical pattern is for younger men to have one wife, and additional wives may join the household as men age and accumulate resources and assets. Typical of national characteristics, the sample indicates minimal formal education; on the average, one person per household speaks French, usually a dependent enrolled in school. The importance of documenting the number of persons speaking French is that it is, to some extent, a measure of social integration with modern national and commercial culture. Illiteracy is a serious hindrance to economic and social development in general and the expansion of modern agricultural inputs in particular. The inability to read and understand fertilizer packages and instructions for use restricts the effectiveness of using written information as a means of disseminating knowledge about fertilizers. Pictorial depictions of proper fertilizer use should be considered.

Patterns of Dry-Season Migration

For those men who migrate during the dry season, Côte d'Ivoire and Ghana appear to be the favored destinations among the Djerma of western Niger. Although some may work as stevedores in Abidjan, the most prevalent work among seasonal migrants is small-scale trade. In that type of work, the migrant receives cloth, shoes, watches, and like items on consignment from a wholesaler; these goods are sold by the migrant, and profits are shared. Temporary migrations of 6-9 months are not uncommon. As shown in Table 8, earnings of US $650 are possible. In some cases young men will permanently move to Ghana or Côte d'Ivoire, periodically return to present money to the household, and then depart only to repeat that process.

Migration is a complex topic of sociological research, but it is very useful in understanding labor and finances that are available for capital investment in land, general agriculture, and fertilizer.

The theoretical relationship between dry-season migration and farm-level fertilizer use is one where earnings may be used to purchase fertilizers and other modern agricultural inputs to improve household production. That observation should be further validated through empirical research.

Overview of the National Transportation System

The transportation system of Niger is constrained in that it serves the largest landlocked country in West Africa. Poor internal and external transportation linkages have always hindered economic development.

Although substantial improvements in Nigerien domestic transportation have been realized during the past two decades, the rapid population growth and urban expansion will require future road development. Adequate paved highways link major cities, but the secondary and tertiary roads are poor. Often there are no roads linking remote villages with centers of production and consumption. Motorized forms of transportation are frequently overloaded with goods and people, and vehicles with broken axles, shock absorbers, and suspension systems are often seen on roads and highways.

The external transportation system of Niger also requires consideration. The main external linkages are (1) a road connection to Abidjan which links to rail in the Côte d'Ivoire, (2) a road connection to Cotonou which links to rail in Benin, and (3) a road linkage to Lagos and Port Harcourt which links to rail in Nigeria. Although those linkages are

adequate, future economic development is contingent upon elaborations of those linkages with the outside world. Both the internal and external transportation systems of Niger deserve serious research and policy attention because the delivery of agricultural inputs to farming areas and food to urban areas are dependent on that infrastructure.

Distances From Households to Commercial Locations and Fields

The distances from households to fields and markets and the very infrequent ownership of animal-drawn carts are serious constraints to agricultural development in general and the transportation of fertilizer and crops output in particular. The mean distances from households to markets and fields are shown in Table 9. Farm-level transportation of people and goods in western Niger is typically accomplished on foot, by donkey or camel, or by cart. When fertilizers are purchased, farmers often make smaller packages from the 50-kg bags and complete several trips from the cooperative to the fields.

A donkey can transport two 50-kg bags, and that weight limitation also requires multiple trips to transport fertilizer. The better form of transportation is a cart drawn by oxen or a donkey-drawn cart. However, only 1% of the farmers interviewed in this study owned carts.

Cooperative credit is available to farmers to purchase carts, but the cost of a donkey cart, estimated to be CFA 78,000 or US $265, is still prohibitive. Farmers who make that substantial investment sometimes experience delays in delivery of 2-3 months and often longer. Cart ownership requires new expense to maintain the beast of burden but may also provide a source of income when transportation services are hired by other farmers. A fee of about CFA 300/day (US $1) appears to be the customary and usual price for cart transportation services. When payment for farm-level transportation services is made in kind, a measure of cowpea straw is not uncommon.

Because the average distance from households to fields is about 3.0 km and fields are scattered, an estimated 15%-20% of each working day is spent commuting on foot. That arduous task reduces productivity and requires a substantial expenditure of spirit and energy. The problem of inadequate farm-level transportation is particularly evident during the harvest season when numerous trips from households to fields are necessary. When fertilizer, manure, and production are transported on foot, the task is more laborious and proceeds at an even slower pace.

Land Tenure and Use

Because land is a sine qua non of human existence, it is the single most essential object of possession among Nigerien farmers. In the absence of a well-developed economy, most sustenance is drawn from the soil.

Land tenure systems in Niger reflect both African and Islamic traditions. Although the intricacies of Nigerien land tenure exceed the scope and intent of this study, some basic characteristics are discussed. The basis of the system of land tenure is the recognition that, although village residents have the right to use as much community land as needed for their support, the land is the ultimate property of the village and is controlled by village chiefs. Village chiefs may allocate land to new village residents and to residents requiring additional land. In the event of migration, allocated but uncultivated land or land of heirless farmers reverts to the control of the village chief. Although land is owned by "use rights," it may also be inherited; an agreement about inheritance is made at the time of allocation.

The general pattern of land tenure in western Niger indicates that land may be borrowed or owned by individuals or households. The frequency of these types of arrangements for plots of farmers in the sample is shown in Table 10. When land is borrowed from another village resident, payment of 10% of production appears customary and is a means for the owner to realize benefit without investment.

It should be noted that the farmers interviewed for this study are members of the Djerma ethnic group. Therefore, the observations about land tenure shared in this study may not be characteristic of those among the Hausa or other ethnic groups. More detailed studies would perhaps show useful contrasts and comparisons, but that task is beyond the intent of this study.

The relative proportions of owned and borrowed land are difficult to accurately determine for whole departments and villages. It is, however, clearly in the political interests of village chiefs to maintain control over land that is available for borrowing and to avoid permitting use rights to land to dominate the village pattern. Individuals who are in a position to loan land also have political and economic interests at stake. Although the commercialization of land may be increasing in Niger, no instances of such transactions were observed in this study.

Land that is obtained by inheritance, gift, or purchase is more secure for long-term investment. Those farmers in western Niger who are dependent on borrowed land, and therefore on the good graces of village chiefs and landowners, almost never make capital investments for land improvement. Even the manuring of borrowed fields is rare or nonexistent. Thus, to the extent that borrowed land dominates the land use pattern, investment and therefore fertilizer use and agricultural production are stifled and severely constrained.

Cropping Systems on Household Plots

The principal food crops of western Niger are millet, cowpea, and sorghum. Less common are rice and sorrel. The questionnaire was structured to obtain data on a 4-year history of cropping strategies. The longitudinal data for 116 plots shown in Table 11 indicate that patterns of intercropping vary between the villages sampled in the departments of Niamey and Dosso.

It appears that Djerma farmers in western Niger establish a crop pattern that minimizes risks and promotes productivity, and they do not alter that pattern over time. The data show that the millet-cowpea intercrop is more prevalent in Dosso and the millet-cowpea-sorrel intercrop is more frequent in the Niamey department.

Although millet is a staple in both departments, risk is reduced in Dosso with sorghum and in Niamey with sorrel. That difference is probably attributable to the expectations of the greater rainfall and heavier soils in Dosso that are required for sorghum. These strategies of risk reduction through intercropping are methods that have been established through years of experience and trial and error. The intercrops should be taken into account in establishing recommendations for fertilizer use. Table 12 shows that the production of millet, the principal food staple, is greatly improved by fertilizer use.

Farm-Level Production

Agricultural production statistics for Niger, especially average per hectare yields, vary by source and should be viewed with skepticism. Impressions are that subsistence farmers in Niger generally cultivate 4 or 5 ha, but such subjective estimates make no contribution to rigorous statistical analysis. The measurement of land areas will undoubtedly remain a constant problem in future farm-level research in Niger.

Byproduct Use

Following the advice of agricultural authorities, farmers frequently use millet and sorghum stalks as groundcover to reduce wind erosion. Additionally, those stalks are used for construction of fences, wind barriers, housing, and, to a lesser extent, animal feed.

Straw from cowpea, sorghum, and millet is frequently used as animal feed and is a source of income. Although it is difficult to be precise, a commonly encountered price for a "bundle" of cowpea straw is CFA 225 or about US $0.80. Straw is also traded for goods and services and may also be given as a gift. In short, straw byproducts are a medium of exchange among the Djerma of western Niger. Production research should be cognizant of the value and uses of straw and should generate appropriate calculations on per hectare yields of valuable byproducts. The specific use of byproducts is shown in Table 13.

Farm-Level Labor

It is customary for heads of households in western Niger to labor exclusively on household plots, but other smaller plots may be cultivated by individuals within the households for personal use. Young men, perhaps older than 12 years of age, work with household heads in the tasks of planting, weeding, and harvesting. It appears that weeding is the task for which labor is most frequently hired, and wages are a major expense. Table 14 shows data that describe labor, wages, and tasks.

No shortages of labor were reported by the farmers who were interviewed for this study. Labor "bottlenecks" reported by various sources are most likely to occur in eastern Niger in the departments of Zinder and Maradi where intensive cash crops prevail.

The average daily wage paid for hired labor among the Djerma of western Niger is CFA 640 or US $2.20. It should, however, be noted that the sick and elderly are provided with village labor as a charitable and humane gesture.

Agricultural Cooperatives in Niger

French colonial law governed the activities of agricultural cooperatives until 1960. Following independence, the GON initiated policies to accelerate social and economic development, distribute modern agricultural inputs, and bolster agricultural production through cooperatives.

As organized, the cooperative system is based on the support and activities of villages rather than individuals. The structure of the cooperative system in Niger is as follows:

1. Groupement Mutualistic Villageois (GMVs) are organized at the village level and are the basis of the structure of cooperatives.
2. The cooperatives are organized to include groups of perhaps five or ten villages that are mutually supportive in the production and marketing of agricultural goods.
3. Associations Locales des Cooperatives (ALC) are found in those regions where markets are substantial enough to support unions of cooperatives. Five or ten cooperatives usually form a union.

The cooperative system began in 1965 (Table 15). Because of limited financial resources and the devastating drought, cooperative development slowed during the period 1969-74; however, the cooperative formation was greatly accelerated during the period 1974-78. Although there have been some changes from 1978 to the present, the structure has remained basically the same. Perhaps the most significant and important change in the cooperative structure was the collapse of credit for fertilizers for cereal production in the early 1980s.

The ambitious goals of the 1960s and 1970s have not been realized, but the GMVs cover about 50% of the agricultural producers in Niger. The lack of credit deters the expansion and development of cooperatives and constrains the expansion of fertilizer use.

Benefits of Agricultural Cooperatives

When questioned about the benefits of cooperatives, Nigerien farmers expressed approval of the credit plans for the purchase of plows and carts but virtually universal disappointment about the lack of credit for the purchase of fertilizer. The responses of farmers about the benefits of cooperatives are shown in Table 16.

Emphasis has been placed on expanding cooperatives in Maradi and Zinder, but in western Niger cooperatives are not viewed as beneficial.

Fertilizer is an agricultural input that necessarily passes through cooperatives and extension services to reach the farm level. The success of such efforts depends on the literacy of the participating farmers. The ability of the farmers to read and write, understand and use simple arithmetic and bookkeeping, and understand management and agricultural practices is a basic and critical prerequisite to agricultural development.

Few Nigerien farmers have any formal education, and few speak French. An effort to enhance agricultural skills was realized in 1978/79 when 20 permanent agricultural training centers were created in the department of Dosso. Although such efforts are commendable and important, progress remains slow.

Nigerien farmers may obtain information about fertilizer use from several sources other than cooperatives. The farmers interviewed in this study were asked to identify the principal source of information about the use of fertilizers, and those data are shown in Table 17.

Not surprisingly, Djerma farmers appear to be aware of fertilizer and to learn about fertilizer use by observation and by exchanging advice and experience with others on an informal basis. The educational role of cooperatives and extension is substantial; however, informal learning undoubtedly occurs in those contexts and the categories therefore are not mutually exclusive.

Although farmers do receive formal advice and guidance from authorities, that advice is undoubtedly modified and altered by perceptions of risks and unique conditions. For example, authorities advise farmers to incorporate fertilizer before and at planting time. Although that is excellent technical advice, farmers are very reluctant to risk fertilizer use until rain and small plants are clearly visible. That practice hinders root development but makes infinite sense to farmers who find it difficult to till very dry topsoil and are reluctant to risk fertilizer loss through heavy windstorms before planting.

Characteristics of Users and Nonusers of Fertilizer

Additional insights into farming systems and fertilizer use are obtained by comparisons between the departments of Niamey and Dosso in terms of the frequency of fertilizer use and the types of fertilizers that are attractive to farmers.

As shown in Table 18, the use of fertilizers appears more prevalent in Dosso than Niamey. Therefore, the expected overall level of fertilizer use is greater in Dosso than in Niamey, and the difference is partially explained by a higher probability of adequate rainfall in the Dosso department. The proximity of Dosso to the Nigerian border and access to additional fertilizer supplies may also contribute to the increased use of fertilizers.

The sample data that show the relative use of various types of fertilizers are presented in Table 19. The use of SSP was prevalent in both departments, whereas urea was used only in some sampled plots of Dosso. The use of SSP fertilizer appears to be increasing in the Dosso department, but 15-15-15 fertilizer is not widely used.

The farmers interviewed in this study were asked to identify what each understood as constraints to fertilizer use, and those data are shown in Table 20. The constraints of cost and credit are closely related and are understood as significant constraints that reflect the lack of financial resources by farmers to purchase fertilizers. Lack of knowledge and familiarity is also a frequently cited constraint.

Those data support the observation that an increase in the frequency of demonstrations, trials, and other forms of information dissemination will enhance the adoption and use of fertilizer. Restoration of farm-level credit in Niger is a complex problem, but improvements in knowledge and familiarity with the benefits of fertilizer use appear possible.

A comparison of users and nonusers is helpful in understanding farm-level constraints to fertilizer use. As shown in Table 21, the households of fertilizer users are closer to both commercial markets and household fields than are those of nonusers. Those differences are probably related to the nature of farm-level transportation constraints. Specifically, users of fertilizer are somewhat less constrained by distances to transport fertilizer to fields and crops' production to household and market.

Users of fertilizer have labor provided by nonhousehold relatives at a frequency four times that of nonusers. In contrast to nonusers who offer monetary compensation to hired labor, users compensate the labor provided by

relatives with some share of production. Because of the pattern of labor use by fertilizer users, increased production is a social asset as well as an economic one. The data also show that users of fertilizer hire an average of six workers, whereas nonusers hire an average of less than three workers (2.7), but fertilizer users demand more labor at the point in the season when weeding is necessary, but nonusers hire labor for the varied tasks of planting, weeding, and harvesting.

As expected, users of fertilizer frequently cite it as the single most important input, whereas nonusers have yet to realize the benefits of commercial fertilizer and instead hire herds of animals to deposit manure on fields for an average of 25 days per year.

Users and nonusers of fertilizer are also contrasted by the sources of their information about fertilizer. As shown in Table 22, fertilizer users cite agricultural cooperatives as the principal source of information about fertilizers five times more frequently than do nonusers. The data also show that nonusers cite extension services as the principal source of information about fertilizer five times more frequently than do users.

The greater frequency of farmer meetings among fertilizer users is probably a result of more frequent participation and activity by users within agricultural cooperatives. Nonusers reported no participation in meetings of farmers. Such meetings should be given attention in the future development of fertilizer use in western Niger. Finally the data show that nonusers are more likely to have learned about fertilizer from informal sources than are users and that nonusers remain mostly outside the realm of formal information. These observations suggest that information dissemination and accelerated contact with nonusers are needed and required for the expanded use of fertilizer.

As shown in Table 23, users and nonusers of fertilizer exhibit differences in the use of crop byproducts (basically straw). Millet straw is virtually always used as ground cover; by nonusers of fertilizer, however, sorghum and cowpea byproducts are more likely to be used as ground cover than by users. An inventory of animals is not included in this study, but the data suggest that the extent of animal ownership is greater among users than nonusers because byproducts of both sorghum and cowpea are more frequently used as ground cover among those who do not use fertilizer. The speculation

on that point would be that fertilizer use supports the development and maintenance of farm animals; nonusers own fewer animals and therefore are generally poorer than those who use fertilizer.

The value of cowpea straw among fertilizer users is apparent in its use for animal feed, market sale, and trade. Perhaps proximity to markets explains the ability of fertilizer users to sell and trade cowpea straw, whereas, because of transportation constraints, nonusers have limited choices and are compelled to use cowpea straw as ground cover. Fertilizer users have a source of income from cowpea straw that bolsters their ability to continue to purchase fertilizer and enhance their cash flow.

Significant Differences Among Users and Nonusers of Fertilizer

Additional insights concerning the differences between users and nonusers of fertilizer were explored through statistical analyses. In the search for contrasts, the variables of owned and borrowed land, age, household size, number of wives, number of children, number of family members speaking French, dry-season migration, and cart ownership showed no meaningful differences between users and nonusers of fertilizer.

Some meaningful contrasts and distinctions are shown in Table 24. Those data suggest that the availability of household labor and the distance from household to market are significant variables explaining the use or nonuse of fertilizer. Those variables should be evaluated in future research. The observation of no significant differences in the use of organic manure among users and nonusers of fertilizer is instructive. Previous research has sometimes suggested that the use of fertilizer is associated with a decline in or lack of the use of organic manure and that the organic richness of the soil is thereby lost. The data suggest that this is not the case, and Djerma farmers complement the use of fertilizer with the traditional use of organic manure. This observation should also be evaluated in future research.

Summary

Niger is a country that exemplifies the demographic, economic, and agricultural problems of the Sahelian region of West Africa.

High rates of population growth are occurring amidst declining agricultural and economic sectors. Substantial increases in food production are needed to meet the requirement of the Nigerien population, which is expected to be in excess of 10 million in the year 2000.

The use of appropriate fertilizers and other modern agricultural inputs is necessary to build a sustainable and prosperous agricultural sector. At present, the use of fertilizer in Niger is among the lowest in the world. Nigerien agricultural authorities are keenly aware of the contribution that fertilizer can make in increasing food production and are developing policies to enhance and strengthen the diffusion of modern agricultural inputs.

Farm-level socioeconomic research, data, and information are critical factors in properly assessing the agricultural sector and developing appropriate and beneficial policies. This study is an initial and exploratory effort to gather data and provide a report on farm-level constraints to fertilizer use in western Niger.

On the basis of agricultural production theory, a questionnaire was prepared and field tested in the departments of Niamey and Dosso during the period March 1-15, 1987. Following that pretest, the questionnaire was refined, and field interviews were conducted among 48 Djerma farmers in western Niger during the period June 15 to August 6, 1987. The villages of Bambey, Galmi, Dan Gona, Sorkorbey, Falmey, Torodi, Karma, Gotheye, Goberi, and Simari were visited in the departments of Niamey, Dosso, and Tahoua.

The data indicate that Djerma farmers in western Niger are expected to support an average of eight persons often including more than one wife. Dry-season migration earnings in other West African countries average about US $650 for as much as 9 months of work. Those earnings are important sources of household finances.

The lack of transportation is a serious constraint to fertilizer use and agricultural development, and distances to fields and markets present a frequent problem. A cart is a prized but expensive purchase, and most farmers are dependent on foot transport. Although the system of land tenure is complex, land may be owned or borrowed by households and individuals. Djerma farmers are reluctant to make capital investments in borrowed land and generally forego using fertilizer and manure. Therefore, the frequency of borrowed land is a constraint to fertilizer use.

Crop histories of household plots show little variation in cropping patterns over time. Intercroppings of millet and cowpea or millet and sorghum are common risk-reduction strategies. Virtually no household production is sold. Straw byproducts are used in a variety of ways; cowpea straw is a medium of exchange and is traded for goods and services.

Farm labor for weeding is frequently hired, and wages are a significant expense. Few women and children labor on household plots, but labor from nonhousehold relatives is compensated with harvested grain or straw. The weeding of fields is the most frequent task for hired labor, and the average daily wage is about US $2.20. On the average, seven laborers are hired for about 13 days per cropping season.

A major constraint to fertilizer use in western Niger is the lack of government-supported credit. Farmers interviewed in this study expressed virtually universal disappointment about the lack of credit to purchase fertilizer. Farmers in western Niger view agricultural cooperative organizations as offering few and limited benefits.

Illiteracy is a constraint that prevents full realization of the contributions of agricultural training.

The users of fertilizer differ from nonusers in that their households are closer to markets as are their household plots. The users of fertilizer benefit from the labor of nonhousehold relatives, and that labor is compensated with a share of the increased production that is attributable to fertilizer use. The users of fertilizer also hire more labor than do nonusers, and the contribution of fertilizer in creating farm-level employment is evident. The data clearly show that the traditional practice of organic manuring is not abandoned when commercial fertilizer is used.

In summary, the principal constraints to fertilizer use among Djerma farmers in western Niger include illiteracy, lack of financial resources aggravated by severely limited agricultural credit, poor transportation and access to fertilizer supplies, insufficient household labor, and lack of knowledge and training about the use of fertilizers. As government programs alleviate those problems, fertilizer use will become more attractive and widespread.

Suggestions for Future Socioeconomic Research in Niger

Farm-level research in Niger should be conducted among the Djerma in the western region of the country. Although the Hausa in eastern and southern Niger should not be ignored, the fact is that western Niger has received only scant and inadequate research attention. Western and southeastern Niger represent distinct agroclimatic and cultural areas, and that distinction should be permanently recognized in the literature on farm-level constraints to fertilizer use. The distinction between the departments of Niamey and Dosso provides an excellent dichotomy that should be maintained and elaborated through empirical research.

Continued research on patterns of dry-season migration is important in understanding the nature and dynamics of farm-level financial resources and income and should be pursued. A more elaborate understanding of the origins and destinations of migrants, types of work pursued, duration of residence, and wages would be particularly useful and informative.

This study has outlined and described the salient aspects of land tenure and use in western Niger; however, more sophisticated techniques of sampling will allow useful comparisons between those who "borrow" land and those who own land through "use rights." Differing levels of fertilizer use, production, and capital investment in land are some potentially interesting points of comparison.

Land use and agricultural productivity among Djerma women were not extensively explored in this study, but it does appear that "women's crops" are an important source of household income and should not be neglected in future research. The role of women in Nigerien agriculture should be considered as an important topic in future research.

Ascertaining the sizes of household plots in Niger is difficult, and therefore per hectare yields are notoriously inaccurate and misleading. One alternative is to explore the adequacy of production to meet household needs. This study did not seek data on household grain storage or explore the frequency and costs of grain purchases, but those variables should be explored in future research.

The use, value, and sale of crop byproducts, especially cowpea and straw, should be investigated with more empirical rigor and detail. Farm-level fertilizer trials should provide information about the volume or weight of straw byproducts per hectare.

This study was conducted during the period of planting and weeding and therefore offered no insight into the socioeconomic variables related to harvesting. The use of household and hired labor during harvesting should be explored in future research.

The role of children in farm labor rests on the social distinction between adult and child. The age at which young boys are expected to provide labor on household plots was not well established in this study but should be carefully documented in future research.

Although animals owned by a household represent capital, farmers in western Niger are reluctant to discuss their livestock holdings, which is unfortunate. However, continued attempts should be made to inventory farm animals as sources of money to purchase fertilizers and, of course, as sources of organic manures.

Cooperatives and extension services are established to offer Nigerien farmers information and training about modern agricultural practices in general and fertilizer use in particular. These services, however, are not uniformly beneficial and useful to farmers. Some comparisons of "successful" and "less successful" cooperatives and extension services should be made in future research where the attitudes of farmers are assessed concerning the usefulness of structured training and assistance.

The factors discussed thus far may, of course, be included in a single study and would represent a refined replication of the work discussed here, but there are also new directions for socioeconomic research in western Niger.

Important areas for future research include the following:

1. This type of study should be replicated in northwest Niger, where no socioeconomic research has been conducted. The area north of Tillaberry to the Malian border is an area where this study may be usefully replicated. Such research was suggested by the USAID mission in Niamey.
2. Farm-level fertilizer trials in western Niger should be evaluated from a socioeconomic perspective. Attention should be given to the location and organization of the trials to increase the probability that farmers will understand the technical, social, and economic benefits of fertilizer use.

3. The development of phosphate resources in the Parc W region of western Niger will require literate labor. A socioeconomic assessment of labor availability should be conducted if those resources are to be beneficially exploited.
4. The agricultural practices of the Fulani ethnic group in western Niger have been virtually ignored. Provided that some work is accomplished with that group, a comparison of agricultural practices and fertilizer use among the Djerma, Hausa, and Fulani groups could be pursued. Such comparative research would be a valuable basis for understanding regional and ethnic distinctions and Nigerien agriculture as a whole.
5. Future research on farm-level constraints to fertilizer use in Niger should be pursued within small geographical units such as cantons and villages as opposed to departmental and national studies. The research discussed here may be replicated within such smaller geographical areas.
6. The observations of this study suggest that many farmers are uninformed about fertilizer and have not participated in a formal introduction. The socioeconomic means to expand initial and general information may represent an independent project in its own right.
7. Agricultural training centers are rather numerous and diverse in Niger. Research on the curriculum should evaluate how modern fertilizers are presented to farmers, and technical and socioeconomic factors should be given particular attention.
8. The role of the media in presenting fertilizer messages at the farm level should be explored. Variables such as clarity, appropriateness, and receptivity by farmers should be evaluated.
9. The role of women in Nigerien agriculture should be considered as an important topic in future research.
10. Finally, research attention should be given to integrating the youth organizations and movement in Niger with the introduction of fertilizer technology.

Quite naturally, other ideas and research projects will emerge as these ideas are discussed, elaborated, and considered. Through such exchanges a course of socioeconomic research can be charted by IFDC that will provide direction for alleviating the farm-level constraints to fertilizer use in Niger.

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Table 1. Selected Demographic Characteristics of Niger in 1987

Characteristic	Numerical Indicator
Midyear population, 1987	7.1 million
Annual natural increase	2.9%
Doubling time	24 years
Projected population year 2000	10.6 million
Infant mortality rate	141 per 1,000
Fertility rate	7
Population under 15 years	47%
Average life expectancy	44 years

Source: Population Reference Bureau, Washington, D.C., 1987

Table 2. Population Density Per Square Kilometer of Agricultural Land for Selected Years, 1960-85

Year	Density
1960	23
1965	28
1970	31
1975	37
1976	38
1977	39
1978	41
1979	42
1980	43
1985[a]	53

a. An estimate based on population growth.

Source: The World Bank, World Tables, Vol. II Social Data 1983. 3rd Edition.

Table 3. Estimated Per Capita Gross Domestic Product for Niger, 1978-85 at Constant 1976 Prices

Year	GDP (Billions of US $)	Per Capita GDP (US $)
1978	1,123	214
1979	1,288	239
1980	1,369	246
1981	1,356	237
1982	1,345	230
1983	1,310	216
1984	1,100	176
1985	1,172	175

Source: Based on Rural Finance in Niger: A Critical Appraisal and Recommendations for Change. The Ohio State University, 1987 and FAO population estimates.

Table 4. Annual Growth Rates in Real and Per Capita Gross Domestic Product, 1978-85[a]

Year	Growth Rate Per Capita	Real Gross Domestic Product
	- - (%) - -	- - - -(%) - - -
1978	5	7
1979	11	15
1980	4	6
1981	-4	-.9
1982	-4	-.8
1983	-5	-.3
1984	-19	-16
1985	4	7

a. The figures are rounded.

Source: Rural Finance in Niger: A Critical Appraisal and Recommendations for Change. The Ohio State University, 1987.

Table 5. Key Indicators for the Nigerien Agricultural Sector, 1981-85

Indicator	1981	1982	1983	1984	1985
Agricultural Share of GDP (%)	30	31	33	33	47
Cereal imports ('000 mt)	89	120	45	45	247
Food aid in cereals ('000 mt)	11	71	12	13	218
Average index of per capita food production		122	113	95	
1974-76 = 100		(1981-83)	(1982-84)	(1983-85)	

Source: World Bank, World Development Reports, 1980-87.

Table 6. Total Fertilizer Deliveries for Niger by Types, 1980-84

Type of Fertilizer	1980	1981	1982	1983	1984
	(mt)				
Urea	1,455.8	2,824.6	2,351.3	2,726.0	3,835.0
Ammonium sulfate	56.9	17.0	3.2	56.0	61.0
CAN	3.8	11.4	3.3	58.0	50.0
SSP	2,865.2	7,089.9	5,206.4	3,823.0	1,584.0
TSP	370.8	219.3	660.6	47.0	530.0
Ground phosphate rock	314.6	73.4	432.3	730.0	487.0
15-15-15	717.2	1,339.1	701.1	2,136.0	2,503.0
14-7-7	40.0	77.4	0.0	0.0	0.0
Other	127.4	29.5	9.8	5.0	40.0
TOTAL	5,951.7	11,681.6	9,368.0	9,581.0	9,090.0

Source: Etude Retrospective de l'Offre et de la Demande d'Engrais au Niger. Ministere de l Agriculture Direction des Etudes, de la Programmation et des Statistiques Agricoles, Septembre 1986.

Table 7. Average and Standard Deviation of Selected Sociodemographic Characteristics of the Households Studied (N=48)

Characteristic	Average	Standard Deviation
Number of children per household	5	3.1
Household size	8	3.5
Number of wives	2	0.55
Age of household heads (years)	48	12.2
Years of schooling of household head	3	0.0
Persons in household speaking French	1	1.5

Table 8. Selected Variables Describing Dry-Season Migration of Household Heads Interviewed (N=18)

Variable	Percentage
Percent of total sample that migrated in the 1986-87 dry season	38.0
Percent migrating to	
Within Niger	17.0
Côte d'Ivoire	67.0
Benin	5.0
Nigeria and Côte d'Ivoire	5.3
Within Niger and Côte d'Ivoire	5.7
Type of Work	
Sales and trade	98.0
Labor and construction	2.0
Estimated average dry season earnings (US $/6-9 months)	650.00

Table 9. Mean Distances From Households to Fields and Markets in Kilometers (N=48)

	Total Sample	Niamey	Dosso
Households to Markets	7.0	12.0	5.0
Households to Fields	3.0	2.3	2.3

Table 10. Number and Percentage of Household Plots Owned and Borrowed Per Household in Niamey and Dosso (N=116)

	Plots Owned by Household		Plots Borrowed by Household	
	Number[a]	Percentage	Number[a]	Percentage
Niamey	1.8	60	1.2	40
Dosso	2.2	85	0.4	15
All Sample	2.1	75	0.7	25

a. Average number of plots per household.

Table 11. Percentage Distribution of Crops on Household Plots Over 4 Years in Niamey and Dosso (N=116 Plots)[a]

Crops	1984		1985		1986		1987	
	Niamey	Dosso	Niamey	Dosso	Niamey	Dosso	Niamey	Dosso
Millet	17	10	13	10	17	10	17	10
Millet-cowpea-sorghum	2	18	2	18	2	18	2	18
Millet-cowpea	21	56	25	56	21	56	21	56
Millet-sorghum	-	6	-	6	-	6	-	6
Millet-cowpea-sorrel	33	3	33	3	33	3	33	3
Millet-cowpea-sorghum-sorrel	17	-	17	-	17	-	17	-
Other	10	7	10	7	10	7	10	7
TOTAL	100	100	100	100	100	100	100	100

a. Rounded.

Table 12. Mean Household Production of Millet, Cowpea, and Sorghum in 1986 Among Users and Nonusers of Fertilizer (N=48)

Crop	Production	
	Users (N=19)	Nonusers (N-29)
	- - - - - - - - - (kg/farm) - - - - - - - -	
Millet	2,341	1,351
Cowpea	134	125
Sorghum	120	180

Table 13. Uses of Millet, Cowpea, and Sorghum Byproducts (N=48)

Crop/Use	Percentage
Millet	
Groundcover	92
Animal feed	4
Other	4
TOTAL	100
Sorghum	
Groundcover	77
Animal feed	18
Other	5
TOTAL	100
Cowpea	
Groundcover	29
Animal feed	35
Gift	3
Market sale	27
Trade	6
TOTAL	100

Table 14. Characteristics of Farm-Level Wage Labor (N=48)

Variable	Percent or Mean
Percent of farmers hiring labor	100
Mean number of laborers hired per farm	7
Mean number of household laborers per farm	2
Mean number of days of hired labor per farm	13
Mean daily wage in US $	2.20
Percent of farmers hiring labor for:	
Weeding only	64
Planting and weeding	18
Planting, harvesting, and weeding	9
Land preparation and weeding	4.5
Harvesting only	4.5
TOTAL	100

Table 15. The Expansion of Agricultural Cooperative Organizations in Niger, 1965-78

Department	1965	1974	1975	1976	1977	1978
Niamey	8	15	23	27	48	78
Dosso	4	14	29	29	64	68
Tahoua	5	35	49	50	55	64
Maradi	8	72	125	153	158	159
Zinder	7	97	164	165	194	195
Diffa	-	-	3	8	29	31
Agadez	-	2	3	15	21	27
TOTAL	32	235	396	447	569	622

Source: Niger Agricultural Sector Assessment. Vol. II. Agency for International Development, Niger, 1979.

Table 16. Perceived Benefits of Participation in Agricultural Cooperative Organizations (N=48)

Benefit	Percentage
No perceived benefits	67
Tools available on credit	19
Fertilizer transported to village	6
Seeds and fertilizer available	4
Fertilizer available	2
Increased knowledge about fertilizers	2
TOTAL	100

Table 17. Sources of Knowledge and Information About Fertilizer as Reported by Farmers (N=48)

Sources	Percentage
Informal sources	40
Cooperatives	19
Field trials	14
Extension workers	19
Farmers' meetings	4
No knowledge source	4
TOTAL	100

Table 18. Percentage of Sampled Household Plots Receiving Fertilizer in Niamey and Dosso, 1984-87 (N=116)

Department	Percent of Plots Receiving Fertilizers			
	1984	1985	1986	1987
Niamey	8	6	8	6
Dosso	18	38	38	37

Table 19. Percentage of Sampled Fertilized Household Plots Receiving Various Types of Fertilizer in Niamey and Dosso, 1984-87 (N=116)

Fertilizer	1984		1985		1986		1987	
	Niamey	Dosso	Niamey	Dosso	Niamey	Dosso	Niamey	Dosso
SSP	75	67	100	58	75	61	100	88
15-15-15	25	-	-	-	25	12	-	12
Urea	-	33	-	42	-	27	-	-
TOTAL	100	100	100	100	100	100	100	100

Table 20. Types of Constraints to Fertilizer Use as Cited by Farmers (N=48)

Constraint	Percentage
Cost	21
Cost in conjunction with lack of credit	48
Lack of knowledge and familiarity	25
No constraint identified	4
Other	2
TOTAL	100

Table 21. A Comparison of Selected Socioeconomic Characteristics of Users and Nonusers of Fertilizer (N=48)

Characteristic	Mean or %	
	Users (N=19)	Nonusers (N=29)
Mean distance to markets (km)	5.4	7.6
Mean distance to fields (km)	2.5	3.0
Mean number of nonhousehold relatives providing labor per farm	11.0	3.0
Mean number of hired laborers per farm	6.0	2.7
Percent citing fertilizers as most important agricultural input	84.0	36.0
Mean number of days a hired herd is used for organic manure	0.0	25.0

Table 22. Principal Sources of Information About Fertilizer Cited by Users and Nonusers of Fertilizers (N=48)

Source	Percentage	
	Users (N=19)	Nonusers (N=29)
Agricultural cooperatives	36	7
Agricultural extension services	5	27
Farmers' meetings	11	-
Farm-level trials	16	14
Informal sources	32	45
No sources cited	-	7
TOTAL	100	100

Table 23. Uses of Byproducts Among Users and Nonusers of Fertilizer (N=48)

	Users (N=19) (%)	Nonusers (N=29) (%)
Millet byproducts		
Ground cover	90	93
Animal feed	5	3
Other	5	4
Sorghum byproducts		
Ground cover	63	89
Animal feed	25	11
Gift	12	-
Cowpea byproducts		
Ground cover	7	45
Animal feed	43	30
Gift	-	5
Market sale	43	15
Trade	7	5

Table 24. Variables Showing Significant Differences Between Users and Nonusers of Fertilizer (N = 48)

Variable	Mean		Difference[a]
	Users	Nonusers	
Distance to market (km)	5.4	7.6	-2.2*
Distance to field (km)	2.5	3.0	-0.5*
Number of household laborers	6.4	2.1	+4.3*
Number of hired laborers	6.0	2.7	+3.3*
Percent of farmers using organic manure	50	58	-8

a. Users with respect to nonusers.

*Significant at the 1% level of significance.

APPENDIX 7

BASIC QUESTIONNAIRE FOR VERIFICATION SURVEY OF SOIL FERTILITY RESTORATION PROJECT

IFDC

JUNE 1988

1. IDENTIFICATION

Country _____ Village _____ Farm No. ____

2. INFORMATION ABOUT THE FARMER

Name: _____

Sex: Man _____ Woman _____

If a woman, is she:
Never married ____ Married ____ Widowed ____ Divorced ____

To what ethnic/cultural group does the farmer belong?

Ashanti ___ Djerma ____ Kabye ____ Fulani ____

Hausa ____ Other (specify) _____

. LOCATION OF HOUSEHOLD

What is the average distance from the household to: (km/miles)

- The farmer's household plots? _____
- The farmer's individual plots? _____
- Market where their agricultural products are usually sold? _____
- Store where products for household consumption are purchased? _____
- Store where fertilizers are (or could be) purchased? _____

What is the principal mode of farm transportation?

Donkey ___ Donkey Cart ___ Auto ___ Ox Cart ___ Foot ___

Other (specify) _____

Does the farmer have access to regular and predictable commercial transportation to market centers?

Yes ____ No ____

4. HOUSEHOLD COMPOSITION, EDUCATION, AND EMPLOYMENT

Household Members	Age (Years)	School Years	Employment Outside the Farm				
			Yes /No	If Yes, Where? Country/City/Village	Type of Work	Months per year	Estimated Earnings
- Farmer							
Adult Men (1):							
-							
-							
-							
-							
-							
-							
-							
Adult Women (1):							
-							
-							
-							
-							
-							
-							
-							

(1) Indicate relationship with farmer.

Number of Children? (less than 13 years) _____

5. INFORMATION ABOUT THE FARM

A. Land Availability and Tenure

Draw a diagram of the farm indicating plots having different crops or management and their dimensions.

Obtain the following information on the farm plots with crops this season

Type of Plots by Land Tenure	Men Managed Plots		Women Managed Plots		All Plots	
	No. of Plots	rea (ac/ha)	No. of Plots	Area (ac/ha)	No. of Plots	Area (ac/ha)
Household Plots:						
- Owned						
- Borrowed						
- Rented-in						
Individual Plots:						
- Owned						
- Borrowed						
- Rented-in						
Other Plots: (specify)						
-						
-						
-						

B. Availability of Machinery, Equipment, and Animals. (Questions to farmer)

Do you own or use a tractor?

Owns: |____| Use (rented or borrowed): |____| No: |____|

Do you use other equipment?

No: |____| Yes: |____|--> What equipment? (specify):

	Own	Rented or borrowed
-		
-		
-		
-		

Do you use animal traction?

No: |____| Yes: |____|--> What animals? (specify):

	Own	Rented or borrowed
-		
-		

Do you own other animals?

No: |____| Yes: |____|--> What animals? (specify):

	Number
-	
-	
-	
-	

6. AGRICULTURAL CREDIT (Questions to farmer)

Did you borrow money for your farm this crop season?

Yes: |___| No: |___|--> Did you TRY to borrow money?

No: |___|--> Why? _____

_____

Yes: |___|--> From whom? _____

_____

Why did you not get it? _____

_____

---> - From whom? _____
- Distance from household? _____ (km/miles)
- How much did you borrow? _____
- What interest rate are you paying? _____ (% per year)

7. SOURCES OF INFORMATION AND KNOWLEDGE ABOUT FERTILIZERS

How helpful have the following sources been in providing information about fertilizers to the farmer?

Source	Very helpful	Somewhat helpful	Not helpful	Not sure
Personnel of Cooperatives				
Extension Workers				
Other Farmers				
Fertilizer Dealers				
Radio				
Other (specify)				

Does the farmer own a radio? Yes: |___| No: |___|

Has the farmer seen advertisement for fertilizers on television?

Yes: |___| No: |___|

How many times was the farmer visited by extension workers last year?

8. INFORMATION BY FARM PLOTS HAVING DIFFERENT CROPS OR MANAGEMENT

A. Crops, Management, Areas, Tenure, and Production.

Type of Information	Plot 1	Plot 2	Plot 3	Plot 4
Crop				
Variety (local, improved)				
Management (Man or Woman)				
Area (acres or hectares)				
Tenure (specify)				
Previous crop in plot (specify)				
Length of fallow (months)				
Date of planting				
Method of planting (specify)				
Date of harvesting				
Production--Name First Crop:				
-Main Product Production (Kg)				
-Straw Production (Kg)				
Production--Name Second Crop:				
-Main Product Production (Kg)				
-Straw Production (Kg)				
Production--Name Third Crop:				
-Main Product Production (Kg)				
-Straw Production (Kg)				

B. Use of Fertilizers.

Type of Information	Plot 1	Plot 2	Plot 3	Plot 4
Use of Fertilizers:				
-Urea, Quantity (Kg)				
-Urea, Application Method				
-Urea, Date of Application				
-CAN, Quantity (Kg)				
-CAN, Application Method				
-CAN, Date of Application				
-TSP, Quantity (Kg)				
-TSP, Application Method				
-TSP, Date of Application				
-SSP, Quantity (Kg)				
-SSP, Application Method				
-SSP, Date of Application				
-Other Fertilizer Used? (specify)				
-Quantity (Kg)				
-Application Method				
-Date of application				
-Other Fertilizer Used? (specify)				
-Quantity (Kg)				
-Application Method				
-Date of application				
-Other Fertilizer Used? (specify)				
-Quantity (Kg)				
-Application Method				
-Date of application				
-Other Fertilizer Used? (specify)				
-Quantity (Kg)				
-Application Method				
-Date of application				

C. Use of Organic Manures and Crop Residue.

Type of Information	Plot 1	Plot 2	Plot 3	Plot 4
Use of Organic Manures:				
-Manure Used? (specify)_____				
-Quantity (Kg)_____				
-Application Method_____				
-Other Manure Used? (specify)__				
-Quantity (Kg)_____				
-Application Method_____				
Use of Crop Residues:				
-Crop Residue Used? (specify)__				
-Application Method_____				

D. Use of Machinery and Animal Traction.

Type of Information	Plot 1	Plot 2	Plot 3	Plot 4
Use of Tractor (yes/no)				
-If yes, for what purpose?				
-Land Preparation (yes/no)				
-Other Activity (specify)				
-Other Activity (specify)				
Use of Animal Traction (yes/no)				
-If yes, for what purpose?				
-Land Preparation (yes/no)				
-Other Activity (specify)				
Other Activity (specify)				

E. Use of Labor.

Type of Information	Plot 1			Plot 2			Plot 3			Plot 4		
	M	F	CH	M	F	CH	M	F	CH	M	F	CH
	<----------(Number of Working days)---------->											
Use of Household Labor in:												
-Land Preparation												
-Planting												
-Fertilizer Application												
-Weeding												
-Pruning												
-Pest Control												
-Harvesting												
-Storage tasks												
-Marketing												
-Other (specify):												
Use of Hired Labor in:												
-Land Preparation												
-Planting												
-Fertilizer Application												
-Weeding												
-Pruning												
-Pest Control												
-Harvesting												
-Storage tasks												
-Marketing												
-Other (specify):												

M = Males; F = Females; CH = Children (Less than 13 years old).

9. DISPOSAL AND USE OF AGRICULTURAL PRODUCTION

Crop	Product or byproduct (specify, grain, straw)	Disposal/Use of product(1)	If product sold or traded				
			Quantity sold kg	%	Who sold it? (2)	Where? (sale place)	At what price?(3)
1.							
2.							
3.							
4.							
5.							

(1) Indicate use of product or byproduct--household consumption, animal feed, ground cover, building material, market sale, storage etc.
(2) Indicate relation of person to farmer. If not related indicate sex of person.
(3) Indicate the units.
% = indicate quantity sold as percent of production.

10. OTHER INFORMATION ABOUT INPUTS USE AND COSTS

A. Use and Cost of Fertilizers

Is the farmer using fertilizers this season?

YES: |___| NO: |___|

If NOT:

- Did he ever use fertilizers in the past?

  Yes: |___| No: |___|--> Why? _____

  |-> Why did he discontinue use? _____

  _____

If YES, (the farmer is using fertilizers this season), obtain the following information:

Type of fertilizer purchased	Quantity purchased (kg)	Amount paid ($)	Transport of fert. from supplier		
			Means of Transport	Distance (km)	Cost of Transport ($)
1.					
2.					
3.					
4.					
5.					

B. Use and Cost of Organic Manures

Is the farmer using organic manures this season?

YES: |___| NO: |___|

If NOT:

- Did he ever use organic manures in the past?

Yes: |___| No: |___|--> Why? _____

|-> Why he did discontinue use? _____

_____

If YES, (the farmer is using manures this season), obtain the following information:

Type of Org. Manures Used	Quantity Used (in kg or No. of days of herd parking)	If purchased:	
		Quantity Purchased (in kg or No. of days of herd parking)	Amount Paid (indicate amount of payment in money or in kind)
1.			
2.			
3.			
4.			
5.			

C. Use and Cost of Labor

	Men	Women	Children
Number of household members who work on household plots?			
Number of nonhousehold relatives who work on household plots?			

Was labor hired by the farmer?

Yes: |___| No: |___|--> Why? _____

What labor?	For what activities?	For what wages per day?(1)
Men:		
Women:		
Children:		

(1) Indicate payment in money and/or in kind (meals, grain, etc.).

. FARMERS PERCEPTIONS ON CONSTRAINTS TO FERTILIZER USE AND AGRICULTURAL PRODUCTION

What does the farmer think are

- the most important constraints to improve crop yields?

  First: _____ (most important)

  Second: _____

  Third: _____

- the most important constraints to use fertilizers?

  First: _____ (most important)

  Second: _____

  Third: _____

Centre International pour le Développement des Engrais—Afrique

International Fertilizer Development Center—Africa

APPENDIX 8

MEMORANDUM

IFDC - AFRICA

DATE: 24th May, 1988

TO: P.L.G. Vlek

FROM: E.R. Rhodes and K. Acheampong

SUBJECT: Participation of Women in The Soil Fertility Restoration Project.

STATUS REPORT AND PLANS
BY
E.R. RHODES AND K. ACHEAMPONG

Preamble

One of the covenants specified by USAID for its sponsorship of the Soil Fertility Restoration Project is that "IFDC will ensure that recommended strategies for government investment in soil fertility restoration and maintenance will take into consideration factors that facilitate or impede women's access to and utilization of soil fertility improving techniques. To accomplish this objective, the following measures will be undertaken (1) women farmers will constitute approximately 50% of respondents for the planned socio-economic studies of pilot areas; (2) at least 1/3 of the participants in pilot on-farm-trials will be women-farmers; and (3) the analysis of data collected will be gender-disaggregated where possible."

Accomplishments

1. Five out of ten respondents in the exploratory survey of Ghana were women.

2. In Ghana, women farmers are responsible for nine out of the 19 on-farm-trials being conducted. It seems that although the trials in Ghana are registered either as male or female, husbands and wives are partners in the management of each maize/cassava trial with the man having the dominant role. Photographs of the women-farmers participating in the on-farm-trials were taken.

3. The in-country coodinators in Niger and Togo have been informed about the requirement for women participation in the project.

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Plans

1. Fifty per cent of respondents in the exploratory surveys in Niger and Togo will be women.

2. Efforts will be made to get at least 1/3 of participants in on-farm-trials in Niger to be women.

3. Between forty and fifty per cent of respondents in the detailed survey in Ghana, Niger and Togo will be women.

4. The true extent of involvement of women in terms of (a) decision making (b) labour contribution to various farming activities will be assessed in the detailed base line and subsequent surveys.

5. The sample size in the verification survey will be sufficiently large to allow for gender disaggregation of data in the analysis.

6. Since fertilization of whole villages (starting from the 2nd year of the project) will involve all farms growing a given crop, it will be possible to assess the participation of women by appropriate survey design.

In pursuing these objectives, opinions of village leaders will be sought in order not to disrupt existing socio-cultural arrangements.

Appendix 9

LIST OF PARTICIPANTS AT THE ON-FARM TRIAL TRAINING IN GHANA

S. Opoku	-	In Country Coordinator, Ministry Agriculture
E.R. Rhodes	-	Agronomic IFDC
K. Acheampong	-	Sociologist IFDC
T. Thompson	-	Sociologist IFDC
K. Dartey	-	Principal Technical Officer, Soil Research Institute
E.A. Dennis	-	Soil Research Officer, Soil Research Institute
A.M. Nyamekye	-	Senior Technical Officer, Ministry Of Agriculture
I.A. Arthur	-	Senior Technical Officer, Ministry of Agriculture
J.K. Opong	-	District Agriculture Officer, Ministry of Agriculture
E. Asiedu	-	District Agricultural Officer, Ministry of Agriculture
T.K.A. Marboah	-	District Agricultural Officer, Ministry of Agriculture
K. Boamah Djan	-	District Agricultural Officer, Ministry of Agriculture
J.O. Mensah	-	District Agricultural Officer, Ministry of Agriculture
D. Boateng	-	Research Assistant, Ministry of Agriculture
E.A. Acquaye	-	Research Assistant, Ministry of Agriculture
M. Bafour Asare	-	Technical Officer, Ministry of Agriculture
J. Doku	-	Technical Officer, Ministry of Agriculture

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-	A. Asamoa	-	Technical Officer, Ministry of Agriculture
-	A. Noah	-	Technical Officer, Ministry of Agriculture
-	E.G. Mensah	-	Technical Officer, Ministry of Agriculture
-	C.K. Senazah	-	Research Extension Officer, CIDA Kumasi
-	K.M. Fordjour	-	Agriculture Officer, Ministry of Agriculture

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Appendix 10

LIST OF TRIPS MADE TO PROJECT ZONES BY IFDC STAFF

DATE	DESINATION/PURPOSE	PERSONNEL
5-8 Oct '87	To arrange meetings between IFDC and Officials of the Ministry of Agriculture in Accra, Ghana.	K. Acheampong
20-21 Oct'87	To hold meetings with officials of the Ministry of Agriculture in Accra, Ghana on collaboration in the SFRP.	P.L.G. Vlek & K. Acheampong
18-20 Nov'87	To hold meetings with officials of the Ministry of Agriculture in Accra, Ghana on collaboration in the SFRP.	P.L.G. Vlek & K. Acheampong
19-20 Dec'87	To collect secondary data for exlporatory survey of Ghana.	
7th Feb'88	To discuss implementation of SFRP with officials of the Ministry of Agriculture in Accra, Ghana.	P.L.G. Vlek, E. Rhodes K. Acheampong
14-21 Feb'88	To discuss signing of the M.O.U and implementation of SFRP with officials of INRAN in Niamey Niger.	P.L.G. Vlek A.U. Mokwunye E. Rhodes K. Acheampong
22Feb-4Mar'88	To obtain feed-back on memorandum of understanding drafted by IFDC, and to discuss draft work plan.	P.L.G. Vlek E. Rhodes K. Acheampong
20-25Mar'88	To assist Ghanian collaborator in the conduct of the exploratory survey in the Ashanti region of Ghana.	E. Rhodes K. Acheampong
	To participate in phase 1 of the training of Ghanian collaboration for O.F.T.	
	To collect information on population data in the Ashanti region.	
8-9April'88	To participate in phase 2 of training of Ghanian collaboration for O.F.T.	K. Acheampong T. Thompson

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	To follow up on IFDC request for permit to send fertilizers to Ghana for O.F.T.	
9-13May'88	To inspect O.F.T.	E. Rhodes & K. Acheampong
5-12June'88	To assist Niger collaborators in the conduct of the exploratory survey in the Maradi Dept of Niger.	E. Rhodes & K. Acheampong
	To find out whether the M.O.U had been signed.	
27-16Jul'88	To collect secondary data for the exploratory survey of Togo and have discussions with research and extension workers.	K. Alognikou & A. Sakite
7-12Jul'88	To assist Ghanian collaboration in determining a sampling frame for the detailed verification survey.	K. Acheampong
18-22Jul'88	To assist Togolaise collaborators in the conduct of the exploratory survey in the Savannes.	E. Rhodes & K. Acheampong

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APPENDIX 11

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September 9, 1988

VIA TELEFAX

Mr. Abdelwahed Benchekroun
Secretary General
World Phosphate Institute
Angle Route d'El Jadida et
Bd Grande Ceinture
B.P. 5196 Maarif
Casablanca, Morocco

Re: Fertilizer Investment for Soil Fertility Restoration Project in West Africa - Steering Committee

Dear Mr. Benchekroun:

At our meeting in Niamey, Niger, on August 30-31, 1988, the Steering Committee unanimously approved the conceptual model for the Fertilizer Investment for Soil Fertility Restoration Project ("SFRP"), the work plan for the SFRP during September 1988 - December 1989 and the 1989 fertilizer requirements which the World Phosphate Institute ("Imphos") as well as the American Phosphate Foundation ("APF") have agreed to supply. While we did not have enough time to complete our discussions or to see the actual project sites in Maradi as Director General Soumana had desired, it is clear that substantial progress is being made in implementing the project. IFDC and its IFDC/Africa staff are to be commended for their organization of the meeting.

As should be evident from the detailed "Progress Report," the presentations to the Steering Committee by senior IFDC/Africa staff, the discussions by the SFRP's national coordinators and through our field visits, Imphos and APF have a significant opportunity and an important challenge to make successful this important project.

We can achieve this goal only if we are willing to work together with IFDC and to trust each other to act in the best interests of the project.

It is with this in mind that I am writing in a spirit of cooperation to respond on behalf of APF to your comments during the August 31, 1988 executive session of the Steering Committee. As you may have observed, I was a little lost for words and feel it important to respond so that you understand our position. I had thought that the issues Imphos raised had long ago been settled and that our agreement on them had been embodied in the Protocol which was signed in September 1987. Let me assure you that APF remains firmly committed to the Protocol of Agreement and the responsibilities it has undertaken.

For APF, the questions of the name of the Steering Committee, the use of the formal title of the project and the question who originally proposed the project are insignificant in comparison to the substance of the project and its implication for economic development in West Africa.

This is not IFDC's project, not Imphos' project, not APF's project. For us, it is <u>our collective</u> opportunity to carry out together a project that, in the final analysis, has been approved and structured by the international aid agencies which are providing the substantial funds for its implementation. Since IFDC has responsibilities to these agencies to solely account for the proper expenditure of funding and to assure compliance with the project as executing agent, it is the international aid donors who set the standards. As Dr. Stewart of IMC said, "He who pays the piper calls the tune."

The Protocol of Agreement reflects this reality. The duties of the Steering Committee are set forth in Section II of the Protocol. In that regard, APF believes that the Steering Committee must concern itself with technical questions rather than focusing solely on "policy" as you suggested. It is our responsibility, indeed one of our major roles, to bring to the Committee the substantial, technical expertise of Imphos and APF in order that the project may be steered in the proper direction in adopting fertilizer strategies. APF believes that the Steering Committee is properly carrying out its intended responsibilities and that IFDC is fairly and reasonably working to assure that the Protocol is properly implemented. To that end, Dr. McCune has suggested that the Steering Committee meet later this year when the budgets for the work plans are being developed for 1989 in order that the Steering Committee might carry out its responsibilities in Section II.E. of the Protocol.

As you further are aware, Section IV of the Protocol requires Imphos and APF to supply on a delivered basis such non-indigenous fertilizer as may be required to carry out the work of the project. In that regard, I must tell you that IFDC was very distressed and upset to learn during our meetings in Niamey that Imphos was declining to pay its share of 1988 fertilizer costs. While the actual cost of the 1988 fertilizer requirements was substantially higher than the $20,000 IFDC finally submitted to us, IFDC reduced its request to this lower amount at APF's request, and APF has paid its full $10,000 contribution on this basis. Since it was Imphos who repeatedly urged in 1988 that the project be implemented as quickly as possible, its refusal now to pay its contribution seems not only unreasonable but rather ironic. APF strongly urges Imphos to reconsider this question.

Finally, I want again to assure you personally that I am writing this letter in a spirit of cooperation rather than confrontation. The SFRP provides a significant opportunity for Imphos and APF to achieve the goals of our September 13, 1985 Protocol. We have made substantial progress in that regard and, working together, as we are privileged to do with IFDC, we can continue the sound beginning we have made.

Sincerely yours,

Howard W. Fogt, Jr.

HWF:las

cc: Dr. Gino P. Giusti
Mr. C.C. Williams
Dr. Donald L. McCune
Dr. Kenneth M. Pretty (Via Telefax)
Dr. John A. Stewart
Dr. Paul L.G. Vlek (Via Telefax)

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FERTILIZER REQUIREMENTS 1989 SOIL
FERTILITY RESTORATION PROJECT
DRAFT FOR DISCUSSION AT IFDC/APF/IMPHOS MEETING
AUGUST/SEPTEMBER 1987

1.0 GHANA (Humid Zone)
1.1 Village Level Fertilization
1.11 Investment Strategies
a. 15:15:15 + Urea
b. SSP + Urea + MOP
c. Togo PAPR 50 + Urea + MOP

These treatments will be randomized among farms. i.e approximately 33% of maize/cassava farms in the "fertilizer village" will receive one of the above.

1.12 Estimation of Fertilizer Requirements

Materials	Rate of Application (kg/ha)	Number of farm families per village	Average farm size per family ha	Total area to be fertiliz. ha	Quantity of carrier (t)
a. 15:15:15	40KgN/P_2O_5/K_2O	422	1	141	37.6
Urea	40KgN				12.3
b. SSP (18%P_2O_5)	40Kg P_2O_5				31.3
Urea (46%N)	80KgN				24.5
MOP (60%K_2O)					9.5
c. Togo PAPR (26% P_2O_5)	40Kg P_2O_5				21.7
Urea	80Kg N				24.5
MOP	40Kg K_2O				9.5

SUMMARY

Urea	61.3 t	+	15%	contigency	=	70.5 t
SSP	31.3 t	+	15%	contigency	=	34.0 t
Togo PAPR 50	21.7 t	+	15%	contigency	=	25.0 t
15:15:15	37.6 t	+	15%	contigency	=	43.3 t
MOP	19 t	+	15%	contigency	=	22 t

1.2 On Farm Trials (maize/cassava)

1.21 Treatments

TSP 0, 30, 60, 90 kg P_2O_5/ ha
TSP-S 0, 30, 60, 90
DAP 0, 30 60, 90

SSP 0, 30, 60, 90

Urea at 90 Kg N/ha + MOP at 40 kg K_2O/ha are common to all plots

1.22 Estimate of Fertilizer Requirements.

Material	Rate of Application (Kg/ha)	Plot size (m^2)	Number of Plots per site	Number of sites per village	Number of villages	Quantity of carrier (Kg)
TSP (46% P_2O_5)	30 Kg/ha	50	3	4	5	19.6
	60					39.2
	90					58.8
TSP - S (46% P_2O_5)	30 Kg/ha	50	3	4	5	19.6
	60					39.2
	90					58.8
DAP (46% P_2O_5) (18% N)	30					19.6
	60					39.2
	90					58.8
SSP	30					50.0
	60					100.0
	90					150.0
Urea	90 Kg N		12			234.8*
MOP	40 KgP_2O		12			80.0

* Correction will be made for N supplied by DAP.

SUMMARY

Urea	234.8 Kg	+	10%	contigency	=	258.3 Kg
SSP	300 Kg		10%	contigency		330.0 Kg
TSP	117.6 Kg		10%	contigency		129.4 Kg
DAP	117.6 Kg		10%	contigency		129.4 Kg
MOP	80 Kg		10%	contigency		88.0 Kg

2.0 NIGER (Sahel zone)

2.1 Village Level Fertilization/amendment

2.11 Investment strategies

(a) SSP + manure

(b) SSP + Urea

(c) Tahoua PR + Urea

Treatments to be randomized among farms such that approximately 20% receive treatment (a), 40% receive treatment (b) and 40% receive treatment (c) above.

2.12 Estimate of fertilizer Requirement

MATERIALS	RATE OF APPLICATION (Kg or t/ha)	No. OF FARMS FAMILIES PER VILLAGE	AVERAGE FARM SIZE/FAMILY (ha)	TOTAL AREA TO BE FERTILIZED (ha)	QUANTITY OF CARRIER (t)
(a) SSP	30 Kg P_2O_5	188	5	188 (1/5 of 940)	31.4
Manure	5 t			"	940.0
(b) SSP	30 Kg P_2O_5				
Urea	45 Kg N			376 (2/5 of 940)	62.8
(c) TPR (28% P_2O_5)	30 Kg P_2O_5				36.8
Urea	45 Kg N				40.3
					36.8

SUMMARY

SSP	94.2t +	25%	contigency	=	117.8 t
TPR	40.3t +	25%	contigency	=	50.4
Urea	73.6t +	25%	contigency	=	92.0
Manure	940t +	25%	contigency	=	1175

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2.2 On Farm Trials (millet based)

Similar P- source trials as in Ghana. Lower rates of N and P will be tested.

The following amounts of fertilizers are estimated:

Urea	132 Kg	+	10% contigency =	145.2 Kg
SSP	150 Kg		"	165 Kg
TSP	110 Kg		"	120 Kg
TSP-S	110 Kg			120 Kg
DAP	110 Kg			120 Kg

3.0 TOGO (Savanna zone)

3.1 Village Level Fertilization

3.11 Investment Strategies

(a) 15:15:15 + Urea

(b) SSP + Urea + MOP

(c) Togo PAPR 50 + Urea + MOP

(d) Manure + SSP

These treatments will be randomized among farms such that approximately 30% of sorghum/millet farms will receive treatment (a) or (b) or (c). Ten percent will receive treatment (d).

3.12 Estimate of fertilizer Requirements

Materials	Rate of Application (Kg/or t/ha	Number of farm families per village	Average size per family (ha)	Total area to be fertilized (h)	Quantity of carrier (t)
(a) 15:15:15	30 KgN/P2O5/K2O	200	4	240(30% 800)	48
Urea	30 Kg N				15.7
(b) SSP	30 Kg P2O5			240	40.0
Urea	60 Kg N				31.4
MOP	30 Kg K2O				12.0
(c) Togo PAPR50	30 Kg P2O5			240	36.9
Urea	60 Kg N				31.4
MOP	30 Kg K2O				12.0
(d) SSP	30 Kg P2O5			80(10% of 800)	13.4
Manure	5 t/ha				400

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SUMMARY

Urea	00.[illegible]	25% contingency		98.5
[illegible]	5[illegible].4t	[illegible]	=	[illegible]
Togo PAPR 50	36.9t	[illegible]		88.8
MOP	24.t		=	46.2
15.15.15	48.t		=	30
Manure	400t		=	60
			=	500

3.2 On Farm Trials (Sorghum/millet)

Similar to P source trial in Ghana. Lower rates of N, P and K intermediate between Ghana and Niger will be tested. The quantities estimated are as follows:

Urea	176.1 Kg	+	10% contigency	=	193.7Kg
SSP	200		10% contigency	=	220 Kg
TSP	78.4			=	86.3 Kg
DAP	78.4			=	86.3 Kg
MOP	60			=	66 Kg
TSP-S	78.4			=	86.3

4. (a) FERTILIZERS TO BE MANUFACTURED AT MUSCLE SHOALS

Togo PAPR 50	72 t
Sulphur-fortified TSP	336 Kg

(b) FERTILIZERS TO BE PURCHASED

Urea	262 t
MOP	53 t
SSP	220 t
TSP	336 Kg
DAP	336 Kg
15:15:15	104 t

(c) MATERIALS TO BE OBTAINED LOCALLY IN NIGER

Tahoua Phosphate Rock	51 t
Manure	1175 t

(d) MATERIALS TO BE OBTAINED LOCALLY IN TOGO

Manure	500 t

5. Notes

(1) Materials to be shipped directly to individual countries

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(2) Latest date for fertilizers to be in the various countries for timely distribution and planting are as follows:

GHANA	31st January 1989
TOGO	28th February 1989
NIGER	31st March 1989

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