FARM AND VILLAGE PRODUCTION SYSTEMS IN THE SEMI-ARID TROPICS OF WEST AFRICA:

An Interpretive Review of Research

Research Bulletin No. 4, Volume 1

International Crops Research Institute for the Semi-Arid Tropics

ABSTRACT

Norman, D.W., Newman, M.D., and Ouedraogo, I. 1981. *Farm and village production systems in the semi-arid tropics of West Africa: an interpretive review of research.* Research Bulletin No. 4, Vol. 1. Patancheru, A.P. India: International Crops Research. Institute for the Semi-Arid Tropics.

This report is an analytical review of socioeconomic research on farm and village production systems in the semi-arid tropics (SAT) of West Africa. It uses a farming systems framework for the development of guidelines on crop technologies in the region.

The authors stress that the economies of the West African SAT are undergoing a transitional process that will have marked implications for the developmental policies of individual nations, as well as of different groups within those nations. Factors in this transition are: increasing population densities, the emergence of the region into the global economy, and the progressive erosion of traditional institutional structures that have previously been important for stability, security, and survival.

This dynamic environment provides the milieu for examining the stocks and flows of: land, labor, and capital inputs used by farmers in production; crop, livestock, and off-farm enterprise processes that result; and various relationships between inputs and processes. The review concentrates on information available on rainfed crop production during the 1960-80 period. Neither irrigated agriculture nor livestock pastoralism are considered except when they directly interact with rainfed crop production.

Applicability of research aimed at improving the welfare of farming families can be enhanced through methodologies that explicitly recognize the heterogeneity, in terms of both the technical and human environment, that exists at the farm level. The authors hypothesize that this heterogeneity is in many areas increasing, resulting in increasing distributional inequalities. To address this issue it is suggested that the use of farmer-based "bottom-up" approaches, combined with interdisciplinary research teams, is needed. Thus work must be directed at the identification of strategies that attack both the need for relevant improved technologies for different groups of farming families, and complementary institutional and policy development.

Specific socioeconomic research areas that the authors suggest are important to the SAT of West Africa are: first, methodological issues such as the development of more cost- and time-efficient methods for the ex-ante analysis of relations between technical, economic, and noneconomic variables; and, secondly, issues -related to the design of technological relevaricy such as risk preferences, seasonal labor, cash and nutritional flow levels, and differing technical efficiencies of small and large farmers.

RESUME

Norman, D.W., Newman, M.D., Ouedraogo, I. 1981. Farm and village production systems in the semi-arid tropics of West Africa: an interpretive review of research. (*Systèmes de production à la ferme et au village dans les zones tropicales semi-arides de l'Afrique de l'Ouest—Revue analytique de la recherche*). Research Bulletin No. 4, Vol. 1. Patancheru, A.P., India: International Crops Research Institute for the Semi-Arid Tropics.

Ce rapport est une revue analytique des recherches socio-économiques faites sur les systèmes de production à l'échelle de la ferme et du village dans les zones tropicales semi-arides de l'Afrique de l'Ouest. Il se sert d'un modèle agricole pour élaborer des recommandations sur les technologies agricoles de la région.

Les auteurs soulignent que l'économie des pays situés dans les zones tropicales semi-arides de l'Afrique de l'Ouest subit un processus de transition qui affectera d'une manière significative les politiques de développement de chacun de ces pays, ainsi que les communautés qui les composent. Les facteurs-clés de cette transition sont: la densité démographique croissante, l'entrée de la région dans une économie globale et l'érosion progressive des structures traditionelles des institutions qui étaient importantes pour la stabilité, la sécurité et la survie.

Cet environnement dynamique fournit le milieu pour évaluer l'état et l'évolution des éléments suivants: terres, main-d'oeuvre, capital investi par l'agriculteur dans sa production; culture, élevage et activités para-agricoles; ainsi que les relations entre les inputs et les activités de production. La revue s'intéresse aux données disponibles sur l'agriculture pluviale pendant la période 1960-80. Les auteurs ne tiennent pas compte de l'agriculture irriguée ou du pastoralisme, sauf lorsque ces sujets sont reliés directement à l'agriculture pluviale.

L'applicabilité des recherches visant à accroître le bien-être des familles paysannes peut être favorisée par des méthodologies reconnaissant explicitement l'hétérogénéité qu'on retrouve à l'échelle de la ferme — comme environnement à la fois technique et humain. Les auteurs émettent l'hypothèse que cette hétérogénéité augmente dans plusieurs domaines; ce qui entraîne des inégalités de distribution. Pour résoudre ce problème, il est proposé d'utiliser des approches conçues par les paysans et des équipes interdisciplinaires. Ce travail doit viser l'identification de stratégies qui permettront à la fois d'améliorer les technologies de différents groupes de familles paysannes et le développement complémentaire des institutions et des politiques.

Les domaines de recherche socio-économiques les plus importants dans les zones tropicales semi-arides de l'Afrique de l'Ouest sont d'abord les questions de méthodologies, telles que la mise au point de méthodes visant une utilisation plus efficace du temps et du coût pour une analyse estimative des variables techniques, économiques et non-économiques; puis les questions reliées à l'application de la technologie, telles que le choix face au risque, la main-d'oeuvre saisonnière, les liquidités, l'évolution des stocks alimentaires et la différentiation de l'efficacité technique des petites et grandes exploitations.

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PREFACE

This monograph arises out of an assignment requested by ICRISAT concerning a review on the socioeconomic aspects of farm and village production systems in the semi-arid tropical region of West Africa. The original unpublished report was submitted in June 1980 in two volumes: the first one containing the review itself and the second one consisting of a partially annotated bibliography (Ouedraogo et al., in press).

In undertaking a review of this nature, especially in a short time span, one inevitably becomes greatly indebted to a large number of individuals. Without their support it would have been impossible to undertake this assignment. Unfortunately we cannot hope to name all those that have contributed one way and another to the study. However, some of them are as follows. In Senegal we wish to express our gratitude to the Director General of ISRA, Monsieur Fall, and Monsieur Pochtier at CNRA, Bambey, and Monsieur Faye and Monsieur Niang in the Unite Experimentales at Kaolack. Also a special word of gratitude is due to Monsieur Diop, Directeur du Centre National de Documentation Scientifique et Technique, who produced a comprehensive computer listing of papers on Senegal relevant to the subject matter of the review. In Gambia a special word of gratitude is due to Mr. Lowe, Project Manager of the Rural Development Project. In Mali Dr. F. Traore was most helpful in facilitating our work. In Niger assistance was provided by Dr. M. Garba, Director of INRAN, Mr. Challon of UNDP, and USAID Niamey. In Nigeria we are very grateful for the help provided by Drs. Abalu and Krishnaswamy of IAR at Ahmadu Bello University. In addition to these specific individuals in the various countries we would also like to express our gratitude for help provided by individuals linked one way or another with work in the region. Specific individuals are Madame Felix of ORSTOM, Madame Jeanguyot and Monsieur Dumont of IRAT, Mr. R. Longhurst of the Institute of Development Studies, University of Sussex, Dr. W. Morris of Purdue University, Dr. C. Eicher of Michigan State University and Messrs. deBenke and Lauer of the Sahel Documentation Center, Michigan State University.

Also without the continuous support of ICRISAT personnel stationed in West Africa it would have been impossible to have undertaken this project. We wish to specifically thank the following individuals who were so helpful: Phil Serafini, Pat Pattanayak, Willhem Stoop, Shad Okiror and B.B. Singh. A special word of gratitude is also due to Claude Charreau who was so long-suffering and hospitable. Without his unending support and encouragement it would have been very difficult to have completed the assignment.

Finally we wish to express our gratitude to ICRISAT for asking us to undertake this assignment. The intellectual stimulus that we have received is very significant, and we hope it will have an impact beyond the bounds of the present project.

LIST OF ACRONYMS

AAAS	*American* Association *for the Advancement of Science*
ABU	Ahmadu Bello University (Nigeria)
ADC	Agricultural Development Council (USA)
AMIRA	Groupe de Recherche sur l'Amelioration des Methodes d'lnvestigation en Milieu Africain
AVY	Autorite des Amenagements des Vallees des Volta (Haute Volta)
BARRA	Bureau Africain de Recherches Appliquees (Cote d'lvoire)
CEEMAT	Centre d'Etudes et d'Experimentation du Machinisme Agricole (France)
CFDT	Compagnie Francaise pour le Developpement des Fibres Textiles
CILSS	Comite Permanent Inter-etats de Lutte Contre la Secheresse dans le Sahel
CMDT	Compagnie Malienne de Developpement des Textiles
CNRA	Centre National de Recherches Agronomiques (Senegal)
CNRS	Centre National de la Recherche Scientifique (France)
CRDE	Centre de Recherche en Developpement Economique, Universite de Montreal (Canada)
CRED	Center for Research and Economic Development, University of Michigan (USA)
CTFT	Centre Technique Forestier Tropical (France)
FAO	Food and Agricultural Organization of the United Nations
GERDAT	Groupement d'Etudes et de Recherches pour le Developpement de l'Agronomie Tropicale (France)
HMSO	Her Majesty's Stationery Office (UK)
IAR	Institute for Agricultural Research, Ahmadu Bello University (Nigeria)
IBRD	International Bank for Reconstruction and Development
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
I0EP	Institut Africain de Developpement Economique et de Planification (Senegal)
IEMVT	Institut d'Elevage et de Medicine Veterinaire des Pays Tropicaux (France)
IER	Institut d'Economie Rurale (Mali)
IFAC	Institut Francais de Recherches Fruitieres
IFAN	Institut Fondamental d'Afrique Noire (France)
IFCC	Institut Francais du Cafe, du Cacao et Autres Plantes Stimulantes
INRA	Institut National de la Recherche Agronomique (France)
INRAN	Institut National de Recherches Agronomiques du Niger
INSEE	Institut National de Statistiques et d'Etudes Economiques (France)
IRAT	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres (France)
IRCA	Institut de Recherches sur le Caoutchouc en Afrique (France)
IRCT	Instttut de Recherche du Coton et des Textiles Exotiques (France)
IRHO	Institut de Recherches sur les Huiles et oleagineux (France)
IRSH	Institut de Recherche en Sciences Humaines (Niger)
ISRA	Institut Senegalais de Recherches Agricoles
MSU	Michigan State University (USA)
0ACV	L'Operation Arachide et Cultures Vivrieres (Mali)
OECD	Organisation for Economic Cooperation and Development
OLC	Overseas Liaison Committee, American-Council of Education (USA)
ORD	Organisme Regional de Developpement (Haute Volta)
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer (France)
SAED	Societe d'Amenagement et d'Equipement du Delta (Senegal)
SAT	Semi-Arid Tropics
SATEC	Societe d'Aide Technique et de Cooperation (France)
SEDES	Societe d'Etudes pour le Developpement Economique et Social (France)
S0DEVA	Societe de Developpement et de Vulgarisation Agricole (Senegal)

1

The Semi-Arid Tropics of West Africa

1.1 Introduction

The geographical areas covered in this review consist of the whole of Senegal, Gambia, Upper Volta, and substantial parts of Mali, Niger, Chad, northern Nigeria, Ghana, Benin, and Cameroon. These areas represent the main part of the semi-arid tropics (SAT) of West Africa (Table 1.1). Areas not included in this review are Mauritania and Cape Verde Islands, though they are also located in the SAT of West Africa. The areas included in the review constitute about 17% of the total semi-arid areas and include 23% of the semi-arid population of the world. The West African countries have an unusually high proportion of their area located In the semi-arid ecological region, i.e., an average of 67% compared with 33% of semi-arid countries in the rest of the world.

The semi-arid tropics are defined by Troll (1966) as areas where precipitation exceeds potential evapotranspiration for 2 to 7 months of the year. In West Africa, the SAT have a mean annual precipitation of approximately 250-1300 mm (Charreau 1975). ICRISAT includes in its definition areas between isohyets of 400-1400 mm/year. In the present review, discussion is largely confined to an area with precipitation between 400 and 1300 mm/year.

The isohyets run more or less parallel to the equator (Fig. 1.1). The precipitation gradient on the coast is relatively steep and, as one moves eastward, the boundary of the semi-arid ecological zone dips south (Charreau 1975). Moving from north to south, the average annual precipitation increases. The coefficient of variation in precipitation is inversely related to the average annual precipitation (Cocheme and Franquin 1967). Drought, when it occurs, becomes more serious as one moves north through the region.

There are certain interdependencies between the various ecological zones in West Africa in human organization. Most people depend on systems of pastoralism or agriculture—mainly rainfed—for a means of livelihood, and the precipitation distribution makes rainfed agriculture seasonal. Seasonal migration of people and animals occurs, and migration is exacerbated during periods of drought.

1.2 Ecological Zones[1]

The areas in West Africa can be broadly divided into four ecological zones, the middle two (the Sahel and the Sudan) being of principal concern in this review. The four areas together with brief descriptions are as follows.

I. The *Sahara zone* includes areas with a mean precipitation of less than 250 mm/year. This zone corresponds to most of Mauritania and substantial parts of Mali, Niger, and Chad. There is, as a whole, no agriculture in the zone. Rather, it is the transhumance zone with herding of cattle, camels, sheep, and goats. During the dry season, cattle, sheep, and goats are moved southward particularly into the Sahel and Sudan zones. During the dry season some movement is also possible into areas even farther south due to the decreased significance of the tsetse fly, the vector of trypanosomiasis which is particularly debilitating to cattle. The southward movement during the dry season in search of food for livestock has traditionally been based on a complementary relationship with the crop farmers in the agricultural zones (Section 11.1). In recent years large increases in both human and livestock population in the Sahara zone have occurred. Increases in livestock population have occurred due to improved veterinary services. Also, substantial numbers of boreholes have been excavated in order to provide water for livestock (Baier1976).[2] These factors, resulting in substantial increases in livestock population on a fragile ecological base, have increased the vulnerability of livestock owners to drought. It is important to emphasize that the problems In this area directly influence what will happen in the zones further south.

II. The *Sahel zone* is located between the 250- and

1. This discussion closely follows Charreau (1975). The crops of the zones mentioned In the text are the following.

bambara nut	: *Voandzeia subterranea*	millet	: *Pennlsetum americanum*
cassava	: *Manihot esculenta*	onion	: *Allium cepa*
cotton	: *Gossypium* sp	pepper	: *Capsicum* sp
cowpea	: *Vigna unguiculata*	red sorrel	: *Hibiscus sabdarilla*
Oeccan hemp	: *Hibiscus cannablnus*	rice	: *Oryza sativa*
groundnut	: *Arachis hypogaea*	sorghum	: *Sorghum bicolor*
hungry rice	: *Digitata exilis*	sugarcane	: *Saccharum officlnarum*
maize	: *Zea mals*	tomato	: *Lycopersicon esculentum*

2. These have occurred to such an extent that cattle tend to die of hunger rather than of thirst.

Table 1.1. Semi-arid areas of West Africa.

Country	Semi-arid area ('000 km^2)	Proportion of country semi-arid (%)	Semi-arid population (million)	Number of references[a]
Senegal	196	100	4	187
Gambia	10	100	1	23
Mali	721	60	5	70
Upper Volta	274	100	5	76
Niger	507	40	4	113
Nigeria	693	75	42	216
Chad	514	40	3	16
Ghana	119	50	4	34
Benin	92	80[b]	2	3
Cameroon	119	25	1	29
Total	3245	67[c]	71	767(1052)[d]

Source : Ryan and Associates (1975).

a. Includes all references in the bibliography (Ouedraogo et al. 1979).

b. This figure is thought to be an overestimate.

c. This is an average figure (not total).

d. Includes those references that are not country-specific.

750-mm/year isohyets. The rainy season lasts 60-120 days. The zone corresponds to all the cropped areas of Niger and to 33-50% of the areas cropped in Senegal, Mali, Upper Volta, and Chad. It also includes part of northern Nigeria and northern Cameroon. The main limitations to growing crops in this area are the shortness of the rainy season and the erratic monthly distribution of precipitation, particularly at the beginning and the end of the rainy season. Soil is another limiting factor. About 15% of the soils are unsuitable for agriculture because of their shallow depth and the pres-

Source : Charreau (1975).

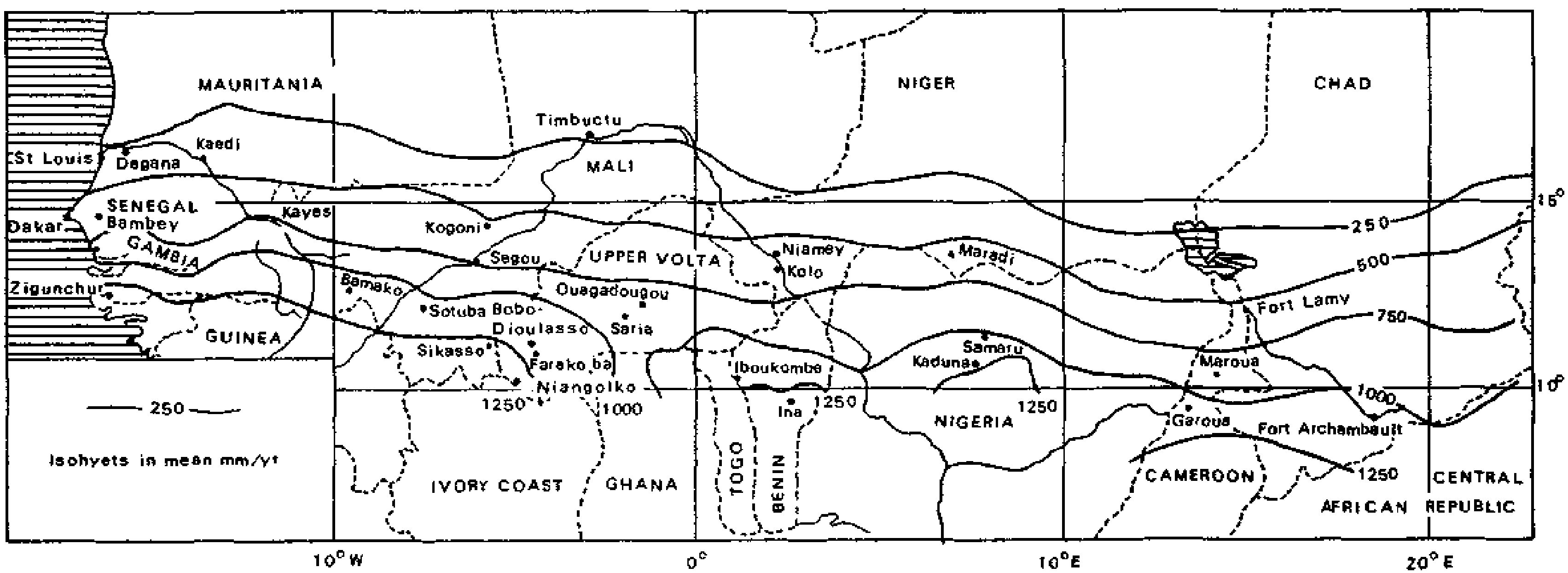


Figure 1.1. Mean annual precipitation In the seml-arld region of West Africa.

ence of iron pans. The crop species that can be grown in this zone are, in the absence of Irrigation, limited to millet, sorghum, and cowpea. According to Charreau (1975), it is possible to double the present yields of the cereals through the use of improved practices, while the yields of legumes—mainly cowpea—could be increased by 20-80% (Table 1.2).

III. The *Sudan zone* has a 750-mm/year precipitation at the northern edge and extends to an area in the south characterized by a rainy season of 150 days. Depending on the region, this limit corresponds to a mean precipitation ranging from 1000 to 1300 mm/year. This region includes all of Gambia and most of the southern part of Senegal, Mali, Upper Volta, Chad, northern Nigeria, and northern Cameroon. It also includes parts of Benin and Ghana. Although areas of shallow depth and iron pans also occur in this zone, the constraints of precipitation variability and rainy season duration are less than in zones I and II. Consequently, it is not surprising that the Sudan zone supports that bulk of the populations of those countries that are located mainly in zones I, II, and III. The number of crop species that can be grown is obviously greater, and the potential for increasing yields is also higher. According to Charreau (1975) it should be possible to more than double the yields of the traditional cereals, millet, and sorghum, and to increase the yields of other cereals, such as maize and rainfed rice, by 3 to 10 times. Export cash crops are also grown in this area. Yields of cotton can be more than doubled while those of groundnut can be increased by up to 80% (Table 1.2).

IV. Other areas to the south have higher precipitation and longer growing seasons. In these areas are located the *Guinea* (North and South) and *Forest* (Cereal and Root Crop) *ecological zones. Permanent tree crops are* possible along the coast. These areas support substantial migration of people from the Sudan zone and the Sahel zone (Byerlee 1979).

The political boundaries of some of the countries in West Africa do not cross the ecological zones and, as a result, the countries are limited in their ability to adjust internally to annual variations in weather conditions, particularly drought. Droughts have not been uncommon in West Africa (Glantz 1976; Campbell 1977; Berg 1975). In particular the drought in the early 1970s attracted worldwide concern. As a result, international agencies have mobilized considerable interest in helping this area of the world. Substantial funds are being channeled to the area for research and Implementation of development projects. A coordinating mechanism has been set up by CILSS and it should now be possible to avoid problems of duplication in the implementation of programs.

It is not possible in the present review to present a more detailed discussion of the characteristics of the region as a whole. However, a number of useful references covering various aspects are available (FAO 1976; IBRD 1976; Charreau 1978; Kowal and Kassam 1978).

Table 1.2. Traditional and potential yields of crops. Senegal.

Variable	Sahel		Sudan		
	Northern	Central	Sine-Saloum	Eastern	Southern
Precipitation (mm/year)	250- 500	500- 750	7 50- 900	900-1000	More than 1000
Yield (kg/ha)[a]:					
Millet:					
Indigenous	578	368			1105
Improved	948	999			2429
Sorghum :					
Indigenous			893	1086	1617
Improved			2100	2729	2190
Maize :					
Indigenous				792	168
Improved				2425	2684
Cowpea:					
Indigenous	6 53				
Improved	875				
Groundnut:					
Indigenous	861	998	1454	1426	1644
Improved	1044	1154	1997	2339	2072
Cotton :					
Indigenous				1109	
Improved				2061	

Source: Charreau (1975).

a. "Indigenous" equals traditional shifting cultivation with no fertilizer and hand superficial tillage while "Improved'' equals a potential semi-intensive cultivation system with heavy fertilization and deep plowing with oxen draft. The yields determined experimentally appear to be somewhat higher than would be the case under practical farming conditions.

2

The Framework

2.1 Objectives of the Review

The objective of this study is to provide an analytical review of the available published and unpublished research studies on the socioeconomic aspects of farm and village production systems in the semi-arid tropical region of West Africa. Specifically, the review is designed to address the various constraints to improving food production and agricultural development in this region. Because of the extensive nature of the task, it was necessary to confine the review to information produced during the period 1960-1980 and to emphasize rainfed crop production. In terms of the latter this meant that neither irrigated agriculture nor livestock pastoralism were considered except when they directly interacted with rainfed crop production. During the review, the need to expand the discussion beyond the somewhat narrow economic base originally envisioned became evident. For example, many factors outside the control of the individual farming family influence their present situation, indeed, will be a factor in assessing their future prospects. As a result, the problems of income distribution at the village level, and the role of noneconomic variables, are quite important. Although we have not been able to do justice to such issues, they receive at least some consideration in the review. We believe that such issues will become increasingly important in deriving relevant guidelines for the design of viable food crop technologies for rainfed agriculture in the region.

2.2 Schematic Framework

2.2.1 BIASES AND DIMENSIONS

While reviewing the microlevel studies, it became apparent that three biases tend to influence differentially the investigation of farmers (i.e., farming families). These are as follows.

a. *"Point" bias.* Studies with this bias consider the farmer at one point in time. In other words he is considered to be in a static rather than a dynamic environment. This approach overlooks the fact that the farmer today is a product of what has happened in the past, and that what he or his descendants will be in the future is partly a function of what happens now. The "vertical" dimension—which can be subdivided into the "historical" subdimension in terms of the past and the "prospective" subdimension with reference to the future—is often missing.

b. *"Individualistic" bias.* Studies with this bias consider the farmer as a decision-making universe. This neglects the fact that a farmer's decisions are partly a function of his dependency on the relationship to the world around him—the community he lives in, linkages with the world outside the village, etc. This type of relationship constitutes the "horizontal" dimension and is often ignored.

c. *"Homogeneous" bias.* Farmers as a group are often assumed to be homogeneous. Studies with this bias fail to show the dimension and extent of "heterogeneity."

There are a number of reasons for the above biases in microlevel studies. Three possible ones are as follows.

a. Individuals—not interdisciplinary teams—often undertake such studies. The studies emphasize the dimension associated with the researcher's particular discipline. At the risk of overgeneralization, anthropologists/sociologists and geographers appear to be better at examining the "historical" subdimension. Agricultural economists, on the other hand, do a more satisfactory job of looking at the "horizontal" dimension; they are also more likely to make predictions about the future and to use these as a base for policy recommendations.

b. Governmental policies affect large numbers of people. Heterogeneity is recognized in terms of the society. However, policy makers are often forced to abstract from the heterogeneity in order to develop workable, reasonably cost-effective policies. Agricultural economists are often called upon to help in developing practical policies. Yet agricultural economists, in trying to derive policies that are practical, sometimes employ statistical procedures which often are biased towards assuming a degree of homogeneity in the society. The case study approach more typical of anthropologists/sociologists better lends itself to describing the heterogeneity in the society but, at the same time, has limitations in helping to derive practical policy implications.

c. Due to limited resources of time, manpower and/or finances, researchers often are compelled to lay down severe boundary conditions for the objectives of their studies. Therefore, the full multidimensional aspect that would be desirable is, of necessity, curtailed.

Most studies have been undertaken with one or more of the limitations given above and, consequently, the results of the studies are based upon severe ceteris paribus conditions which are sometimes not explicity stated. A reduction of the ceteris paribus conditions would provide a greater recognition of the dynamic environment in which the farmer operates—this environment being a pro-

duct of the "historical" subdimension and "horizontal" dimension that, in turn, help determine the future.

2.2.2 DETERMINANTS OF THE FARMING SYSTEM

A simple schematic framework of some of the possible determinants of the farming system practiced by a farming family is given in Figure 2.1. An important characteristic of the West African farmer is that his means of livelihood and his household are inseparably linked. In order to achieve a specific farming system, he allocates certain quantities and qualities of basic inputs, i.e., land, labor, capital, and management, to three processes-crop, livestock, and off-farm enterprises. The farmer makes these allocations in a manner which, within the knowledge he possesses, will maximize the attainment of the goal(s) he is striving for. However, some of the underlying determinants of the potential farming system are outside his control.

Simplistically, the environment can be divided into two parts (Institut d'Economie Rurale 1976): the technical (natural) element, and the human element. The technical element determines the types and physical potential of livestock and crop enterprises and, therefore, forms the necessary condition for what the farming system can become. Constituents of the technical element include physical and biological factors, often modified to some extent by man as a result of technology development. For example, man has been able to improve the availability of water through irrigation, to use chemical techniques to improve soil quality, etc.

The farming system that actually evolves is a subset of what is potentially possible as defined by the technical element. A very important determinant that provides the sufficient condition for the presence of a particular system is the human element, characterized by two factors: exogenous and endogenous.

Exogenous factors (i.e., the social environment) are largely outside the control of the individual farmer but will influence what he can and/or will do. They can be divided into three broad groups.

a. Community structures, norms, and beliefs.
b. External institutions.[3]
c. Other influences, such as population density and location.

Unlike the exogenous factors, the endogenous factors are controlled by the farmer himself, who ultimately determines the farming system that will emerge. This determination is influenced and sometimes constrained by the technical element and the exogenous factors.

The schematic framework in Figure 2.1 explicitly takes Into account the "horizontal" and "heterogeneous" dimensions. The "vertical" dimension, though not explicitly stated in Figure 2.1, is the cumulative function of what happens in terms of the "horizontal" and "heterogeneous" dimensions over time. The relationship is schematically represented in Figure 2.2.

2.3 Common Trends and Implications for Technology Development

In this review we emphasize the dynamic and evolutionary nature of the farming systems as an aid to identifying both the potentials and problems that are likely to emerge in the future. Many factors have contributed to constantly changing the environment in which farming families operate. However, there are two factors that are of particular importance. These are in increasing population densities throughout the region, and the gradual emergence of the region into the world economy. The latter has arisen in part due to the continuing development of the communications system throughout the region. This has had two effects. The first is that it makes the commercialization of agriculture more feasible through the production of export cash crops. The second effect is that there have been changes in the relationships within communities. Ones that were more self-contained and sharing in philosophy have become increasingly dependent upon the outside world and more individualistic in orientation.

These factors or influences will provide the foundation for much of this review. Our investigations have led us to the conviction that many of the changes in the quantities, characteristics, qualities, and distribution of the factors of production can be explained, partially at least, on the basis of these influences. It is our contention, therefore, that these influences will determine to some extent the farming systems that result and the ensuing distribution of welfare in the rural sector. They will also help to determine both the potentials and problems of the farming systems in the region.

Consequently, we believe these influences are of paramount importance in designing appropriate and effective strategies for improving the farming systems and hence the welfare of farming families in the region. For example, to be relevant, technology developed must take into account the "historical" subdimension and "horizontal" dimension and also recognize the heterogeneity of farmers. It should also take into account what might happen in the future as a result of its adoption—that is, the "prospective" subdimension—involving the distribution of benefits, trends in soil productivity, etc. In effect.what we are advocating is that improved technology, in order to be relevant, must be time-, place-, and to some extent individual-specific—a daunting task!'

An underlying concern of this review is that the influ-

3. These can be subdivided into two main groups: input and output. In low-income countries programs pertaining to such inputs as extension, credit, and Input distribution systems are often financed and manned by the government and reflect its policies. On the farm product side the government may directly (e.g., marketing boards) or indirectly (e.g., Improved evacuation routes, transportation systems, etc.) influence the prices farmers receive.

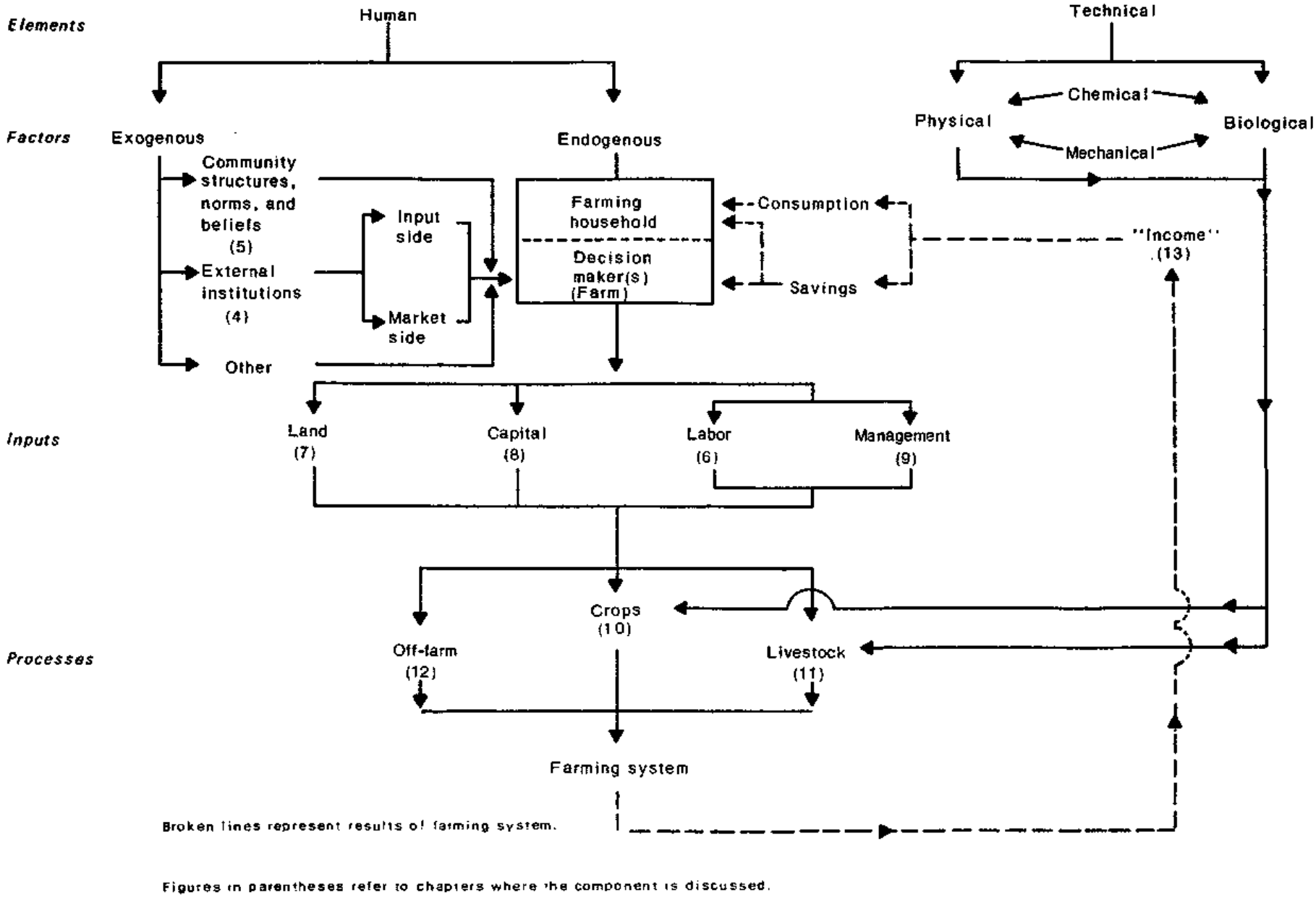


Figure 2.1. Schematic representation of some determinants of the farming system.

ences discussed above which are leading to the intensification and individualization of agriculture, are resulting in increased heterogeneity and inequalities in the distribution of welfare in agriculture (see Fig. 2.2c). Such trends are more developed in other parts of the world: for example, in India. Although we have not attempted to enter into any comparative discussion in this review, valuable insights could be obtained through examination of the reasons for such trends in other regions. Such understanding would be a useful input in designing strategies that will not exacerbate existing problems in the semi-arid region of West Africa.

2.4 Layout of the Review

In presenting the results of the review, we use as a backdrop the schematic framework in Figure 2.1. The review is divided into chapters determined by the schematic framework. The chapter in which each component of the framework is discussed is recorded in Figure2.1. Along with the components, implications considered important for the

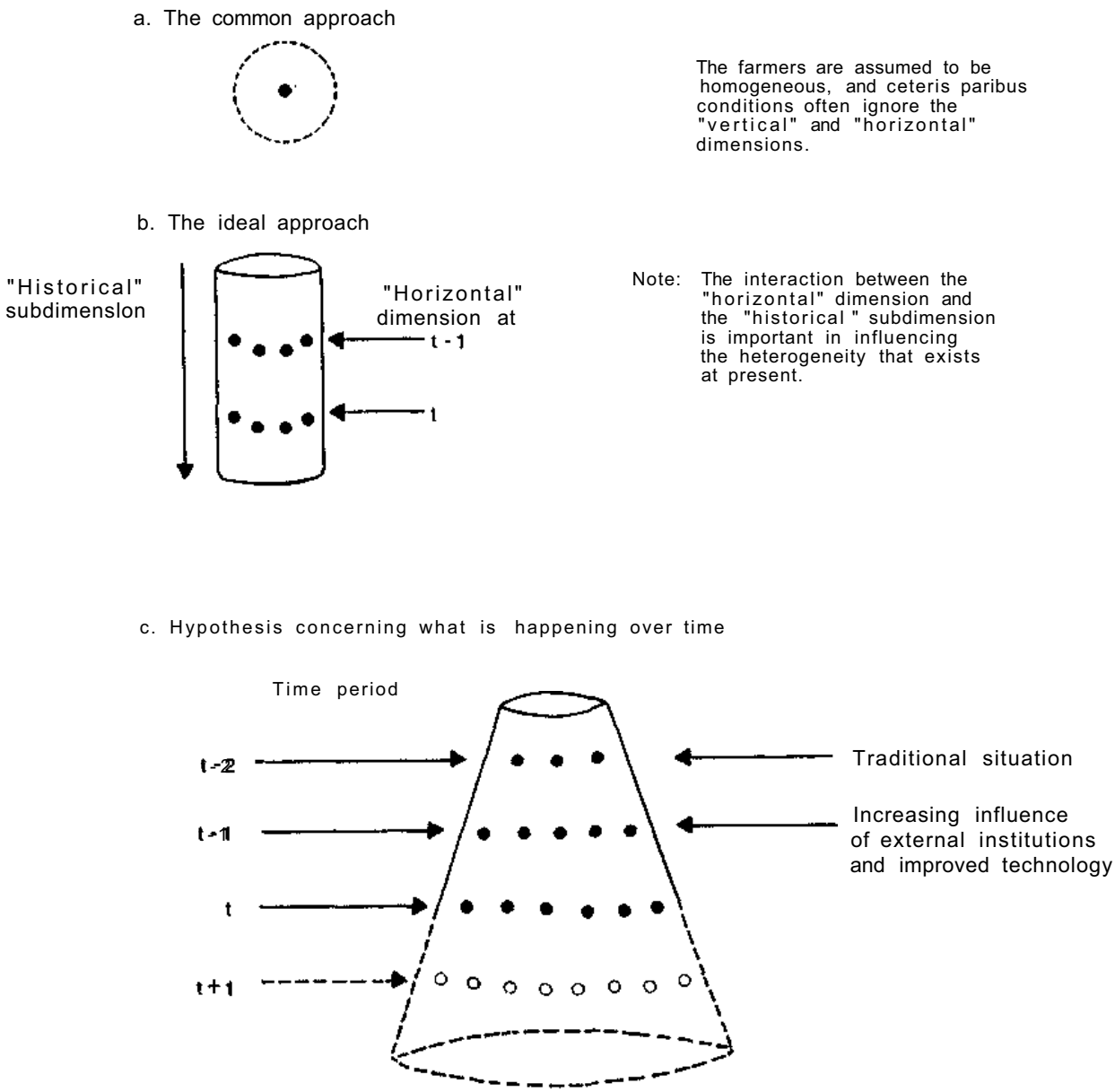


Figure 2.2. The farmer and the dimensions In his envlroment

development process are also mentioned. Although the review is divided into chapters, an attempt was made to write it holistically, particularly because many of the topics are interdependent. Nevertheless, some duplication in the discussion occurs. Before considering the individual topics in detail, we briefly discuss a few of the major methodological issues.

3

Methodology

3.1 Introduction

Among reference materials of direct relevance to the methodology of data collection and analysis in the West African situation are: Benoit-Cattin (1975a; 1975b; 1978), Collinson (1972), Kearl (1976), Lynch (I976), Spencer (1972), Farrington (1975), Connell and Lipton (1977), and Norman (1973; 1977). Two references that deserve special attention are: Palmer-Jones (1978b) who challenges the conventional approach which emerges in many studies; and a series of publications produced by the AMIRA (1978) research group. AMIRA was founded in 1974 with the goal of rationalizing data collection and analytical procedures, particularly in francophone Africa. Many papers produced by this group are of particular relevance to topics in this review. However, rather than attempting exhaustively to review the methodological literature, we highlight four significant issues in conducting village-level studies in the semi-arid region of West Africa, and suggest the need for innovative approaches in undertaking such studies.

In conducting village studies the following important decisions must be made.

a. What the sampling unit should be.
b. The sampling procedure to be used and the sample size to be selected.
c. The type of data to be collected and the method to be used in its collection.
d. The way in which labor data[4] are to be collected and analyzed.

These issues should be solved on the basis of the objectives of the study. However, constraints of time, finances, manpower, or discipline/knowledge often determine the way in which they are resolved.

3.2 Defining the Decision-making (Sampling) Unit

The basic social unit in traditional societies of the SAT of West Africa is the compound—a physical entity—which is usually organized along familial or lineage lines. A compound may be composed of a number of related male adults and their families (i.e., dependents). Traditionally, such a complex family unit also formed the unit of production decision making (i.e., economic unit). The term "economic unit" relates the consumption unit with the work unit, by defining it as a group of people whose basic consumption needs are met from a common field(s).[5] However, there has been an increasing tendency for the identify of the economic and social units to become blurred. The complex family unit is increasingly becoming fragmented into smaller economic units (Section 6.1), but varying degrees of responsibility to the head of the social unit still remain. Such responsibilities may be present even after an individual has broken away to form his own compound (Hopkins 1975), thus further complicating the identification of a suitable sampling unit (Maymard 1974; Monnier et al. 1974; Kleene 1974a; Faye et al. 1977).

Because of varying degrees of interdependence between work units and consumption units in transitional societies, it is often difficult to identify a definitive decision-making unit and, thus, a sampling unit. It is necessary to realize that work and consumption units do not have the same independence as would commonly be found in nuclear family units in many high-income countries. The polar alternative assumption of an economic unit involving correspondence between work and consumption units also has shortcomings, even in societies where much of the labor on the family farm is derived from family sources and much of the production is consumed within the household. In addition to the above complications in defining an economic unit, there are further complications resulting from the increasing frequency of individual decision makers within families[6] (Rocheteau 1975b) having individual fields, and from seasonal fluidity in the composition of families which results from changes in the level of economic activity at different times of the year (Hill 1972).

The dangers of not understanding the decision-making processes are underlined by Kleene's (1976) reference to a case in Senegal where research was aimed at working with 5000 compound chiefs, only to discover that decisions were actually being made by 12 000 rice producers within those compounds. There is obviously no easy answer to the problem of defining a suitable sampling unit, but certainly a basic prerequisite is an under-

4. Labor is a particularly significant Input in the region (see Chapter 6).

5. This unit, which in French is termed the *exploitation agricole,* has been similarly defined by Unite d'Evaluation (1978) as a unit directed by a person who has authority over a group of Individuals concerning some agricultural work and consumption.

6. For the purposes of this review, "economic unit" Is considered synonymous with the words household and family.

standing and appreciation of the decision-making processes within the society being studied.

3.3 Sample Selection

In many of the studies reviewed there was in fact no discussion of the sample selection procedure. The representativeness of the results can therefore be questioned, particularly where a case-study approach was employed. Problems involved in sample selection often arise because of lack of information on the population being sampled. For example, frames from which to sample are rarely available, especially when one takes into account the problem of defining a satisfactory sampling unit. As a result, obtaining a suitable sampling frame can be very expensive in terms of research resources—manpower, finances, and time.

A compromise approach often consists of two stages: selection of villages and selection of the sample within the chosen villages.

The village is sometimes purposively selected, while in other cases—particularly those relying on rigorous statistical analysis—a more systematic approach is sometimes employed. The geographical area under investigation is stratified according to various criteria (e.g., accessibility to an urban area, population density, etc.) and from this a number of villages are selected on a random or nonrandom basis. The nonrandom approach to selecting villages is often justified on the basis that only small numbers of villages are selected,[7] and that, since in many parts of West Africa hand labor is still the main power source, wide variations in input and product combinations do not occur (Clayton 1964; Tollens 1975).[8]

Within villages, sampling units are selected either purposively or randomly. As stressed above, the problem arises in having a suitable frame from which to sample. Attempts have been made to use lists drawn up for other purposes, as frames. However, most of these appear to have severe disadvantages. For example, Hopkins (1975) mentions the problem that only heads of compounds (i.e., social units) appear on tax roles. Therefore, if one wished to draw a sample of economic units, this frame would not provide a complete list. Venema (1978) mentions the fact that lists of members of cooperatives often confuse heads of economic units and social units, therefore making such a list suspect. The expense involved in constructing a frame from which to sample prompts many researchers to use a purposive sampling approach. The other alternative is to undertake a census of the villages selected in order to derive the frame from which to sample. This approach is often used in studies where rigorous statistical analysis is attempted. Such preparatory work can be expensive in terms of research resources and, as a result, data collection at this stage is minimal. Obviously it would also be desirable to use a stratification system in selecting these samples. However, two problems often arise in attempting stratification.

a. The collection of additional information in the initial census can substantially increase the required research resources.
b. A single interview may be inadequate for obtaining accurate information on some of the criteria used in stratifying a sample.

Consequently, a stratified sampling pocedure is rarely used, although stratifying after the data are collected is sometimes employed to partially compensate for this problem. Stratification has been based on a number of criteria including income levels, levels of resource availability such as land and labor, crops produced, etc. Palmer-Jones (1978b) has argued for stratification based on factors related to the mode of production such as farm type, number of workers, off-farm employment, etc. This is likely to be a more practical way of prestratifying the sample. A few of the studies have, in fact, used this approach to some extent (Lowe in Dunsmore et al. 1976; Unite d'Evaluation 1978).

Two considerations can contribute to facilitating the selection of the correct sampling unit and, at the same time, minimize the cost involved in its selection.

a. Since the distinction in the West African context between the economic unit and social unit is at times difficult to define and is indeed in a state of flux, there may well be justification in basing sample selection on a number of compounds and then interviewing every economic unit in each of those compounds. In this way it would be possible to obtain a better picture of the interdependencies that exist while at the same time guarding against the incorrect specification of an economic unit.
b. Systematic sampling procedures—for example, a systematic approach sampling every fifth compound in the village based on its physical location—would eliminate the need for drawing up a detailed frame from which to sample.

The above suggestions are based on practicality. The implications of possibly invalidating the use of rigorous statistical analysis have not been considered.

3.4 Method of Data Collection

The objectives of the study should determine the degree of accuracy required for the data collected. This criterion of accuracy should in turn determine the sample size and method of data collection. Research resources, skill, and the knowledge/discipline of the investigator tend to play a major role in determining the way in which these issues are resolved. As Collinson (1972) has pointed out, there is sometimes a preoccupation with collecting some data

7. In terms of research resources it is obviously more efficient to pick larger sample sizes from a limited number of villages than small sample sizes from large numbers of villages.

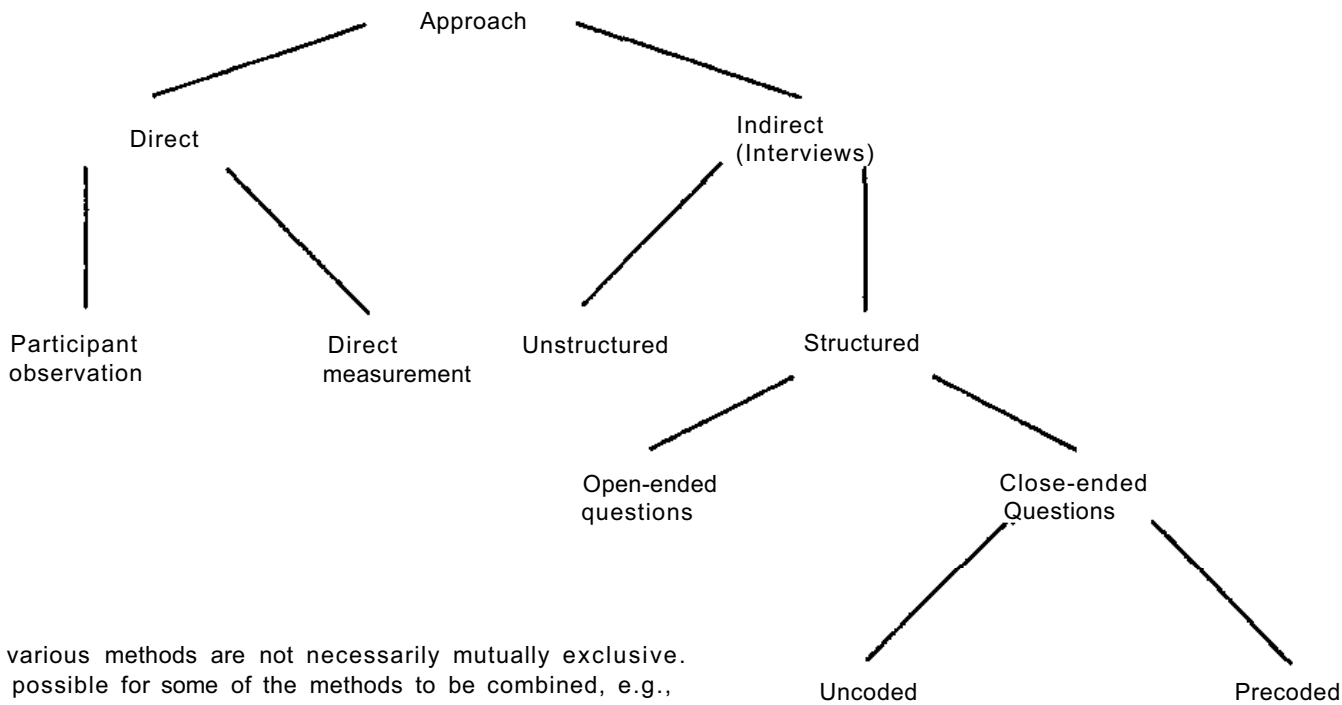
8. The potential for variation increases greatly when larger amounts of capital are employed in operating the farming systems.

very accurately while other data are collected less accurately. This ranking in terms of accuracy often arises as a result of the ease with which the data can be obtained, rather than from the importance of particular data.

A key point in determining the approach to be used in collecting data is to recognize the characteristics of different types of data. Collinson (1972) and Lipton and Moore (1972) have recognized this and have made useful distinctions between single-point and continuous data, and between registered and nonregistered data. The continuum ranging from single-point to continuous data refers to the length of time taken to complete an activity. The continuum ranging from registered to nonregistered data refers to how circumstances influence the respondent's ability to remember the details of an activity. For data classified in the single-point registered class (e.g., purchases of inorganic fertilizer), minimal measurement errors are likely to occur even with infrequent interviewing. However, the collection of data classified in the continuous nonregistered class (e.g., family work on a specific field) requires frequent interviewing to keep measurement errors at a reasonable level, since memory recall will not be good. Unfortunately .while errors of measurement can be reduced by more frequent interviewing, therefore necessitating relatively small samples, errors of sampling are reduced only by using large samples.

The appropriate method to be used should, therefore, depend on the characteristics of the data being collected and the degree of accuracy required in their collection.[8] The various approaches that are used in data collection are shown in Figure 3.1. Often the same investigator uses a combination of approaches. Although generalizations may be dangerous, there appears to be a tendency for anthropologists, sociologists, geographers, and most individuals working in the francophone countries to use a case-study—or a participant observation—approach, often with unstructured interviews. On the other hand, in the case of agricultural economists, and in anglophone countries, there has been relatively more emphasis on a statistical, analytical approach involving larger samples and emphasizing structured interview methods.

More careful consideration often needs to be given to the approach used in data collection. Substantial benefits can be obtained through a combination of elements of traditional approaches used by sociologists/anthropologists and those employed by agricultural economists. This is required In order to obtain the qualitative and quantitative information that is essential for understanding the environment in which the farmer operates. The type of information required is an important factor in determining the approach to be used (e.g., qualitative information requiring unstructured interviews, yields of



The various methods are not necessarily mutually exclusive. It is possible for some of the methods to be combined, e.g., participant observation with unstructured interviews.

Figure 3.1. Approaches used In village studies.

9. The potential conflict between minimizing measurement errors and reducing sampling errors needs to be recognized in cases where research resources are limited.

crops requiring direct measurement, etc.). Where an interviewing approach is used, sampling at two levels can be considered (Matlon 1977). A large sample of farming families can be interviewed at infrequent intervals with little risk of high measurement errors on single-point registered data (e.g., quantity of inorganic fertilizer purchased). A smaller sample that can be interviewed at frequent intervals'[0] can be used for collecting information of a continuous nonregistered type, such as labor flows, in addition to data of a single-point registered type.

3.5 *Actif* versus Man-equivalent

As will be seen later in the review, labor is a critical input in the SAT of West Africa (Chapter 6). Numerous problems arise when investigating this input. These problems revolve around the difficulty of measuring the quantity of labor used and the fact that the productivity of labor varies according to the task (i.e., arduousness and urgency), as well as the sex and age of the worker. With reference to labor input studies undertaken in the francophone and anglophone countries, a dichotomy is seen to exist.

The difficulty of measuring the flow of labor has resulted in the tendency in francophone countries for the *actif* concept to be used as a stock measurement. *Actifs* in a household are generally defined as individuals between 15 and 59 years in age." There is often no differentiation between sexes. The problems of using the *actif* concept have been recognized (Ancey 1975a), but its use continues. The basic problem revolves around the fact that a stock measure which is in itself imperfect in definition is used in an attempt to give some idea of the availability of labor on a flow basis. As such, it really needs to include in its weighting system some implicit notion of the potential productivity of labor which is a combination of the length of time worked and the productivity per unit of time worked by individuals. Related to this problem are additional complications in its use. Some of these are as follows.

a. The definition of *actif* given above is at times very restrictive. For example, Kohler (1968) in Upper Volta, Echard (1964) in Niger, and Monnier and Talibart (1971) in Senegal provide empirical data indicating that substantial amounts of work on the farm are undertaken by individuals outside the age group mentioned in the definition.
b. Labor availability is to some extent a function of custom and ethnic origin. This further complicates the problem of deriving a relevant weighting system. For example, in northern Nigeria (Smith 1955) and Niger (Piault 1965) customary seclusion of wives limits the availability of women for work in the fields.
c. The productivity of work undertaken by individuals can change as a result of changes in technology. For example, the Unite d'Evaluation (1978) notes that, when oxen are introduced into an area where hand cultivation previously dominated, young children become particularly useful in guiding the team.
d. The family size may have some influence on the potential availability of individuals for work on the farm. For example, Milleville (1974) notes that having more than one wife in a family may result in a greater availability of women for working on the farm. This occurs because one wife can concentrate on household chores, thus freeing the other women for work on the farm.

In the anglophone countries the man-equivalent approach has been adopted (Cleave 1974; Malton 1977; Lowe in Dunsmore et al. 1976). It is often used in situations where labor flow data are being collected. As a result it eliminates one of the basic limitations of the *actif* concept. In calculating men- or male adult-equivalents the weighting system needs only to reflect differences in the productivity per unit of time of labor. However, even this is not an easy undertaking. As mentioned abovethe productivity of labor varies according to sex, age, and task.[12] In practice, arbitrary weights differentiating age and sex are usually made. These usually involve weighting labor done by women, young children, and old people as less than that done by male adults. Weighting by task is rarely undertaken, an unfortunate fact which could, on occation, result in spurious conclusions. For example, women picking cotton are generally more productive than men. One approach used by Spencer and Byerlee (1977) is to assume that the wage rates paid to men and women reflect different degrees of productivity and that, as a result, a weighting system should be based on wage rates. The question that arises concerning this approach is the extent to which differential wage rates reflect not only different degrees of productivity but also noneconomic factors, such as social positions in the society.

Although the man- or male adult-equivalent approach is generally superior to the *actif* concept, the weighting systems that have been used in the former have often been based upon unacceptable criteria. For example, weights have been used that reflect differences in levels of consumption rather than in terms of work productivity. It is important to distinguish and differentiate between consumption units and work units since such weighting systems are useful for different purposes. In some

10. The statement that information on continuous nonregistered data should be collected at intervals is deliberately vague, to stay within the scope of the present review. However, interviewing at 3-day intervals has become an accepted norm, although the validity of this has not been rigorously ascertained (Norman 1977).

11. ISRA in Senegal has modified this by including children and differentiating male and female labor (Benoit-Cattin 1976).

12. The nature and urgency of the task will to some extent be factors in determining the amount of time spent resting. Resting in the field while undertaking the task is usually considered to be an integral part of the operation.

publications it is not clear what weighting system was employed.

3.6 The Need for Innovative Approaches

Many of the types of Issues addressed in this review cross discipline boundaries and, as a result, should involve multidisciplinary approaches to data collection and analysis. A failure to adopt such an approach can result in fallacious conclusions being drawn (Palmer-Jones 1978b).[13] The tendency to derive fallacious conclusions is rooted in two factors.

a. The methodologies employed tend to be influenced by the discipline of the researcher.
b. The backgrounds of many researchers are in the high-income countries, and some use approaches from such societies without ascertaining their relevancy to the local situation.

The result is a tendency not to examine topics that, although particularly important in the SAT of West Africa, have no frame of reference in the high-income countries. Two obvious examples are the complexities in the economic and social units discussed above (Section 3.2) and the practice of mixed cropping (see Section 10.3).

There is a thus a need for innovative approaches to clarify the true nature of relationships at the village level and to improve the development of solutions relevant to the problems that exist. Much of this new methodology will have to be developed in situ. Fortunately, there is an increasing realization of the problems involved. Palmer-Jones (1978a), for example, argues that farm management studies are almost bound to produce a distorted and harmonious view because of their failure to penetrate the exploitive relationships existing in the society. Verneuil (1978) also discusses the exploitive relationship question from a methodological perspective.

13. See for example the question of the cost of local credit (Section 8.3) and the distribution of welfare In the society (Sections 13.2 and 13.3).

4

External Institutions

4.1 Introduction

The "historical" subdimension is important in determining the type and organization of external institutions. The different colonial experiences of the francophone and anglophone countries have left their mark (Kohler 1971; Ernst 1976; Amin 1970). This legacy is reflected not only in the organization of research and its philosophy, but also to some extent in the agricultural policies that are pursued.

4.2 Research Institutions and Programs

During the colonial era, both the anglophone and francophone countries showed a bias towards research on cash crops (Lele 1975) which often still exists. However, there was a fundamental difference between the francophone and anglophone countries in the way in which research was organized. Unlike the anglophone countries, where considerable decentralization existed, research in the francophone countries has tended to be directed from France. Research organizations on export cash crops (i.e., IRCT for cotton and textiles, and IRHO for oils and oil crops) were created in 1942. It was not until 1960 that IRAT was created to investigate food crop production and general agronomic problems. Since 1970, nine technical research institutes have been placed under the administrative and financial umbrella of GERDAT.[14]

While there is an increasing move towards greater national control of francophone research programs, considerable input by French nationals continues. In this sense, there is a similarity with the anglophone countries where national control of research programs is better developed. However, in both areas, the way in which research programs are at present organized contains elements of the colonial legacy. In terms of the research programs, there are four points that are relevant to the present discussion.

a. Research programs have tended to specialize along commodity lines with a lack of interdisciplinary work even between individuals engaged in work on the same commodities. This is changing, but real progress to date has been limited—especially with respect to integrating crop and livestock enterprises.
b. There has been a general lack of a linkage between technical and social scientists (Wilde 1967; IER/Institut Royal des Regions Tropicales Pays-Bas 1978). In the francophone countries much of the social science work was done under the auspices of organizations such as ORSTOM and IFAN.[15] In the anglophone countries social scientists have tended to be located in university settings separated from the technical agricultural research institutes. Two relatively recent developments in the SAT of West Africa indicate an emerging desire for greater interaction between technical and social scientists. One pertains to ISRA/CNRA at Bambey in Senegal where social scientists became involved in the Center's research program in the early 1960s. This involvement developed from the realization of the need to field-test some of the technologies that had been developed. The Unites Experimentales (ISRA/GERDAT 1978) developed from this realization and specifically incorporated social scientists in their studies. In the anglophone countries a parallel development took place in the IAR at Samaru in northern Nigeria, where social scientists were recruited in 1965 and have played an increasingly greater role since that time. There is still a substantial need to strengthen such linkages where they have begun (e.g., IER in Mali and INRAN in Niger) and also to develop them in other institutions. Table 4.1 provides a partial list of institutions which are currently involved in social science work on production-related topics in the SAT of West Africa.
c. Increasing national control over research priorities presents the opportunity to set them in line with the needs and objectives of the countries in the SAT of West Africa. Various approval mechanisms for determining research priorities and financial budgets have been drawn up. Often, these are decided at the national level with representatives of government research organizations, and increasingly, development agencies provide an input. Although such an approach is good in theory there are problems regarding its effectiveness in practice. For example, government and

14. This includes the following: CTFT lor forests; IEMVT for livestock and veterinary medicine; IFAC for fruits; IFCC for coffee and cocoa; IRAT for food crops; IRCA for rubber; IRCT for cotton and textiles; IRHO for oil and oil seeds; and CEEMAT for agricultural mechanization.

15. Both organizations once again are going through various degrees of nationalization. For example, ORSTOM plays no role in Mall, while in Niger IFAN has become IRSH.

Table 4.1 A partial list of organizations doing social science work on production-related topics.[a]

Country	Type of organization	Name of organization
Senegal	Research	ISRA/CNRA
	Research	ORSTOM
	Research	Purdue University
	Development	SODEVA
Gambia	Development	Rural Development Project
Mali	Research	IER
	Research	Purdue University
	Consultant	BARRA
	Development	CMDT
Upper Volta	Research	ORSTOM
	Research	Purdue University
	Research	Michigan State University
	Consultant	Societe Africaines d'Etudes et de Developpement
N iger	Research	INRAN
	Research	IRSH
	Research	Universite de Bourdeaux
	Development	Niger Cereals Project
	Development	Niamey Department Project
North part of Nigeria:	Research	IAR and other parts of ABU
	Development	Integrated Agricultural Development Projects (Gombe, Funtua, Gusau)

a. This list is very tentative and in terms of some institutions is more a case of intention to work in these areas rather than established records.

development agency personnel may find it difficult to articulate their needs in a manner meaningful for research. On the other hand, problems arise if research personnel do not appreciate the importance of relating their priorities to the needs of the country. Research priorities often have a long-run focus, while many individuals in government, by the very nature of their responsibilities, have a short-run viewpoint. While some trade-offs are possible, conflict is still inevitable.

d. The link between research and implementation, particularly with reference to cash crops—e.g., groundnut and cotton—has been much stronger in the francophone countries. Here, support systems on both the input side and product side have been strongly coordinated with respect to a particular crop (e.g., SODEVA for groundnut in Senegal, CMDT for cotton in Mali, etc.).[16] No similar commodity-based implementation programs have yet become widespread in the anglophone countries.[17] In all countries, however, the approach used in developing improved technology has been "top-down" rather than "botton-up".[18]The "bottom-up" method, involving increased farmer participation, is advocated In the farming systems research approach (Institut d'Economie Rurale 1976).

4.3 Agricultural Policy

Both research and development plans have encouraged the production of export cash crops, continuing a bias that has been noted above. And, derived from the heightened consciousness resulting from the drought in the early 1970s, there has been a move towards articulating a goal of national food self-sufficiency. This has been encouraged under the auspices of CILSS. However, there is some evidence that fulfillment of such a goal would come at a considerable opportunity cost in terms of sacrificed production of other crops (Stryker 1978; Center for Research on Economic Development 1977). With reference to food production, two major factors have influenced government policy, particularly in the francophone countries. These have been the importance of encouraging production of export cash crops (e.g., cotton and groundnut) to provide much needed foreign exchange,

16. These parastatal organizations have also evolved in recent years from French-based organizations. For example, CMDT has taken over from CFDT, and the predecessor of SODEVA was SATEC.

17. Tobacco and tomatoes are rare exceptions (Norman 1976).

18. The problems resulting from the "top-down" approach will become obvious later in the review.

and the attempt to provide cheap food for the vocal urban sector. The latter has met with only limited success.

Perhaps as a result of the drought in the early 1970s and the general absence of improved technologies for growing and processing millet and sorghum, emphasis has been placed in the agricultural policies of some countries on lowland rice production (e.g., Gambia, Senegal, and Mali). There is cause for concern about the implications of such strategies. The development of irrigated rice production schemes requires the use of high-opportunity cost resources both in terms of finances and manpower. This may imply a fundamental conflict with strategies designed to improve the production of millet and sorghum on rainfed land. There is also the question of a loss of the market for sorghum and millet. Evidence seems to be emerging that rice, for many people, has now become an essential rather than simply a superior product (Center for Research on Economic Development 1977). Thus, rice is becoming a substitute for the traditional millet and sorghum in both urban and rural areas. This will have particularly adverse effects on the economies of areas where only millet can be grown. Also, it could have serious agronomic repercussions in areas where groundnut is the major export cash crop. Rotating groundnut with other crops has specific benefits: it reputedly reduces the incidence of rosette disease and it counters the effect of successive crops of groundnut that cause an accelerated breakdown of the soil stucture, a consequent decrease in permeability, and an increase in water runoff and erosion (Dunsmore et al. 1976). Millet, in particular, is seen as the major crop alternative involved in this rotation (e.g. such as in the Sine Saloum area of Senegal).

Increasing recognition of the negative implications of a direct or indirect discouragement of millet and sorghum production is resulting in Senegalese plans to try to reverse the developing consumer preference for rice (Senegal, Ministry of Rural Development and Water Resources 1977).[19] Articulation of plans includes processing millet into bread and couscous.[20] There is some skepticism that this will be effective by itself (C.Charreau, personal communication). It has been reasoned that, for political and economic reasons, it is unlikely that governments will be able to stimulate the production of millet and sorghum through pricing policies alone (Harriss 1978). For example, high producer prices would necessitate unacceptably high consumer prices or major subsidy programs. Furthermore, where increasing the profitability of millet and sorghum leads to their substitution for production of exportable cash crops, vital foreign exchange earnings can be expected to suffer. It would appear that the only possible practical way of reversing the trend will require a generation of relevant improved technologies for the growing and processing of millet and sorghum. The success of such a program is likely to hinge on the competitive position of millet and sorghum compared with rice. However, even in the anglophone countries serious shortfalls in aggregate production appear to be likely, in spite of there having been a mainly free market in millet and sorghum (Abalu 1978).[21] Therefore, the generation of relevant improved technologies for millet and sorghum is also potentially important in the anglophone countries in order to overcome the predicted shortfalls in production.

External institutions, that is support systems, will play a crucial role in creating favorable conditions for the development and adoption of improved technologies for millet and sorghum. Without their support, the task of research agencies in developing technologies that will be adopted by farmers will be even more formidable. The adoption process is likely to be successful only when it is fostered through an integrated framework rather than in narrow, commodity-oriented implementation projects. The objective in Integrated Rural Development projects-such as those popularized by the World Bank—is to embrace both food and cash crops.

One point which perhaps is not sufficiently recognized in the formulation of agricultural policies is the interdependence between countries caused by the problems of controlling movement across national boundaries. This free movement makes it virtually impossible for one country to have an effective agricultural pricing policy which is completely independent of neighboring countries (Collins 1976).

4.4 Implementation of Policy

4.4.1 SUPPORT SYSTEMS AND DEVELOPMENT PROJECTS

We have emphasized that improved technology adopted in the SAT of West Africa has been confined mainly to cash crops and also that there has been a bias towards support systems provided by the commodity development agencies which stimulated cash-crop production.[22]

19. This has also been advocated in Mali (Caisse Centrale de Cooperation Economique, Mali 1977).

20. The Institute for Food Technology in Dakar is placing some priority in working on this issue.

21. Nigeria has, since 1977, taken the first tentative steps In government involvement In the marketing of food crops. Indeed, it could be argued that, even in the francophone countries with government involvement in food crop marketing, well over 70% of the marketed cereals usually go through private channels (i.e., the "parallel" market).

22. In this review, the term "cash crops" is used in the usual West African sense. Traditionally these were the export crops of groundnut and cotton, although other crops that are mainly marketed are included under this rubric. It is recognized that millet and sorghum can be marketed, but, because relatively high proportions are consumed within the household, these are usually not considered to be cash crops.

These agencies have provided support systems such as extension, input distribution, and credit on the input side, and they have established appropriate marketing organizations on the product side. The most successful projects—judged only from an adoption perspective-have been found in the francophone countries. Evidence for this is found in the differences in the levels of yields of cotton and groundnut and the relative degree to which oxen have been successfully introduced in the francophone, as compared with the anglophone, countries. This observation is, however, conditional in the sense that it largely ignores the income distribution problems that may be arising and which will be discussed later in the review.

In contrast to cash-crop production, there has been little or no success with stimulating food-crop production. The reasons can be summarized as a lack of relevant improved technology (Hopkins 1975) and deficiencies in the support system—both in the level of support and in a lack of integration of the various components. For example, institutional credit programs have been successful only when linked with a cash crop that produces revenue for repaying loans. Extension services for food crops have also been inadequate (Black-Michaud 1978).

A more holistic view concerning the implementation of development projects is now emerging. In many countries, the commodity-oriented development projets are being "transformed" into Integrated Agricultural or Rural Development Projects. Although the value of such integration is increasingly being recognized, there are certain problems with their implementation.

Three of these are the following.

a. There is the problem of changing the philosophy of the implementation agencies themselves from the one-commodity approach to that involving the whole farming system.
b. The past neglect of food crops, and a continuation of current policies that inhibit the production of millet and sorghum, are likely to mean that the cash-crop component will continue to be emphasized.
c. Except for the introduction of animal traction, little attempt has been made to integrate crops and livestock. A project which is soon to be implemented in Gambia (USAID 1978) will be addressing this very issue.

Adoption of a broad-based perspective increases the possibility of exploiting complementary relationships between the various enterprises as well as in the support systems. For example, support systems for cash crops could help to stimulate food production. One possibility is the encouragement of the use of oxen on food crops as well as cash crops, with credit being repaid by revenues derived from the cash-crop component. Of course, it is recognized that such a system might serve to perpetuate the dependence on export cash crops for the introduction of improved technology.

It is not possible in this review to discuss in detail the characteristics of the support systems and development projects. However, there are two points we wish to mention briefly which are pertinent to this review,

a. There has been a tendency to use a "top-down" approach with very little decentralized decision making or feedback in the implementation of development projects. A number of writers have emphasized the adverse effects of such an approach (Black-Michaud 1978; Charlick 1972, 1974, 1976; Jones 1976). It has often resulted in irrelevant ways of organizing support systems and, in areas where the support systems have been limited in their availability, increasing inequalities in the accrual of benefits have developed,
b. In some francophone countries (e.g., Niger) the concept of *animation rurale* has been presented as an attempt to provide a means for villagers to articulate their needs. In theory, this is consistent with a "bottom-up" approach. However, in practice there has been less success. Two reasons account for this. One is that it has sometimes been used as a means of motivating villagers to do the things that development agencies consider to be desirable. It has thus played an indoctrination role on behalf of the development agencies rather than an information-gathering role which would provide the development agencies with useful information from the villagers. *Animation rurale* has also been strongly linked with powerful groups within villages, such as groups surrounding the village head (Charlick 1976). Asa result, it has not really been used as a means for expressing the needs of the community as a whole.

4.4.2 COOPERATIVES

Cooperatives have been used as government policy instruments throughout the SAT of West Africa to channel support systems to villagers. Even the Unites Experimentales in Senegal have based much of their work on these organizations. The word cooperative is misleading in that there is often substantial deviation from the principles of democratic control by users, and the provision of service at cost, that characterize American and European cooperatives. In many West African cases, the initiative for forming cooperatives has come not from the village level but from government organizations. For example, the parastatal development agencies in the francophone countries which were involved in encouraging cash-crop production have used cooperatives as organizations to provide systems of input distribution,credit dispensation and the marketing of products. Farmer participation in the organization of such cooperatives has been limited. A number of individuals have critically reviewed the mixed record of cooperatives in the SAT of West Africa. A list, which is by no means exhaustive, includes Gagnon and Savaria (1976), Diarassouba (1968), Jones (1976), Gentil (1971a, 1971b, 1973), Storm (1977), and King (1976a, 1976b, 1978). It is not possible to discuss in detail all the reasons for the lack of success of cooperatives in the region. However, a few of the major ones are as follows,

a. Cooperatives have been presented as being compatible with a traditional village society, believed to operate in a milieu of primitive socialism. However, Jones (1976) observed that villagers regarded the coopera-

tive organization as a novel institution. Charlick (1974) commented that villagers were defensive about accepting cooperatives, since they were viewed as externally imposed institutions. (Part of the inconsistency may lie In the conflicting definitions of cooperatives.)

b. Villages, as King (1976b) pointed out, differ widely In resource base, product differentiation, and societal/ leadership relationships, However, this heterogeneity at the village level has not been recognized in cooperative organizations. Organization has generally been inflexible with a "top-down" orientation. As a result, the cooperative institution, uniform in its organization and imposed on a variety of villages, has often been inappropriate (King 1978).

c. Because skills are lacking at the village level, government employees have often been used to run cooperatives. In order to minimize the resources required in providing service and to ensure some support at the local level, it is necessary to obtain the help of the local leadership in order to run the cooperatives. However, because of the increased individualism that is result ing, such a strategy may in fact exacerbate inequalities at the local level. King (1976b) shows that it is often the more influential and better endowed farmers who get credit through the cooperatives. At the same time, it is such people who have less need for it, since they would have no difficulty in borrowing from traditional sources. As mentioned earlier, the integration and coordination of support systems is important in creating the right milieu for bringing about change. Often credit has been given through cooperatives without linking it to input distribution systems and product marketing. As a result, problems have arisen in the use of credit and in the repayment of the loans.

King (1978) concluded that cooperatives, with their "top-down" orientation, have coincided more with the interest of the state in producing a rural economy providing for urban food requirements and export revenue (Gagnon and Savaria 1976) than with the interest of villagers. Such an orientation is likely to help the commercial farmer rather than to satisfy the needs and aspirations of the rural poor. We suggest that King's observation coincides with the traditional view of many of the governments in the SAT of West Africa.

King (1976b) also argued for much more sensitivity in the design of institutions suitable for delivering support systems into village communities. Appropriate institutions must be capable of responding to locationally specific factors. No attempt should be made to Introduce cooperatives of an identical form and function to all situations. Appropriate institutions can develop in villages if strong desires to take advantage of unrealized economic opportunities exist there, and innovative behavior is not inconsistent with local values and beliefs. Institutional innovations which offer little economic advantage, which offer advantages only to the politically important, or which are abrasive to values and beliefs, are more difficult and more expensive to introduce. The willingness of government to undertake such policies will depend on the social benefits which they expect to result, the opportunity cost of government resources, and their willingness to impose by force changes not currently desired by the population. We argue in this review for more locational specificity in developing relevant improved technology. King (1978) argues exactly the same case in terms of designing appropriate institutional innovations. While such an approach is likely to be more expensive in the short and medium term, there appears to be no alternative if there is a genuine aim to help all members of society. In other words, a genuine commitment to avoid inequitable income distribution does, in the short run at least, come at a cost, although in the long run this may not be so true (Mellor1976).

5

Community Norms, Structures, and Beliefs

5.1 The Village In a Traditional Setting

Traditional villages in the SAT of West Africa, whether nucleated or dispersed in settlement pattern, are generally characterized by a strong sense of community and often hierarchical systems of control (Remy 1977; Ramond et al. 1976; Lewis 1978; Kohler 1968,1971,1972; Wilde 1967; Jones 1976). These hierarchical systems have often been based on longevity of residence in the village and status at the time of arrival. For example, Jones (1976) and Haswell (1975) have described founders of villages, who have traditionally had the leadership role, being Joined by more recent settlers and those who originally came as slaves. Most researchers have not considered this traditional hierarchy to be very exploitive.[23] Three reasons are commonly given for this conclusion.

a. Communal land tenure systems characteristic of the region combined with low population densities have been the rule (Hill 1972; Maymard 1974).
b. Haswell (1975) has pointed outthat, traditionally, communities had a shared poverty concept, with poverty being determined primarily by the technical element (i.e., climate and soil). There was, in a sense, a community welfare state.
c. In the traditional societies in the SAT of West Africa, low levels of capital were found while the significance of concepts of mutual obligations and traditional gifts were very important (Mauss 1954; Vercambre 1974).The former prevented large inequalities from developing in income distribution, while the latter helped to cement the social fabric and, through an ideology that stressed distribution (Watts 1978; Hill 1972; Raynaut 1976), militated against accumulation of wealth.

There appears to be substantial qualitative evidence that the above characteristics were generally true of villages throughout the region, although minor differences did exist due to variations in ethnic origin (Pelissier 1966), religion, and culture. Such community relationships are, of course, difficult to analyze in a neoclassical marginalist framework which necessitates imputing values of individual contributions to activities that have "communal' economic connotations (i.e., mutual security). The difficulty In incorporating such relationships into an analytical framework has often resulted in their significance being ignored.

5.2 Increasing External Contacts and their Effects

Increasing contact with the outside world, and rising population densities, are having a profound effect on villages in the region. This effect has often been overlooked. In fact, many development programs which concentrate on individuals have worked to the detriment of the traditional strengths of the community.

Many examples appear in the literature concerning the changes that are taking place. No doubt European colonialism, particularly French, gave more power to village heads than was normal traditionally. This is said to have increased distrust on the part of villagers towards their leaders and accelerated the breakdown of the precolonial sense of community (Kohler 1971; Ernst 1976; Hopkins 1972). Numerous other changes that are taking place are also influencing the way of life in the villages. These are discussed in the appropriate places later in this review. They include: the breakup of the family structure and the associated individualization of fields (Section 6.1); partial sacrifice of the goal of food self-sufficiency in order to produce cash crops (Section 9.1); a trend towards individualization of land tenure (Section 7.2); changes in the character and remuneration of nonfamily labor (Section 6.2.1.3); and the trend away from a shared poverty concept to one which is more individualized in character (Haswell 1975) resulting in the appearance of new and potentially greater inequalities founded not on social structure but on changes in the relationships of production (Section 13.1).

5.3 Implications

There Is no question that rapid social changes are taking place in villages throughout the region. At the same time, however, traditional hierarchical structures are still important in influencing life at the village level. Two implications arise from the preceding discussion,

a. There is considerable heterogeneity at the village level in relationships within the village itself and with the world outside. If plans for bringing about change are to be appropriate, it is necessary to recognize locational specificity in designing relevant development strategies. One important component of this is recognition

23. Some writers have questioned the lack of exploitation in these traditional societies (Ernst 1976; Kafando 1972). However, for reasons discussed below, the potential for exploitation is likely to be much greater in the future.

of the significance of leadership and decision-making processes in villages. Such knowledge is important in designing strategies which will receive support at the local level (Reverdy 1967; Blanchet 1968-69) without exacerbating inequalities in village living standards. For example, in some communities, channeling support systems through traditional leadership in the village may simply reinforce traditional social power with new economic power. In other villages this may, in fact, not be a problem. Designing relevant strategies, particularly in the former type of villages, is not easy to achieve if the overriding aim is to prevent the development of increasing inequalities in living standards,

b. The loss of community spirit through increased individualization has resulted in a shift from emphasis on collective security to an increased orientation towards individual profit maximization. It can be argued, however, that the traditional community spirit and collective security did inhibit individuals from adopting innovations. A useful illustration of this has been given by Raulin (1964), who cites the case of a new resident in a village being subjected to considerable social pressure to give up the use of a short-handled hoe he personally was accustomed to but that was foreign to his new village, where a long-handled hoe *(iler)* was traditionally used. He eventually bowed to the pressure. Although it can be argued that progress in the village settings has been retarded by traditional norms, it can also be argued that, by decreasing collective security, recent changes have increased farmers' vulnerability to droughts and other misfortunes (Lewis 1978) and has increased their dependence on help from outside at such times. Thus the introduction of changes at the village level through the use of improved technology has come at both a private and a social cost. An appreciation of this trend is important for both researchers and government agencies in developing appropriate criteria for evaluating improved technologies and for implementing relevant developmental strategies.

6
Labor

6.1 Family Structure

A common trend in the SAT of West Africa is that the traditional complex family unit (i.e., consisting of more than one married man plus dependents)[24] is breaking up into simple nuclear family units (i.e., one married man plus dependents) within the same compound and these may then may eventually form new compounds (Nicolas 1960; Benoit-Cattin 1977; Buntjer 1970; Ernst 1976; Goddard 1969; Lowe in Dunsmore et al. 1976).

Family breakup appears to accompany increased contact with the outside world and monetization of the economy. However, the rate at which this family change is taking place depends on a number of complex interactions. It has been suggested that the introduction of cash crops (Reboul 1972; Nicolas 1960), secular education, the influence of the Moslem land inheritance rule (Venema 1978), increased off-farm employment opportunities (Sutter 1977), desire for freedom of action, the presence of certain types of relationships (Buntjer 1970),[25] and new settlements and migration, all encourage this breakup. However, the speed at which this takes place may be tempered by the strength of the traditional hierarchical structure, the ethnic origin of the people concerned (Pelissier 1966), the ownership of cattle (Buntjer 1970), and the specific farming system and its labor requirements (Netting 1965).

Ernst (1976) conducted an analysis of the impact of the process of change from complex to simple family units. Characteristics of the two extremes studied are given in Table 6.1. Although these results indicate that both complex and nuclear family units are of equal importance, evidence from other areas indicated that the trend has developed even further in favor of the nuclear family units. For example, the results for northern Nigeria in Table 6.2 closely parallel those by Sutter (1977) in Niger. They also show that, as a result of the breakup in families, the average economic unit is becoming smaller in size. Haswell (1975), for example, found that in one village in Gambia the percentage of families with less than ten persons increased from 28 in 1962 to 32 in 1973.

An interesting observation by Jones (1976) challenges some of the conventional wisdom concerning the breakup of the family structure. He cites Melllassoux (1960) who studied the economic roots of the social relationships existing in the family. Traditionally, families in West Africa were able to produce the necessities of life with physical factors that were fairly readily available. The major component, of course, was labor, and this was altered only by war, exchange, birth or death. Knowledge about technology was acquired over time and therefore was closely correlated with age. Traditionally, family heads had power. Now, however, knowledge about improved technology is no longer closely correlated with age. Jones (1976) argues that this situation, and not incompatibility of the exchange system with the extended family system (i.e., social units), may account for this breakup. He goes on to say that in villages where the heads of social units have been first to master the new technology and to monopolize contacts with outside technicians, the traditional family structure is strongest.

Important implications arise as a result of the breakup in family structure. Two of them are as follows,

a. The breakup of families is tending in many areas to result in smaller farms although these often have sim-

Table 6.1. Characteristics of complex and nuclear family units (economic units), Mali.

Features	Type of family unit[a]	
	Complex	Nuclear
Percentage of families	36.9	36.9
Percentage of farms	25.2	25.2
Percentage of population	44.6	14.2
Persons per family	14.9	5.1
Nuclear units per family	3.2	1.0
Persons of working age per family	4.2	1.7
Area per family (ha)	7.7	3.5
Area per resident (ha)	0.5	0.7
Area per person of working age (ha)	1.8	2.1
Dependent/worker ratio	4.3	3.0
Draft oxen per family	2.0	1.0
Plows per family	0.9	0.4

Source : Ernst (1976).

a. Ernst also distinguishes two other variants between completely complex units where the economic units are synonymous with the social units, and economic units that are solely nuclear in composition. These have been omitted from this table.

24. This complex family unit is often synonymous with the social unit.

25. Complex family units consisting of brothers are found to be less stable than those consisting of a father/son relationship.

ilar area-per-resident ratios (Tables 6.1 and6.2). However, at the same time there is an increased fragmentation of fields (Venema 1978). Also the nuclear family units that break away often tend to have younger, relatively Inexperienced family heads, higher dependent/worker ratios (Table 6.2),[26] poorer net worth, and lower cash liquidity levels. Such trends raise questions about the appropriateness of certain types of technology and processes. For example, although Table 6.3 does not divide farmers using hand and oxen power into different family types, it appears that, for oxen farmers, complex family units dominate because they have a much larger average family size. Tiffen (1973) also found that complex family units were relatively more common for farmers owning oxen. This situation is not surprising in the light of the characteristics of nuclear family units mentioned above. Certain of these characteristics seem to militate against having cattle (e.g., poorer wealth position, a higher dependent/worker ratio, etc.).

Table 6.2. Characteristics of complex and nuclear family units (economic units), Nigeria.[a]

Variable	Area					
	Sokoto		Zaria		Bauchi	
Population density	Highest		Medium		Lowest	
Family structure	Complex	Nuclear	Complex	Nuclear	Complex	Nuclear
Percentage of families	28.1	71.9	49.0	51.0	35.6	64.4
Size of family	7.1	4.9	10.9	6.2	7.5	5.1
Number of male adults[b]	2.4	1.2	3.0	1.3	2.2	1.2
Farm size (ha)	4.4	3.5	5.4	2.6	4.5	3.6
Area per resident (ha)	0.6	0.7	0.5	0.4	0.6	0.7
Area per male adult (ha)	1.8	2.9	1.8	2.0	2.0	3.0
Dependent/male adult ratio	3.0	4.1	3.6	4.8	3.4	4.3
Age of family head	48	42	-	-	48	42
Average number of cattle	2.11	1.10	4.4	0	1.28	1.00

Source: D.W. Norman (unpublished).

a. All work on the fields is undertoken using hand labor only.

b. Mete adults in Moslem villages in northern Nigeria do the bulk of the work on the family farm

Table 6.3. Families owning oxen compared with those who do not. in four villages, Mali.

Variable	Sirakeme		Chola		Daban		Kobiri	
	650 mm/yr rainfall		850 mm/yr rainfall		930 mm/yr rainfall		1050 mm/yr rainfall	
	No oxen	Oxen	No oxen	Oxen	No oxen	Oxen	No oxen	Oxen
Size of family	6	17	12	18	14	18	14	33
Number of *actifs*	1.5	11	5.5	10	6	11.5	8	16
Area cultivated (ha)	2.3	24.7	7.9	14.4	6.9	11.6	7.7	15.1
Area cultivated/resident (ha)	0.4	1.5	0.7	0.8	0.5	0.6	0.6	0.5
Area cultivated/acr// (ha)	1.5	2.2	1.4	1.4	1.1	1.0	1.0	0.9
Depandent/acr/Y ratio	4.0	1.5	2.2	1.8	2.3	1.6	1.8	2.1
Composition of fields in terms of control (%of total ha):								
Common	97	89	89	80	76	70	69	72
Individual	3	11	11	20	24	30	31	28
Crops (ha)[a]:								
Groundnut	0.3(83)	3.7(52)	2.1(73)	5.9(59)	3.2(49)	6.3(47)	3.7(55)	7.2(62)
Millet and sorghum	2.0(1000)	21.0(95)	5.5(94)	7.4(93)	3.6(100)	5.3(98)	3.1(100)	6.1(97)
Other	-		0.3(100)	1.1(100)	0.1(100)	-	0.9(19)	1.8(28)

Source: Unite d'Evaluation (1978).

a. Figures in parentheses indicate the percentage of ares grown on common fields.

26. Although Table 6.1 is inconsistent with this observation.

b. Related to the breakup in the family structure are changes in the relationship concerning the management of fields. Fields farmed by families in the area have traditionally been divided into common and individual fields. The common fields controlled by the family head provided food for all members of the family. However, an increasing proportion of the fields is now coming under the control of other individuals in the family (Raulin 1969; Nicolas 1961-62). There is, as a result, a decrease in obligations of family members to work on the common fields, and there is no longer the assurance of food from the common farm to meet subsistence needs. Increased individualization of fields (Tables 6.3 and 6.4) plus the need for cash to pay for taxes, have contributed to encouraging the growth of export cash crops for the market. The Increased decentralization of decision making within families creates problems in introducing improved technology, especially if an extension input is involved. If such programs are to be directed to the compound or social unit heads rather than heads of individual families, then the situation is complicated even further. M. Niang (personal communication) has noted that individuals other than the family head grow cotton in the Unites Experimentales area of Senegal, in spite of the fact that cotton is, in revenue terms, less profitable than some other crops. Such individuals grow cotton since, unlike the program for the promotion of groundnut, as an export crop, payment for the improved inputs of cotton is made at the end of the season by giving a lower price per unit weight for the crop. Formal credit programs have to be channeled through the family heads. In many cases family heads are unwilling to take responsibility for individuals in their families who are working on their own fields. Table 6.6 presents another example of the problems involved in the adoption of improved technology on individual fields that are not under the control of the head of the family. The figures indicate that both the average sowing date and the date of first weeding were later for fields under the control of individuals other than the family head. As a result yields were also lower. The reason given by Venema (1978) emphasizes a shortage of labor: family heads ensure that labor requirements on common fields are given priority resulting in lower labor inputs, and also poorer timing of operations, on individual fields. Lower levels of improved technology are also likely to be utilized for reasons mentioned above. There appears to be no easy solution to this problem, especially since there would be enormous problems in directing credit and input distribution programs to individuals rather than to family heads.

Table 6.5. Family and farm characteristics.Senegal.

Variable	Village	
	Diama Yadio	N'Gayene Daour
Size of family	7.6	8.0
Number of working population	6.2	5.5
Farm (ha) : Size	8.0	16.3
Cultivated	5.7	10.0
Fallow	2.3	6.3
Area (ha) per[a]:		
Resident	1.1 (0.8)	2.0 (1.3)
Worker	1.3 (0.9)	3.0 (1.8)
Dependent/worker ratio	1.2	1.5

Source : Hopkins, 1975.

a. Figures in parentheses depict cultivated hectares per resident or worker.

Table 6.4. Breakdown of a family farm, Senegal.[a]

Characteristics	Head of family	Women	Men		Total
			Family[d]	*Navetanes*	
Average hectares :					
Total					25.0
Cultivated[b]	9.3 (54)	3.2 (19)	1.5 (9)	3.0 (18)	17.0
Breakdown of cultivated area (ha):					
(1) According to crops:					
Food	4.9	--	0.5	--	5.3
Cash	4.4	3.2	1.0	3.0	11.7
(2) According to location :					
Near residence[c]	9.3	0.7	0.8	--	10.8 (3.0)
More distant[c]	--	2.5	0.7	3.0	6.2 (5.0)

Source: Klaene (1976).

a. This farm is much bigger than is normal in Senegal (see, for example Table 6.6).
b. Figures in parentheses are the percentage of total land cultivated.
c. Figures in parentheses are additional areas (ha) that are in fallow.
d. Males of family other than family head.

Table 6.6. Groundnut growing by different family members. Senegal.

Position	Average sowing date (range)	Average date of first weeding (range)	Groundnut yield (kg/ha)
Head of family	23 June (21/6-8/7)	28 June (21/6-18/7)	1010
Sourge[a]	22 June (21/6-26/6)	2 July (23/6-11/7)	918
Women	3 July (24/6-11/7)	16 July (26/6-31/7)	881

Source: Venema (1978).
a. Males other than family head.

6.2 Total Time Worked

6.2.1 TOTAL WORK ON THE FAMILY FARM

Individuals In the Sahelian and Sudan areas work in three types of processes—crops, livestock, and off-farm enterprises. There are few studies with detailed labor flow data by season, job, age, and sex, and they are strongly biased towards anglophone countries, particularly Nigeria. This lack of data is unfortunate in the sense that, throughout much of the area, labor and not land appears to be the more limiting factor at the present time (Unite d'Evaluation 1978; Ogunfowora 1972a; Lewis 1978). It is even more unfortunate since, traditionally, little capital has been used in agriculture, and, therefore, the labor input is crucial in determining the level of farm output and income (Eicher et al. 1970).

6.2.1.1 ***Ratio of family to nonfamlly labor.*** The major input on the family farm tends to be provided by family members (see Table 6.7), that is, members of the economic unit (Lowe in Dunsmore et al. 1976; Delgado 1978; Echard 1964). Reasons given for the dominance of family labor include the fact that agriculture traditionally has been largely subsistence in nature and that the nature of the land tenure system and relatively low population densities have prevented the development of a landless laboring class (Raynaut 1976). However, a number of trends are developing over time which are likely to increase the significance of nonfamily labor. These reasons have been mentioned before in other contexts: the increased importance of individualization, of monetization (Monnier et al. 1974), and of cash *crops* and the development of increasing inequalities in land and income distribution.[27]

6.2.1.2 ***Family labor components.*** The figures in Tables 6.7 and 6.9 indicate the significance of family male adult labor on the farm. There is less evidence of the universal significance of the contribution of women to farm work, although their total work load is often high (Tables 6.8). Women Indeed can provide significant contributions to such work (Delgado 1978; Guissou 1977; Unite d'Evaluation 1976; Maymard 1974; Echard 1964). A number of factors determine the significance of the contribution by women. Some of these are as follows.

a. Custom can play an important role. For example, in northern Nigeria Moslem women are kept in seclusion and, therefore, are not available for farm work. This accounts for the low figure for female adults in Table 6.7 (Hill 1972).
b. Ethnic origin also can contribute to differences in the significance of women in farm work.
c. Operations on the family farm can be sex-differentiated (see Table 6.9; Guissou 1977; Piault 1965).
d. Sometimes crop production is sex-differentiated. For example, Haswell (1953) observed that early millet and hungry rice were grown mainly by women in Gambia, while in Senegal women were responsible for cultivating swamp rice (Maymard 1974).
e. The structure and size of the family can have an influence on the amount of work women will contribute on the family farm (Milleville 1974; Guissou 1977).

Table 6.7. Level and composition of work on the family farm, northern Nigeria.

Variable		Sokoto	Zaria	Bauchi
Annual man-hours on the family farm[a]		1566	1800	1317
Source of farm work (% of total man-hours):				
Family:	Male adults	72.4	72.2	73.3
	Female adults	1.1	0.3	1.6
	Large children	8.5	8.9	9.4
Hired[b]:	Hourly	7.7 (3)	8.6 (4)	6.4 (5)
	Contract	3.0 (7)	9.1 (6)	4.5 (8)
	Communal	7.3 (1)	0.9 (1)	5.1 (1)

Source: Norman et al. (1979).
a. Female adult hour=1.0 man-hour and 1 hour by a large child (8-14 years old) = 0.50 man-hout.
b. Figures in parentheses are wage rates in kobo/man-hour.

27. Matlon (1977) found that high-income farmers hired more labor.

Several writers have stressed a certain flexibility in the role of women in farm work and also that changes are taking palace overtime. Guissou (1977), for example, indicates that the increasing popularity of nuclear families, which often increase the dependent/worker ratio, means that women often have to work more on farm work. Haswell (1975) has noted that the building of causeways into the river has encouraged women to switch from growing early millet and hungry rice to cultivating swamp rice which involves harder work in a less healthy environment. It has on occasion been suggested that women sometimes suffer when improved technology is introduced. An example was given earlier (Section 6.1) where women apparently were discriminated against in access to improved technology for the growing of groundnut. It has also been suggested that men have behfitted relatively more from animal traction than have women. The implications in terms of changed relationships within families as a result of introducing improved technologies need to be carefully analyzed.

In terms of time, hours put in by children on farm work can be significant (Echard 1964) (Tables 6.7 and 6.9). However, once again changes over time are influencing their contribution. For example, the possibilities of secular education are potentially decreasing their availability, while changes in the power base from hand labor to oxen

Table 6.8. Hours spent by an average family in work, Upper Volta.

Variable	Family							Non-family	Total
	Males			Females			Total		
	8-14 years	15-60 years	61+ years	8-14 years	15-60 years	61 + years			
Number of persons	0.6	1.7	0.2	0.5	2.0	0.2	5.2		
All tasks[a]:									
Hours	1073	3653	262	569	5238	350	11.145	246	11,391
Percentage of total	9.4	32.1	2.3	5.0	46.0	3.1	97.9	2.1	100
Agriculture : Hours									4,443
Percentage of all tasks									39.1

Source: Dalgado (1978).

a. The activities include work-hours for all activities except those of a purely social nature. Hours worked by individuals of different sex and wage wore not differentiated.

Table 6.9. Task differentiation by sex and age for Mossi and Bisa ethnic groups during the rainy season, Upper Volta.

Task expressed as a percentage of total hours[a]	Mossi			Bisa		
	Children	Male	Female	Children	Male	Female
Agricultural activities:						
Land preparation	6	49	43	11	35	52
Sowing	4	39	54	5	46	47
Weeding	5	52	40	10	48	40
Harvesting	5	45	47	8	38	50
Nonagricultural activities:						
Livestock work :						
Small	68	15	12	47	46	5
Large	14	71	14	26	64	8
Domestic :						
Fetching water	6	4	89	7	19	71
Meal preparation	0	0	98	4	1	92
Other domestic	11	0	73	24	3	70

Source : Delgado (1978).

a. The breakdown may not add up to 10Q% because of rounding errors. Hours by individuals of different sex and BOB were not differentiated.

may increase the productivity of their contribution (Monnier et al. 1974).[28]

6.2.1.3 ***Nonfamily labor.*** In general nonfamily labor on farms in the SAT of West Africa is part-time and rarely permanent. Although there are many types of arrangements under which nonfamily labor is obtained, there are four main classes: reciprocal) communal; contract paid by the task; and labor hired by the day (Kohler 1968; Monnier et al. 1974; Raynaut 1976; Ernst 1976).

Changes are, however, occurring over time. Two of the most important are the demise of group-organized labor with an increasing significance of individually hired labor, and voluntary or low-paid labor giving way to more formal remuneration systems (Raynaut 1973; Unite d'Evaluation 1976). Thus there is a decrease in the more traditional types of family labor as exemplified by the reciprocal and communal types. However, three factors appear to be ensuring the continued use of family labor, although on a diminished scale.

a. There continues to be in some areas vestiges of a concept of mutual responsibility in times of stress. Such a characteristic is likely to encourage slower breakdown of these types of nonfamily labor (Raynaut 1976).
b. These types of labor still exist in one form or another within families. For example, individuals will work on the common fields of the family on certain days (see Section 6.2.1.4).
c. Although there is an increase in contract and hired labor, this is usually remunerated with cash or in kind. As a result its use tends to be more common on cash crops (Raynaut 1976). Reciprocal labor, on the other hand, is often more commonly found in the growing of food crops which do not enter the market place (Unite d'Evaluation 1976).
d. Reciprocal and communal labor can still often be called by influential individuals within the village (e.g., the village head). A variant of the traditional labor types is the existence of age group (i.e., age-set) labor (Haswell 1975; Jones 1976; Ernst 1976; Kohler 1971). Table 6.10 shows that this type of group labor still exists. The figures indicate that more influential individuals command a larger proportion of such labor and at a lower rate of remuneration. In fact, farmers of the ex-slave caste were not able to obtain age-set labor consisting of men, but had to be content with groups of women to whom they had to pay a wage rate much higher than the estimated marginal product of cultivating groundnut in the area (Haswell 1975).

Why have the more traditional types of labor become less common? A major reason can once again be attributed to the general breakdown of the community through increasing contact with the outside world. Increased individualization, and a greater productive potential for labor hired on a contract or daily basis, have no doubt contributed to the increased significance of these types. According to the figures in Table 6.7, the most highly remunerated labor, when reduced to a per-hour basis, is that paid by contract. Remuneration for services rendered is often paid in kind but increasingly in cash.

Table 6.10. Levels of traditional male age-set labor used by class, Gambia.

Class of family	Average number of hours received per family in 1 year	Remuneration per hour in groundnut equivalents (kg)
Descendants of founder settlers	305	0.44
Immigrant settlers	244	0.52
Ex-slaves	155[a]	0.85

Source: Haswoll (1976).

a. Only 53 hours were contributed by male age-set labor, the remainder by the less popular fomale equivalent.

One interesting variation on the use of nonfamily labor in the region is the presence of seasonal migrants or stranger farmers (navetanes), found in the groundnut areas of Senegal and Gambia. They came traditionally in response to relatively high land/resident ratios and the resulting labor bottleneck that arises from the marked seasonality of agriculture. The complementary relationship between stranger farmers and local farmers in the villages has developed through the local farmers' cultivation of groundnut which is sold as a cash crop. The usual arrangement is for the stranger farmer to work for 3 or 4 days on the fields of the local farmer, in return for which he is allocated a piece of land on which he can grow his own groundnut and is also given food and lodging (Haswell 1975). The relationships between local farmers and stranger farmers are, however, changing over time. For example, due to decreasing food self-sufficiency (see Section 9.1), stranger farmers are sometimes requested to produce some food to be given to the local farmers' family from their own fields. Also, the increasingly monetized economy, together with increasing shortages of land, are encouraging cash rent to be paid by stranger farmers to local family heads. Under such arrangements, stranger farmers have decreased obligations for work on the local farmer's fields. As far as the stranger farmer is concerned, the system has permitted him some degree of economic independence. In fact, some of the stranger farmers are young people who migrate from their own villages to work in such a capacity for a period each year. Both Senegal and Gambia are in a fortunate situation in that groundnut is produced near the port of evacuation. In addition, products of various types are readily available for purchase with the income earned from marketing groundnut. For

28. Haswell (1975) has noted that one of the reasons for the demise of early millet In Gambia has been the decreased availability of children who scared birds from the fields near harvest time.

individuals coming from more isolated areas, this provides a considerable incentive. Also, for the local farmer's family accommodating the stranger farmer, the labor advantages are obvious.

6.2.1.4 ***Individual and common fields.*** A distinction between two types of fields was made earlier (Section 6.1): common fields where management is controlled by the family head, and individual fields on which control is exercised by other individuals residing in the family (e.g., men, including stranger farmers,.women, and children).

The family head provides from the common fields at least some of the food required to feed the individuals within the family. He has also traditionally been responsible for the taxes paid by the family. In return, various work obligations develop on the part of individuals in the family with reference to working in the common fields (Monnier et al. 1974; Venema 1978). A common obligation is for individuals to work 4 days of the week in the common fields and the remaining 3 days in their own fields, although this can vary by season, region, and ethnic group. The strength of this obligation varies according to the relationships within the family and, indeed, over time this appears to be diminishing. However, as mentioned earlier this relationship does have certain Implications. In the context of the present discussion one important implication is that, due to the marked seasonality of agriculture, the time when labor is required most on the common fields is also the period when the returns from working on the individual fields would be highest. As a result, conflict situations can and do develop. For one thing, as mentioned earlier, timing of operations on individuals' fields can be adversely affected, resulting in lower yields. There are few data available which permit comparison of total labor inputs on individual fields with inputs on common fields. On the bais of findings in Gambia (Table 10.8), it is anticipated that the common fields are likely to have higher inputs because of the obligations of individuals to the family head.

6.2.2 WORK BY OCCUPATION AND SEX

Work by individuals within families is devoted to three producton processes: crop enterprises, livestock enterprises, and off-farm employment. In addition an important time component, particularly in African societies, are social obligations, including ceremonial and religious activities. These are rarely recorded in studies undertaken in the region. Most of the available flow type data, indicating the allocation of time between various production processes in the region, come from Nigeria, although some scattered figures are available for other countries.

6.2.2.1 ***Male adults.*** Several studies have been made on the time devoted by family male adults to agriculture. Cleave (1974) indicates that on average a male adult contributes 1000 hours per year to agriculture. Reboul (1972) cites work done by Monnier that indicates on average a male adult spends 900-1200 hours per year on agricultural activities. Haswell (1975) and data from northern Nigeria (Table 6.11) give somewhat lower results.

Data on time devoted to all the processes are rarely available. Monnier et al. (1974) indicate that the male adult

Table 6.11. Time worked by family male adults, northern Nigeria.

Variable	Sokoto	Zaria	Bauchi
Days worked per year:			
Family farm	159	140	134
Off-farm : In village	78	89	97
Outside village	35	-	-
Total	273	229	231
Hours worked :			
Hours per day worked :			
Farm[a]	5.8 (5.0)	5.1 (4.4)	5.6 (4.7)
Off-farm	4.8	5.1	4.2
Total hours worked	1484	1166	1159
Distribution of time worked in days[b]:			
20% worked less than	196 (670)	154 (687)	159(671)
20% worked more than	340 (1607)	319 (1544)	334(1468)

Source: Norman et al. (1979).

a. Figures in parentheses exclude time spent walking to and from fields.

b. Figures in parentheses are hours.

works about 1250 hours per year, while Haswell (1953) indicates that the number of days worked per year by each male adult is between 193 and 201 days. The figures in Table 6.11 indicate that in northern Nigeria a male adult worked about 1270 hours per year, which included time to walk to and from fields. This labor was spread over a period of 244 days with an average length of working day of about 5.2 hours. These results are similar to other figures from West Africa (Luning 1965; Kohlhatkar 1965; Mann 1967; Guillard 1958). The amount of work undertaken by male adults can simplistically be considered as a function of a number of factors, including the following.

a. The ability to work, which is a function of health and nutritional level (Section 13.2).
b. Incentives to undertake work, which are a function of subsistence needs and a desire for income over and above that required for subsistence.
c. Opportunities for work, which can be either farm or off-farm in composition and will depend to a great extent on factors such as location, climate (Including its seasonality), resource base, etc.

All the above factors can contribute to the apparent underemployment of male adults. An employee in temperate areas rarely works more than 240 days a year. However, a difference exists in the length of the working day. It appears that a male adult in the SAT of West Africa works only 60% of the hours considered normal for an average employee in temperate climates. However, when consideration is given to the factors mentioned above, there may in fact not be a very serious degree of underemployment. This is most likely to be the case when one considers the time involved in ceremonial or social obligations, which do not usually appear in the figures collected.

What does appear to be very important is the significance of off-farm work. While data and labor flows on this process are seldom collected, the off-farm commitment in terms of time does have a number of important implications for male adults living in the semi-arid region. Three of these are as follows.

a. Off-farm employment opportunities do influence the opportunity cost of labor. Alternative uses of labor must be taken into account in designing relevant technological packages.
b. Related to (a) is the problem that off-farm employment offers opportunities for employment throughout the year, but, at the same time, because of the seasonal labor demand in agriculture, it may succeed in aggravating labor peaks (Section 6.3.2).
c. Time spent in off-farm employment can provide important supplementary sources of income. Matlon (1977) in northern Nigeria found that 28% of an average farmer's income was derived from off-farm sources. Such a source of income can be particularly important for farmers with low food reserves during the growing season (see Section 13.2).

6.2.2.2 ***Female adults.*** As noted above, regional differences make it impossible to generalize about work done by women in agriculture. However, figures that have been given where women contribute substantially to farm work vary from 460—600 hours/year (Monnier in Reboul 1972) to 1034 hours/year (Haswell 1953). Few figures are available on time allocated to household tasks. Cleave (1974) suggests about 2 hours/day, while Monnier and Talibart (1971) recorded as much as 5 hours/day. If this latter figure is used as a base for calculation, together with the figure collected by Monnier for farm work, it appears that women work 2000 hours/year. In addition, such time, unlike the results given in Table 6.8, is not likely to include other off-farm tasks which can be significant sources of income (Simmons 1976).

An increased understanding of the role and contribution of women In different cultures and areas is important in assessing the impact and potentials of improved technological packages. As mentioned earlier (Section 6.2.1.2), it has been suggested that many of the improvements in rural technology have helped men in their occupations while depriving women of remunerative occupations they may have had earlier. In addition, women's work often has not been mechanized (Chambers and Longhurst 1978).

6.2.2.3 ***Farm work and the dependent/worker ratio.*** Levi and Bellamy (1975) discuss evidence for the so-called Chayanov's rule (Sahlins 1974). This rule suggests that people work harder as the ratio of dependents or consumers per worker increases. They cite evidence from northern Cameroon (Guillard 1958) and Gambia (Haswell 1953). In addition, studies done in northern Nigeria (Norman 1972) indicated that the number of days worked per male adult on the family farm was significantly negatively related to the number of male adults in the family. Other indirect evidence for such a relationship has been given by Raynaut (1976), who found that the production of cereals per *actif* decreased with an increasing number of *actifs* within the family (Table 6.12). Finally, Monnier and Talibart (1971) found that women worked less time when there was more than one wife in the family.

The implications from the above observations are important. It was stated earlier that the breakup of the family structure from complex to nuclear family units was

Table 6.12. Relationship between number of actifs and cereal production of the family. Niger.

Variable (for 1-year period)	Number of *actifs* per family 2	3	4	5-7
Average cereal production (kg) per:				
Family	1137	1466	1695	2705
Actif	569	488	423	450
% of total cereal production derived from common fields	70	64	64	57

Source: Raynaut (1976).

resulting in an increase in the dependent/worker ratio. This implies that, as a result, individuals who work on the farm are likely to work more time on agricultural activities than they would if the family structure had not been changed. Evidence is given elsewhere for northern Nigeria (Norman et al. 1979) that this is in fact the case.

6.3 Seasonality

6.3.1 SIGNIFICANCE

Although the annual total work by family members and particularly male adults often appers to be rather low, one must in evaluating it consider the overriding significance of the seasonality of agriculture (Monnieret al. 1974). The coefficient of variation for monthly inputs for the family farm increases as one moves north (Norman et al. 1979). This relates to the increasing seasonality in rainfed agriculture with a concomitant decrease in precipitation as one moves north through the region (Section 1.1). The seasonality of agriculture contributes to two further problems: agricultural labor bottlenecks during the rainy season and underemployment of labor during the dry season.

The allocation of time worked by family members in each of the three processes (i.e., crops, livestock, and off-farm enterprises) is undertaken in such a way as to attempt to even out the annual flow of labor. For example off-farm work is emphasized during the dry season, and is substantially reduced during the rainy season (Matlon 1977) (Table6.13; Figs. 6.1 and 6.2, d). Nevertheless, for a number of reasons farmers are not able to even out the total work each month (Norman et al. 1979) (Figs. 6.2, d, and 6.3), although obligatory social activities can account for a lot of so-called spare time during the dry season (Lowe in Dunsmore et al. 1976) (Fig. 6.1). Efforts to increase the productive use of labor during the dry season also involve cultivating the limited amounts of lowland through using residual moisture or irrigation (Lahuec 1970; Eskelien 1977), and going on short-season migration (Faulkingham 1977; Goddard et al. 1971a) (Fig. 6.2, e), etc.

6.3.2 BOTTLENECKS DURING THE RAINY SEASON

6.3.2.1 *Identification.* Most studies conclude that the seasonal labor bottlenecks are one of the major constraints in rainfed agriculture in the SAT of West Africa. While a number of seasonal labor bottlenecks have been identified in different studies (Wilde 1967) there are complex problems of identification. For example, the appar-

Table 6.13. Indicators of seasonality of work, northern Nigeria.

Variable	Sokoto	Zaria	Bauchi
Precipitation (mm/yr) [a]	752 (137)	1115 (115)	1102 (127)
1 . Busy period :			
a. Four busiest months :			
Name	June-Sept	May-Aug	June-Sept
% of annual man-hours on farm	57	50	53
b. Peak month :			
Name	July	June	July
Man-hours worked on farm[b]	258 (21)	256 (19)	210 (12)
Days worked per family male adult:			
Farm[c]	20 (6.1)	17 (5.0)	19 (5.3)
Off-farm	7	7	7
Total	27	24	26
2. Slack period :			
a. Four slackest months :			
Name	Dec-Mar	Jan-Apr	Dec-Mar
% of annual man-hours of farm	13	16	10
b. Slackest month :			
Name	Jan	Mar	Feb
Man-hours worked on farm [b]	32 '8)	35 (19)	17 (0)
Days worked per family male adult:			
Farm[c]	6 (3.5)	4 (2.7)	3 (4.2)
Off-farm	13	9	9
Total	19	13	12

Source: Norman et al. (1979).

a. Figures in parantheses represent the coefficient of variation in monthly precipitation.
b. Figures in parentheses are the *percentage of* the man-hours that were nonfamily.
c. Figures in parentheses represent the number of hours/day worked by male adults on farm activities

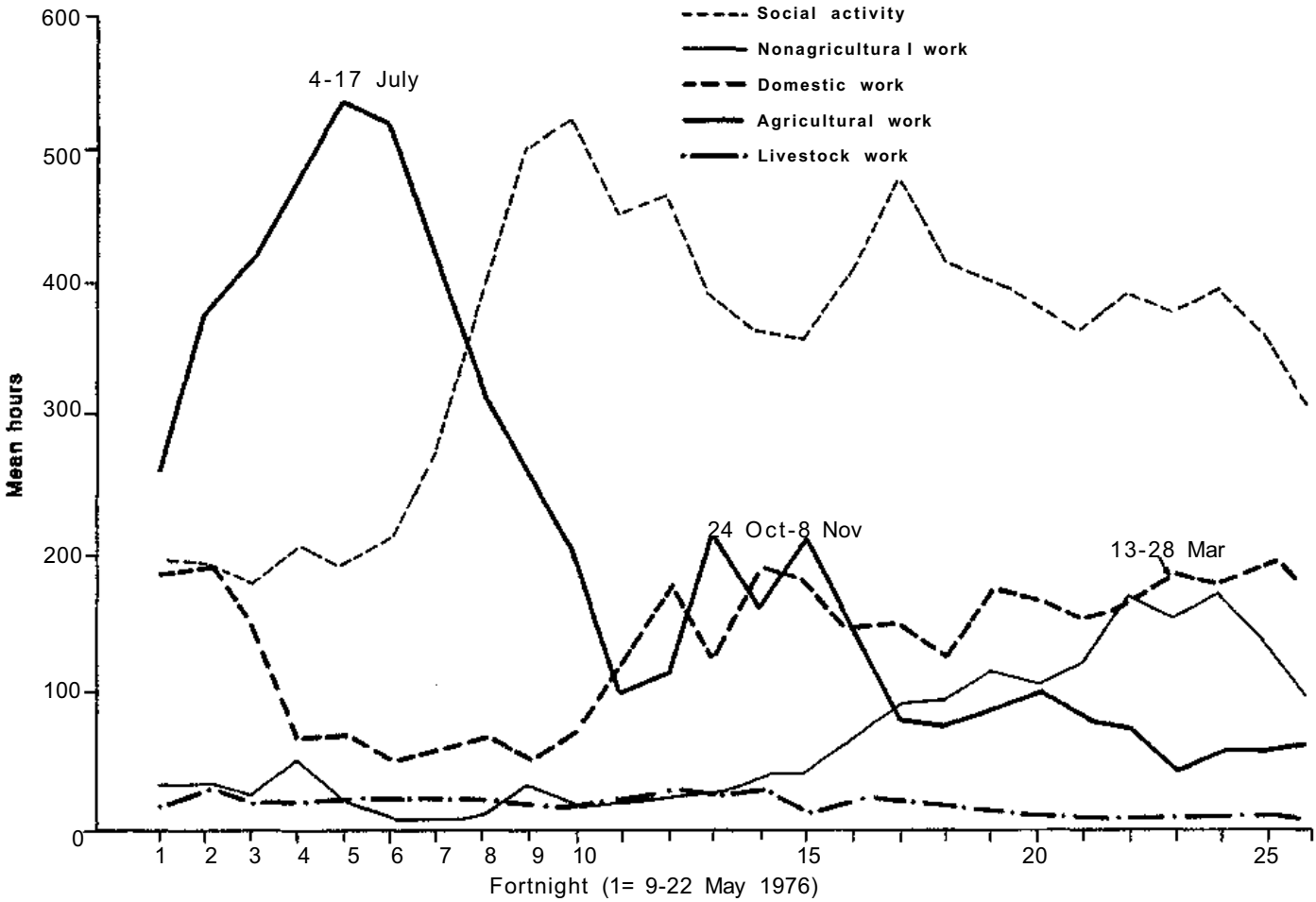


Figure 6.1. Mean total household labor hours each fortnight by category of work, Upper Volta.

ent severity of a bottleneck will to some extent be a function of the aggregation period that is used (e.g., week or month) in data collections. The length of growing season could be important in the sense that, the shorter it is, the more peaked will be the labor activity. Ruthenberg (1971) has suggested that the move from shifting cultivation to semipermanent and permanent cultivation systems as population density increases may, in fact, accentuate the seasonal bottleneck problems in SAT areas. One reason for this is that the movement away from shifting cultivation means much less time is spent on clearing land, being work that can be done in the dry season. Also, with the increasing dominance of semipermanent cultivation systems, increased labor inputs are required during the rainy season, in operations such as weeding, to ensure that reasonable yields are obtained per unit of area. Other factors influencing the types of seasonal labor bottlenecks that will emerge will depend upon the type of technology involved and the power source.

At the risk of oversimplification, the following generalizations are possible concerning seasonal bottlenecks,

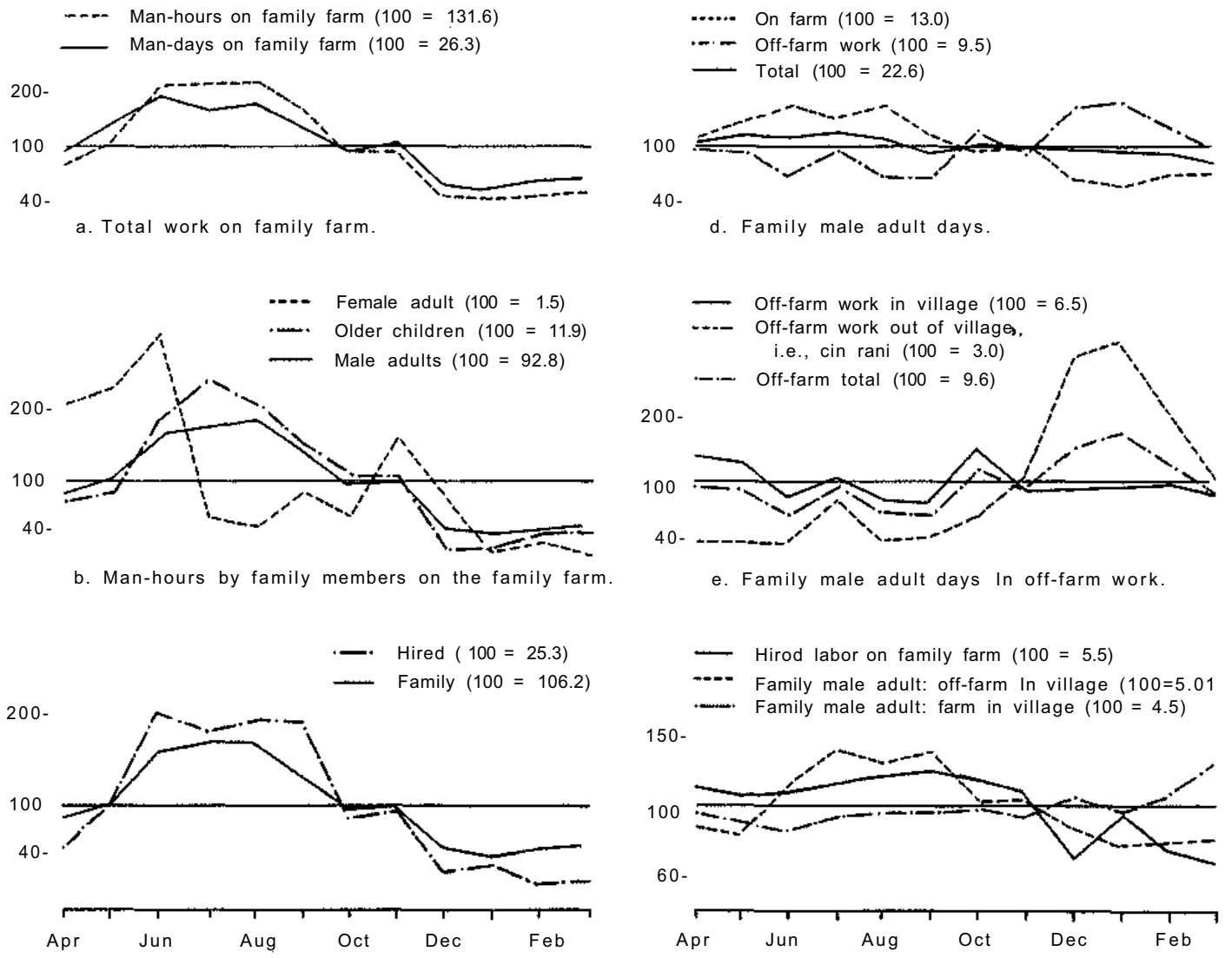
a. With only hand labor and indigenous technology, the time and amount of weeding is often considered to be most limiting (Matlon 1977; R.E. Ford, personal communication; Norman et al. 1979) (Fig. 6.4). The weeding bottleneck can be accentuated if the rains are particularly good (Unite d'Evaluation 1978). Land preparation and planting are also sometimes stated to be bottlenecks. This is particularly the case when timing is important. Timing becomes significant as one moves north and the growing season becomes shorter (Unite d'Evaluation 1978).
b. The introduction of improved land-intensive technology, seed, and fertilizer—without changing the power source—shifts the bottleneck period to harvesting the increased yield (Norman et al. 1974) (Fig. 6.5). However, care should be taken in interpreting this, since timing is a particularly critical factor in the weeding operation (Haswell 1953; Matlon and Newman 1978) and, therefore, analysis of the labor flow data in aggregation periods of less than 1 month would probably enchance the weeding labor bottleneck period vis-a-vis harvesting. Also, for certain crops one can argue that harvesting is really not a serious bottleneck because the rains are over and damage to crops in the field Is less.[29]

29. However, maize can be attacked by rodents while birds may attack cereal crops.

c. A change of the power source from hand to animals, using indigenous technology apart from ridging equipment, only accentuates the weeding bottleneck. Larger areas of land are often prepared which, because of inadequate weeding equipment, have to be weeded mainly by hand (Tiffen 1971; Jones 1976). Also, the harvesting bottleneck under certain conditions may be somewhat more accentuated because land preparation and, hence, planting operations are carried out more quickly and efficiently (Fig. 6.4).

d. A combination of animal power with ridging, planting, and weeding equipment, together with improved land-intensive technology, tends to accentuate the harvesting bottleneck even further (J. Faye, personal communication), although this can be eased somewhat with the use of a cart for evacuating the harvest from the field (Fig. 6.6) .[30]

Coene (1970) discusses elements of (c) and (d) above in some detail. He notes that with animal power the time required to plant was reduced from 90 to 12 hours/ha. Thus, use of animal power enables planting to be undertaken in a more timely manner and, if it is possible to handle the weeding problem, it enables yields to be raised. For example, one rule of thumb suggests that 1 day earlier in planting increased the yields of groundnut by 1 % However, many farmers expand the area of land cultivated as a result of better timeliness in planting, therefore creating a new bottleneck in weeding. The use of weeding

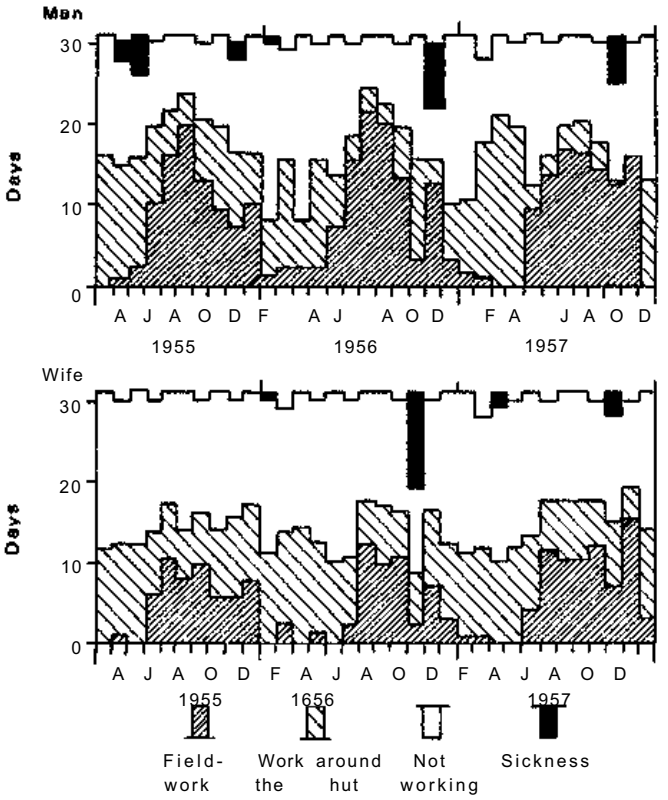


Source: Norman et al. (1979).

Figure 6.2. Seasonal Indices of labor lor the Sokoto area, northern Nigeria.

30. The data used in constructing this figure do not clarify this issue satisfactorily. The reason is that the crops were evacuated both by headload and by cart.

equipment, on the other hand, permitted a reduction of weeding time per hectare from 7 days by hand to only 1 day with animal power.



Source: Guillard |1965|.

Figure 6.3. Seasonal distribution of work, northern Cameroon.

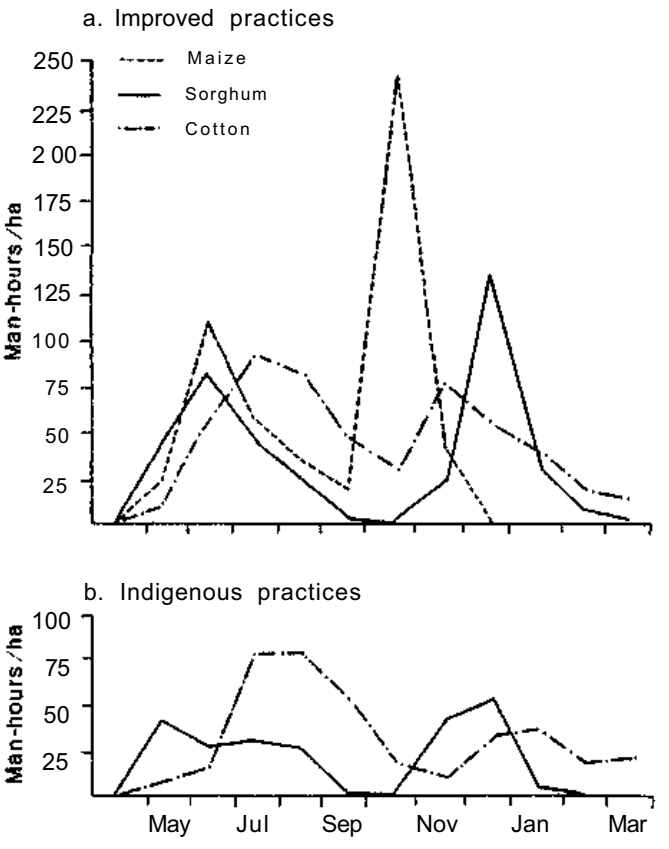
Source: Norman et al. (1979).

Figure 6.4. Seasonality In time worked on the family farm by power source, using mainly traditional practices, northern Nigeria.

6.3.2.2 ***Overcoming seasonal bottlenecks-traditional methods.*** Farmers have traditionally used a number of strategies to ameliorate the adverse effects of seasonal bottlenecks in rainfed agriculture. These are: working more hours per day on the family farm during bottleneck periods; working more days on the family farm during bottleneck periods; obtaining the services of non-family labor; growing crops in mixtures; and planting cash crops after food crops are well established. Each of these is discussed in more detail below.

Several studies give evidence that individuals work more hours per day on the farm during bottleneck periods (Jones 1970) (Table 6.13 and Figs. 6.2, a, and 6.2, f).[31] Figures indicate that the variation can be very great. For example, Delgado (1978) indicates that male adults work up to 10 hours/day during the peak period compared with only 4 hours/day during slack times. Nevertheless, although some adjustment to the labor bottleneck periods is possible through this method, there are some limitations to its effectiveness. Two of these are as follows,

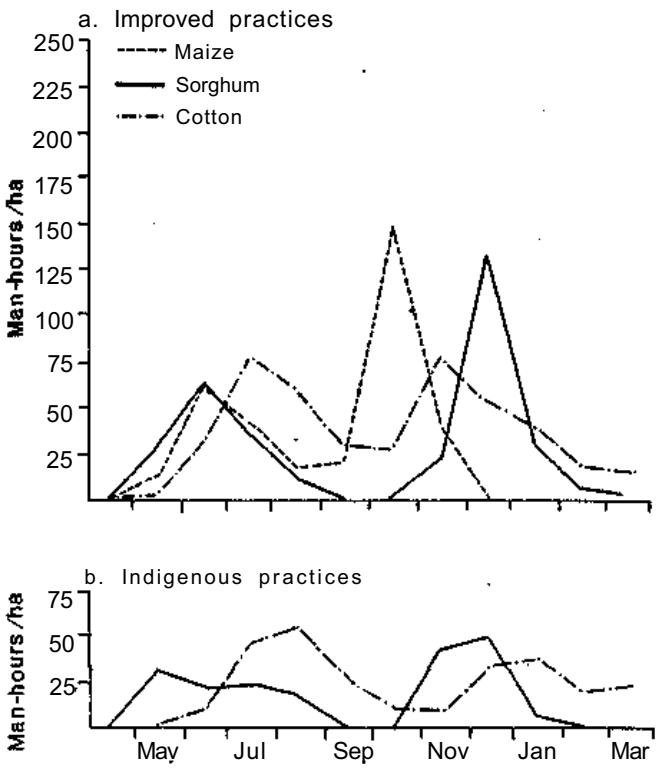
a. The peak period for activity on rainfed agriculture



Source: Norman et al, (1979).

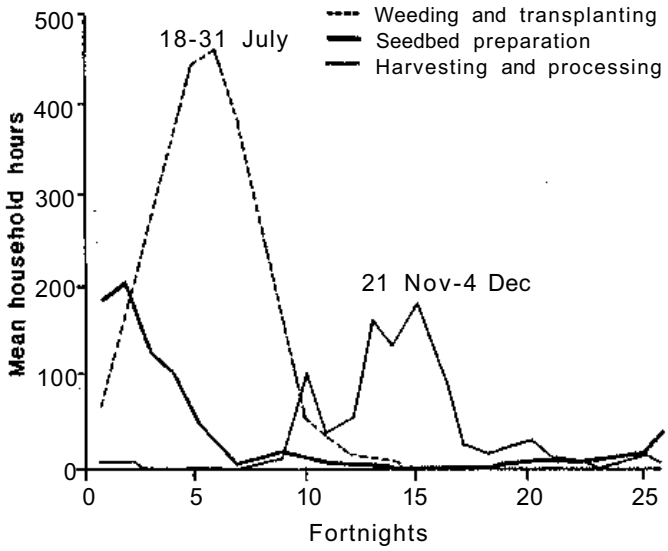
Figure 6.5. Seasonal labor requirements of specific crops using hand labor, northern Nigeria.

31. Unfortunately, labor flow data that are collected by the day or half-day cannot reflect this adjustment to the seasonal bottleneck period (Guillard, 1965; Hopkins 1975; Lowe In Dunsmore et al. 1976; Unite d'Evaluation 1978).



Source: Norman et al. (1979).

Figure 6.6. Seasonal labor requirements of specific crops using oxen, northern Nigeria.



Source: Delgado (1978).

Figure 6.7. Mean household hours allocated to each major agricultural operation, by fortnight, Upper Volta.

Table 6.14. Time spent resting in the field, Gambia.

Crop	Operation	% of time resting
Late millet	Weeding	17
	Harvesting:	
	flattening stems	10
	cutting heads	9
Hungry rice	Planting	11
Groundnut	Brushing	18
	Planting and ridging	16
	Weeding	21
	Lifting	30
	Windrowing	39
	Stacking	4
	Threshing	33
Upland rice	Hoeing:	
	preplanting cultivation	42
	weeding and thinning	29

Source: Haswell (1953).

coincides with the hungry season and related health problems (Haswell 1975) (Section 13.2).

The length of time worked is not necessarily an indication of productivity. One would expect that the length of time worked would be inversely related to the arduousness and character (e.g., monotony and degree of discomfort) of the task (Levi and Bellamy 1975). However, Haswell (1953) maintains that the time worked on different operations was more a function of the urgency of the task. She is one of the few researchers who have attempted to measure the time actually spent resting while undertaking different tasks (Table 6.14). Time spent resting is likely to be a function of the urgency of the task, its arduousness, and its character. Such resting time detracts from productivity per unit of time and provides a likely reason for arguing that the two interpretations of length of time worked given above are not necessarily incompatible. The picture is further complicated by the fact that the composition of tasks on the farm varies significantly during the year (Fig. 6.7).[32]

Another way that families have adjusted to the seasonal bottleneck periods has been by working more days on the farm during such periods (Jones 1970) (Table6.13; Figs. 6.2, a, 6.2,d, and 6.3). Such adjustments are possible through using otherwise slack time or giving up other occupations that could be pursued during such periods. With reference to slack time, people do indeed work more days on the farm. Monnier and Talibart (1971), for exam-

32. Farrington (1975) has, however, advanced an explanation that Is Incompatible with the above. He has suggested that farmers work longer days when the tasks are less physically demanding and that they are relatively Insensitive to the urgency of the task. He then goes on to argue that it might be difficult to induce farmers to increase the labor input significantly in order to adopt new production technology. We do not find that the empirical evidence available from the SAT of West Africa supports such an argument.

ple, indicate that children work up to 930 hours during the 3-month period between August and October. In terms of giving up other occupations, there is some adjustment that often takes place (e.g., Figs. 6.2,d, and 6.2,e). However, there are a number of factors that may limit such a substitution. Two of these are as follows.

a. Some off-farm occupations require a year-round commitment to ensure continuity. In the case of livestock, superivision is required throughout the year. Delgado (1978), in fact, notes that livestock require closer supervision during the rainy season because of the presence of crops in the fields (see Section 11.1). Also, other occupations derive considerable value from regular clientele (e.g., blacksmiths, butchers, some traders, etc.) (Norman et al. 1979).
b. Urgent financial needs of families can cause farmers to devote time to other occupations during the bottleneck periods. Many researchers have stressed the need for working in other occupations during the hungry season in order to provide funds for food purchases until harvest (Section 13.2). Other ways in which families' attention can be diverted away from their own fields during the bottleneck period can result from social or exploitive obligations of various kinds. For example, relationships appear to be emerging between families owning draft animals, and those that do not, in which services provided in the form of plowing at the beginning of the year are repaid through labor during the bottleneck periods (Jones 1976; Ernst 1976) (Section 11.2). Watts (1978) gives another example showing that the limited amounts of lowland that can be cultivated during the dry season result in a premium being placed on their use. Consequently, families renting such land are often compelled to pay for the rent in the form of labor contributed at the labor bottleneck periods on the landlord's fields.

Another obvious way to overcome the labor bottleneck period is to obtain the services of nonfamily labor (Kohler 1971; Lewis 1978) (Fig. 6.2, c; Table 6.13). Although there is indeed evidence that nonfamily labor increases during bottleneck periods, it is often not as great as would be anticipated. One possible reason for this is that there is as yet no landless laboring class in most parts of the region and, therefore, the time when the demand is most high for the labor is also the time when families are most busy on their own farms. Also the period of peak agricultural activity appears as the time when cash resources *are* at their lowest ebb (see Section 8.2), therefore inhibiting the ability to hire labor. However, care should be taken in interpreting these statements. When the use of hired labor is examined from a distributional point of view, some significant differences emerge. Differences in social and economic position do enable the more advantaged groups to obtain labor during the critical periods. For example, the more influential can commandeer age-set labor and at relatively low rates (Section 6.2.1; Table 6.10).The influence of the hungry season, limited resource availability, and possession of certain types of technology can create dependency relationships between different groups within the society that can result in the more advantaged groups being able to demand nonfamily labor during critical bottleneck periods.

Other ways that are used by farmers In order to overcome the labor bottleneck periods are by growing crops in mixtures (see Section 10.3) and planting cash crops after food crops are well established (Jones 1976). It has been suggested that this latter strategy has been one of the major factors for farmers not planting cotton according to the practices officially recommended in northern Nigeria (Norman et al. 1974).

Imperfections in the labor market appear to be the norm. It is not surprising that often there is no substantial monthly variation in wage rates (Norman 1972), although there is obviously a great deal of variation in the marginal productivity of labor. For example, in northern Nigeria the marginal productivity of labor at critical bottleneck periods was found to be up to 4 times higher than the wage rate (Norman 1970).

6.3.2.3 ***Overcoming seasonal bottlenecks-Improved technology.*** The preceding sections indicate the significance of seasonality in rainfed agriculture. Not only does it constrain increases in agricultural production but also, in theory, it can potentially increase the inequalities that exist between families within villages.

The implications for the development of improved technolgy are important. In order for such technology to be relevant, it must take cognizance of the timing of the labor required for its adoption. Too often the technological development aim of maximizing yields per unit area, or of increasing the area cultivated, has resulted in the development of irrelevant improved technology which, if adopted, could result in even greater seasonal bottlenecks (Kafando 1972; Lewis 1978). In fact its adoption could conceivably accentuate the inequalities mentioned above.

The type of technology that would be relevant in many parts of the SAT of West Africa, where there are relatively high land/resident ratios and a marked seasonality in agriculture, would be those that would be labor-augmenting in character. In principle such types of improved technology ameliorate the adverse affects of the seasonal labor bottleneck periods. Two types of improved technology could conceivably fit this criterion. These are as follows.

a. Directly by supplanting hand labor with some type of mechanization (e.g., tractors, oxen plus equipment) or through the use of chemical technology (e.g., herbicides).
b. Indirectly through the use of biological-chemical technologies (e.g., improved seed, inorganic fertilizer, insecticides, etc.).

In practice, mechanization and the use of herbicides have been considered the main ways of overcoming bottleneck periods. However, as discused below, animal traction has not often addressed the specific labor bottlenecks faced by farmers in cases where it has been introduced (Section 11.2). With reference to herbicides, little practical application is found in the region apart from limited areas where cash crops are clearly dominant, e.g.,

groundnut in Senegal (Charreau 1978). Of course, one of the major problems in using herbicides is their crop specificity that inhibits their application in the crop mixtures which are common throughout the regon (Section 10.3). In addition, the value of herbicides could be debated in areas where the rainy season is *very* short and soils are low in organic matter. It is traditional in some such areas to collect weeds in mounds to provide the location on which crops the following year will be planted. Thus, the Introduction of herbicides in such areas may result in a short-run benefit that has a long-run cost due to ever-decreasing levels of organic matter in the soil.

Little effort has been made to ensure that biological-chemical technologies indirectly improve the productivity of labor. Such technologies are generally considered to be land-intensive in nature, and the possible ramifications in terms of labor distributions required for their adoption are usually ignored. This has been particularly unfortunate. A failure to consider the ramifications in terms of labor requirements has contributed to the non-adoption of some land-intensive, improved technologies such as those used in the growing of cotton in northern Nigeria. In order to avoid such failures it is necessary to examine the compatibility of improved technologies with the whole farming system. In doing so it also needs to be recognized that overcoming old labor bottlenecks may result in the creation of new ones.

6.3.3 UNDEREMPLOYMENT IN THE DRY SEASON

As discussed in earlier sections there is in general an inverse relationship between monthly inputs on the family farm and off-farm employment. This relationship suggests that off-farm work is a way of using labor that has a low opportunity cost. It was shown that there is considerable underemployment of labor in the dry season, although social obligations can take up a lot of the slack time. The composition of employment and the degree to which farm families are employed during the dry season varies considerably from one location to another. Availability of limited amounts of lowland, which permit cultivation during the dry season, can provide important employment opportunities, while low availability of local opportunities for employment often result in short-season migration to other areas in search of work (Norman et al. 1979) (Section 12.3).

It should be recognized that technology which utilizes labor during the slack season (e.g., capital improvements to land, irrigation, longer harvest periods for high-yielding technologies, etc.) must be considered in relation to the opportunity cost of labor in off-farm activities (Byerlee 1979). Byerlee (1979) cites Skinner's speculation that the failure to introduce cotton in the Mossi region of Upper Volta was due to the conflict of cotton harvesting with the time for seasonal migration in December.

7
Land

7.1 Land Tenure

In the SAT of West Africa individuals generally have only usufructuary rights to land. Actual ownership is usually vested in the government but controlled at the local level by its representative (i.e., the village head). The usufructuary rights to land can be inherited. Customary law, which predates the introduction of Islam, through large parts of the region, involved a patrilocal inheritance system in which all the land under the control of the deceased family head is inherited by his oldest brother or son. However, with the increasing dominance of Islam, the Islamic or Maliki law is increasingly followed. Under Maliki law, land is divided among all of the sons.

The concept of usufructuary rights is different from the view of land held in developed countries. It has been suggested that this system inhibits development by not encouraging the making of improvements to the land. However, others have argued that this system of usufructuary rights has prevented the big inequalities in land distribution that have developed in other areas of the world. It seems that this debate is just one example of a characteristic that traditionally has been of benefit to the society, but which is not easily transformed into a concept compatible with the individualistic bias implicit in encouraging progress, as visualized in developed countries.

However, the distinction between land as viewed in the region and, differently, in developed countries goes far beyond the question of usufructuary right. Lowe (in Dunsmore et al. 1976) provides a useful discussion of the concept of land as viewed in West African societies.

Lowe starts by saying that land in the region cannot be examined within the familiar economic framework used by economists in developed countries. In such countries the current use of land (e.g., the size of farm), and factor proportions, are determined to a great extent by relative factor prices which change in response to changing technology. In developed countries an increase in labor costs, for example, will result in increasing the amounts of land and capital per labor unit. Land tenure, therefore, in this type of society can be seen as an instrumental variable to be manipulated as part of government policy to achieve target goals. Lowe goes on to emphasize that land tenure in Africa cannot be regarded solely as a production variable but as an extremely significant element in social structure, servicing multiple functional aims and objectives. It is a tangible dimension of the community and has what Polanyi (1964) called a territorial character of the community. Polanyi (1964) also sees it as that part of nature that is interwoven with man's political institutions. Uchendu (1967) identifies two further points relevant to any dicussion of land tenure: the religious dimension in which community land is entrusted to a vast family of which may are dead, few are living, and countless numbers are yet unborn (Elias 1962), and in which, also, traditional security of tenure is given to users even when some of them are absent for long periods (Elkan 1960).

Therefore, as Lowe (in Dunsmore et al. 1976) stresses, land provides community stability and continuity, and it becomes more significant rather than less in a period of rapid social and economic change. The role of land is extremely important in African development. Economic, social, religious, political, and historic variables help to provide the legal definition of the status of land in society and this, in turn, determines the complex pattern of usage, mobility—or lack of it—and value—if any—of land in these societies. Therefore, the legal framework of land tenure is often the codification of customary rights and values, with operational control developed down to the small community that has the right in law of allocation, dispossession, and arbitration on all land within its jurisdiction. The process by which these rights and relationships evolve or are changed over time can be expected to have significant impacts upon the path of development in the region.

The low population density that existed traditionally in much of the region, combined with indigenous technologies that were neutral to scale, prevented potential abuses in terms of land distribution. However, as we discuss in the next section, relationships may be changing in terms of land distribution, holding important implications for future development.

7.2 Farm Size

Many studies provide information on farm sizes and the area cultivated per family (Tables 6.1 to 6.5). In addition Monnier et al. (1974), working in Senegal, found the average area cultivated was 12-15 ha, while Reboul (1972) reported a median area cultivated of 7 ha in the same country. Average figures for size of farm derived in various parts of northern Nigeria amounted to about 4 ha (Norman et al. 1979), while Lowe (in Dunsmore etal. 1976) derived a figure in Gambia of just under 8 ha, of which 84% was cultivated.

The above information indicates it is impossible to make generalizations about the average farm size In the region. There is evidence that in a previous traditional setting, which was characterized by a low population density and the *use* of indigenous technology including a land-labor power source, the area cultivated was highly

correlated with the labor available and the quality of the land (Kohler 1968, 1971). However, generalizations become more difficult when one moves closer to the present time. Increasing contact with the outside world, resulting In increased Individualization, rising population densities, and the introduction of improved technology complicate the picture. The figures cited indicate that the average-sized farm varies between 3 and 15 ha, with larger farms utilizing oxen or other forms of animal traction (Table 6.3), and having larger families which are organized as complex family units (Table 6.1 and 6.2).

Rising population density becomes a critical issue when related to the land resource and other changes that are taking place. Some of these changes and their implications are as follows.

a. Farm sizes are decreasing (Wilde 1967; Haswell 1975) with the result that the short-run private opportunity cost of leaving land fallow is increasing (Norman 1972).[33] Although the figures in Table 7.1 indicate that the usufructuary rights to land are mainly inherited, there is evidence that, as population density increases, other types of land tenure, such as renting, pledging, leasing, and purchasing of the land (Raynaut 1976; Goddard 1972), become more common.34 This change in the land tenure arrangements is obviously a response to its increasing scarcity, which in turn raises the issue of soil fertility (Section 10.1). Changes in the tenure relationships may be exacerbating the problem of deterioration in soil fertility. Luning (1963) observes that in northern Nigeria people renting land were discouraged from applying organic fertilizer. Apparently such applications gave rise to the Implication that the rentee intended to hold onto the control of the land. Cases were reported where land was recalled by the landlord because of such fears. Hopkins (1975) in Senegal indicates that land is rarely rented for more than 1 year at a time, therefore encouraging its exploitation.

b. Distributional problems with respect to land may be becoming an Increasing problem. Because of reasons mentioned earlier (i.e., the landlords, the low population pressures, the use of indigenous technology neutral to scale), land has been until recently fairly evenly distributed. One caveat is, however, necessary at this point. A number of researchers have indicated that, although this even distribution is true in traditional societies in terms of quantity of land, there is, in some instances, a difference in the distribution of quality of land. Earlier settlers in the villages were able to establish rights of production on the better-quality land (Haswell 1975; Swanson 1978). Although statistics giving trends over time are not generally available, there is fragmentary evidence that inequalities in terms of land distribution might be growing.[35] Increased population pressures have on occasion encouraged influential groups in villages to increase their relative share of the land cultivated (Swanson 1978; J.P. DuBois 1975). Such moves have been encouraged by the overall shortage of land and/or by the introduction of certain types of improved technology. Norman et al. (1979) have suggested that in fairly traditional situations, where population density is high, there may in fact not be an increase in inequality of land distribution. If change is in fact taking place, there is a trend towards greater quality in terms of the land being used. This arises for reasons mentioned under (a) above—that is, those farmers with surplus land loaning it to other farmers who are short of land. However, it is likely that such a situation will change very rapidly with the introduction of improved technology and the increased monetization of the economy. Agbonifo and Cohen (1976) give an example in northern Nigeria where the limited amounts of lowland suitable for dry-season tomato production were on occasion commandeered by influential groups within the village.[36] The dry season tomato production technology happens to be very profitble. Weil (1970) cites an example in Gambia where the introduction of oxen resulted in "landlords" demanding the return of land that they had previously rented to other families in the village. These two examples are indicative of the potential for developing inequalities in the distribution of land when Improved technology requires a resource limited in availability

Table 7.1. Land tenure, Niger.

Tenure	Soumarana	Ader-Doutchi
Percentage of fields:		
Inherited	87	76
Gift	1	-
Purchased	1	13
Pledged	5	-
Rented	6	11

Sources: Raynaut (1976); Echard (1964).

33. Farm sizes are obviously decreasing also because of the decrease in family size (see Section 6.1).

34. It should be noted that at least under the strict terms of the law only the usufructuary rights are being purchased, rented, etc. The law also fails to recognize the trend towards Individualization of land tenure which is occurring in some areas (Steedman et al. 1976; Kohler, 1968).

35. Inequalities in the sense discussed here are meant to imply Increasing differentiation in terms of both quantity and quality of land.

36. Lahuec (1970) observed In Upper Volta that control over Irrigated land is becoming a causal factor in determining increased socioeconomic differentiation at the village level.

(e.g., lowland) or has the potential for encourging economies of scale (e.g., oxen). However, in the absence of high population densities, the technology by itself would probably not have resulted in inequalities of land distribution. One characteristic that could result in increased inequalities of land use, even in the absence of increased population density, is the increasing monetization of the economy and the resulting possibilities of exploitive relationships developing between families in villages.[37]

The use of improved technology by some families within a village can aggravate this prolem. Such trends have serious implications for the future. Increased distributional inequalities in the quantity and quality of the land resource base accentuates unequal income distribution, that in turn increases the potential for the development of exploitive relationships, especially where there is increasing breakdown of community and familial solidarity,

c. The land inheritance laws existing in the region are resulting in progressive fragmentation of the fields (Fig. 7.1). The process of fragmentation is accelerated in areas where the Maliki law rather than the customary law dominates (Lowe in Dunsmore et at. 1976), and where the family structure is breaking up. Fragmentation of land is usually considered to be disadvantageous. However, it has a number of advantages in traditional agriculture. These revolve around the notion of greater equality: for example, in the distribution of land of different soil types; in minimizing the effect of microvariations in precipitation, particularly at the beginning and the end of the rainy season (Adeoye 1976); minimizing the inconvenience of field locations where families live in nucleated settlements; etc. Of course, the major disadvantage in the traditional agriculture setting is that, with excessive fragmentation, a disproportionate amount of time is spent in walking between the residence and scattered fields.[38] However, Goddard (1972) found, in more densely populated areas where excessive fragmentation is becoming a problem, that larger farmers were spontaneously consolidating fields through such land transactions as exchange, sale, or purchase. Fragmentation of fields has usually been viewed by development agencies as inhibiting the development of agriculture. Certainly this is true with certain types of improved technology. Land improvement and conservation measures may be difficult to implement because of the need for cooperation among neighbors, and the existence of small fields may prevent the introduction of mechanization. This in turn has led to attempts, in various programs in the region, to encourage field consolidation. Jones (1976) documents an example of such an attempt in one area of Mali. The attempt failed because there was too little sensitivity in terms of tailoring the program to the local situation. On the other hand, there have been occasional success stories, even where the impetus has come from outside. These programs have been characterized by a sensitivity to a local situation and a realization that the local populace have to participate in formulating the consolidation process. Faye and Niang(1977) document an interesting program carried out in the Unites Experimentales in Senegal (Fig. 7.2), while another program that had some degree of success was near Fana in the CMDT area of Mali.

d. One of the results of increasing population density has been a tendency in certain ares for migration to take place towards previously unoccupied areas. Where this has occurred spontaneously, there has been a potential for inequalities in land distribution to result. As mentioned earlier, traditionally the individual who initially clears the land obtains the usufructuary rights to the land. An example of an inegalitarian system of land distribution is that developing in the Saloum Oriental area of Senegal in which the religious leaders (Marabouts of the Moslem brotherhoods or Mourides), with substantial capital and manpower provided by students (Taalibes), were able to gain access to substantial quantities of land.[39] J.P. DuBois (1975) gives some interesting information on farm size. In the areas where land had been settled for a long time the average size of holding was 6.5 ha/family, while in the newly settled areas large farmers were controlling 40-135 ha/family.

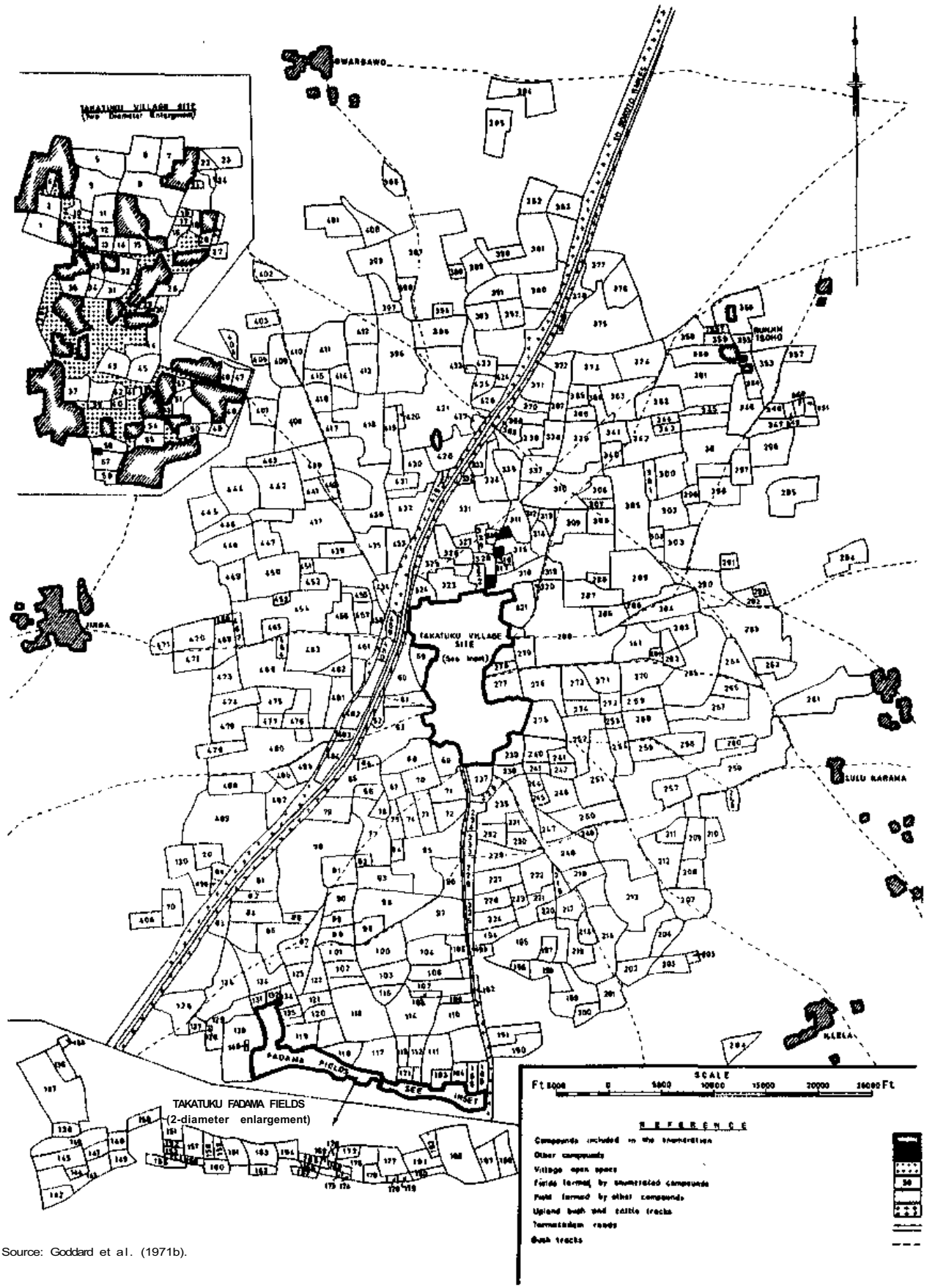
e. The increasing significance of fields under individual rather than family-head control has already been mentioned. The increasing dominance of individual fields is seen in Table 6.3 to be related to the increased monetization of the economy, since they become more dominant as the significance of groundnut in the farming system increases (Unite d' Evaluation 1978).

The observations brought out in the above discussion give rise to the question of whether land reform should be considered to be a major issue in the region at the present time. Although there is some need for concern about the trends now developing, supported, perhaps, by the formulation of policies expressed in terms of relevant external institutional support systems and the development of relevant improved technologies, some of the abuse that seems to be arising can be avoided. There may be merit in having some sort of land reform program involving legal codification of land rights and, in certain areas, land redistribution; but it is doubtful whether the countries in the region have at present the capacity to implement such a

37. This is discussed in detail in Section 13.2.

38. Cleave (1974) reported that in some parts of Africa up to 30% of time spent working on farms is simply used in walking to and from fields.

39. Large traders are another group with capital that have also obtained large amounts of such land.



Source: Goddard et al. (1971b).

Figure 7.1. Field map, Takatuku, northern Nigeria.

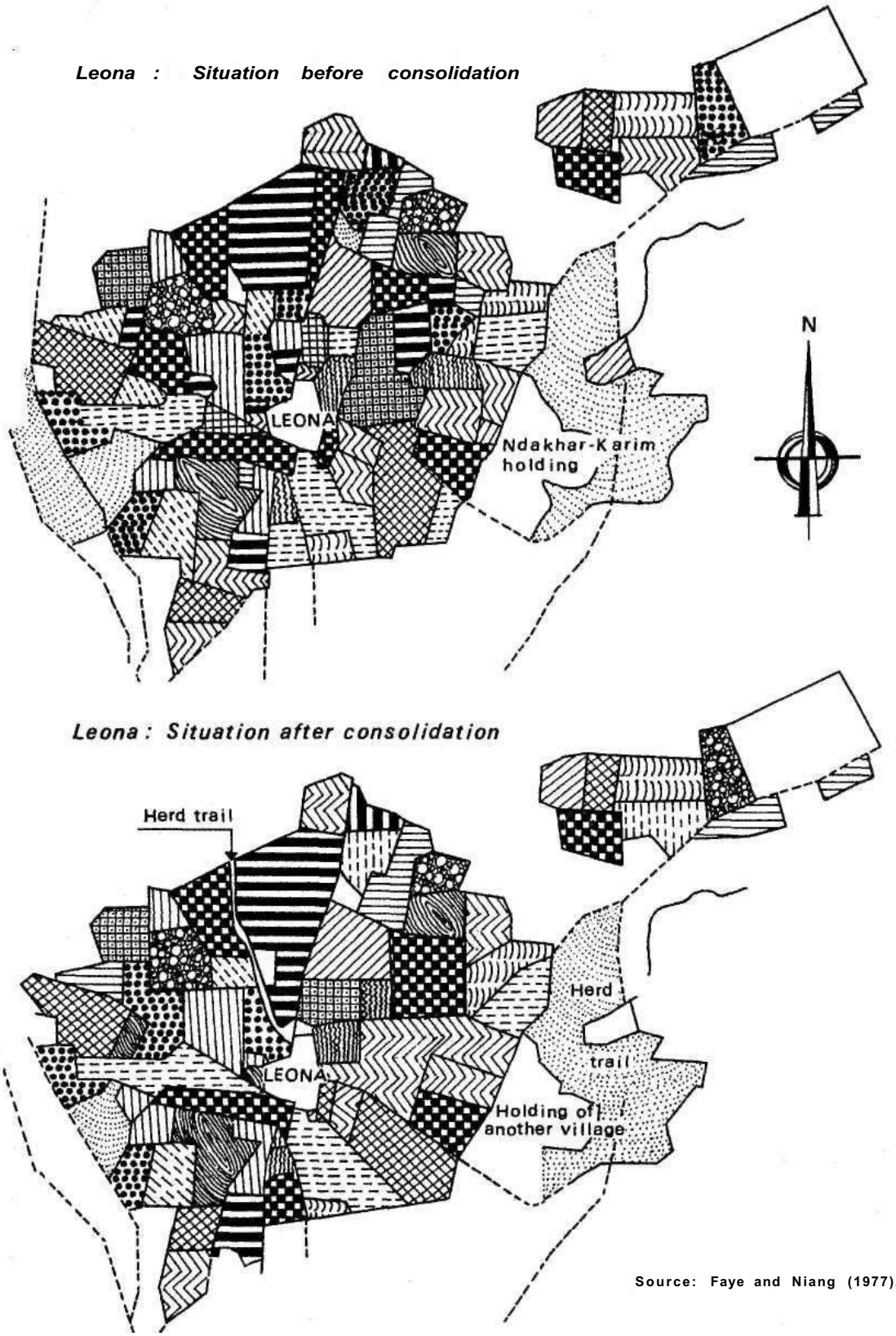


Figure 7.2. Land consolidation program, Senegal, (Each pattern represents a family holding.)

program. Two recent attempts to take administrative action on land tenure are found in the Law of National Domain, which was implemented in Senegal in 1974, and the Land Decree implemented in Nigeria in 1978. We have not been able to examine these statutes in detail, but believe that the law in Senegal is simply strengthening the concept that the land ultimately belongs to the government, while the Nigerian decree is at present largely confined to urban areas where an effort is being made to prevent inequalities in land distribution. In neither country do these laws as yet appear to have any meaningful impact. There are also examples in several countries of moves toward certain forms of individual tenure in special circumstances. Examples can be found where population densities are high near urban areas, where settlement and irrigation schemes have been implemented, and where large tractor-cultivated mechanized farms are found. In conclusion, although a land reform program might be desirable, it is necessary to distinguish clearly between what should be done and what can be done, given the limited resources that the countries have available for implementing all their developmental strategies (Lowe in Dunsmore et al. 1976; Norman 1970).

7.3 Land/Resident Ratios

A number of factors determine the land/resident ratios. Obviously increases in population density tend to depress the land/resident ratio. A negative relationship is also likely to result with higher levels of soil quality. Also the power source is likely to be influential. Changing from a hand-labor system to one utilizing animal traction has been shown to result in larger areas being cultivated (Table 6.3).[40,41] This is in spite of efforts in francophone countries to encourage the use of animal traction as a means of intensifying land use (see Section 11.2). In general the figures in Tables 6.1 to 6.3, 6.5, 7.2 and 7.3, together with figures given in other studies (CMDT1978; Haswell 1975; Matlon 1977; Lowe In Dunsmore et al. 1976; Fall 1977; SODEVA 1976) indicate that hectares per resident range from about 0.4 to 2.0 while cultivated hectares per resident range from about 0.3 to 1.5.

There appears to be no relationship between the land/resident ratio and family structure (Table 6.1 to 6.2). Thus the breakup of families from complex to nuclear units does not seem to give rise to differences in the relative land base, although, as noted earlier (Section 6.1), the number of hectares/worker and the dependent/worker ratios appear to increase. The relationship between land and labor is Important in indicating the intensity of agriculture. For Nasarawa village in northern Nigeria the average labor input where there was no animal traction, was found to be 682 man-hours/cultivated ha (Norman et al. 1979). It is reasonable to hypothesize that the amount of labor used per hectare will be negatively related to the number of cultivated hectares on the farm. In addition this relationship will be complicated by other

Table 7.2. Land/labor ratios, Niger.

Variable	Niamey	Dosso	Tahoua	Maradi	Zinda	Diffa
Hectares per:						
Resident	1.7	1.7	0.6	1.7	1.6	0.9
Actif	0.9	0.9	0.3	1.0	0.9	0.6

Source: Niger, Ministere do l'Economie Ruralo (1973).

Table 7.3. Size of family, farm and land/labor ratios, Mali.

Variable	Koutiala	Fana	Sikasso	Bamako	Segou	Bougouni	San
Size of family	9.3	10.8	15.1	12.4	11.2	13.8	9.4
Area cultivated per family (ha)	5.5	5.9	5.4	5.4	4.7	3.2	4.3
Hectares per:							
Resident	1.1	1.0	0.6	0.7	0.8	0.5	0.9
Actif	0.6	0.6	0.4	0.4	0.4	0.3	0.5

Source: Institut d'Economio Ruralo (1977).

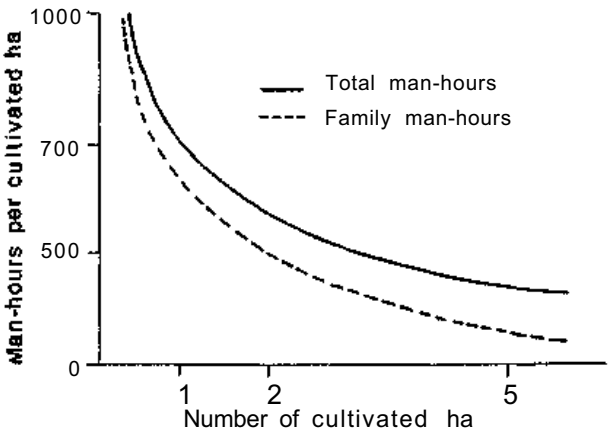
40. Because of the larger families In the case of those who own oxen, this relationship broke down, In the figures In the table, when area cultivated was expressed in per resident or per *actif* terms.

41. Similar results are found in South Asia (H.P. Binswanger, personal communication).

Table 7.4. Cultivated hectares and crops grown, Gambia.

Variable	1949		1962		1973	
	ha	%	ha	%	ha	%
Upland:						
Plateau soils :						
Late millet		11.8		1.7		
Colluvial :						
Early millet		1.9		3.3		NA[a]
Sorghum		1.4		-		
Hungry rice		10.8		-		
Maize		0.7		4.4		
Groundnut		38.1		39.3		
Total	176	64.7	142	48.7	205	56.0
Lowland :						
Rainfed rice		9.2		10.6		NA[a]
Swamp rice		26.1		40.7		
Total	104	35.3	149	51.3	161	44.0
Grand total	280		291		366	
Cultivated area per head	0.58		0.50		0.47	

Source: Derived from Haswell (1975).
a. Not available.



Source: Norman et al. (1979).

Figure 7.3. Relationship between labor Input per cultivated hectare and number of cultivated hectares, Naaarawa, northern Nigeria.

factors such as the quality of land, distance of the field from the residence, crop growth, etc. Proxy variables for land quality were the proportion of cultivated land that was lowland and the amount of organic manure applied per hectare. Once these were taken into account, the negative relationship hypothesized above was found to be true (Fig. 7.3). One interesting sidelight of the result was that the use of hired labor could only partially offset the decrease in family labor input per cultivated hectare so the number of cultivated hectares increased.

There are few statistics on trends over time. However, one study (Table 7.4) indicates that the cultivated area per head of the population has decreased in one region in Gambia over the last 25 years from 0.6 ha to 0.5 ha. This decrease is attributed mainly to an increase in population density.

8

Capital, Cash, and Credit

8.1 Capital Investment

Investment of capital in traditional systems of agriculture In the region has tended to be low (Kafando 1972; Hopkins 1969; Ernst 1976; Jones 1976). This may have been due to both low savings capacity and low returns on investment. Traditionally, capital owned by farming families has consisted, apart from livestock, principally of goods produced by them through a direct embodiment of labor. Examples of production of such durable capital include making hand tools, constructing grain stores and improvements to land such as fencing, terracing (particularly in hilly areas) (Gleave1969; Miller 1952; White 1941), constructing *shadufs* for irrigation, and even clearing land for cultivation. Clearing land for cultivation was obviously a much more time-consuming task where population densities were lower in the area and shifting cultivation systems were more dominant (Ruthenberg 1971). A significant point concerning all these types of capital is that much of it is produced when the opportunity cost of labor is low—that is, during the dry season.

The other form of traditional capital which is not a direct embodiment of labor is the ownership of livestock (see Section 11). Livestock have multiple uses including being a form of savings (Stickley 1977; Eskelien 1977), and investment (Delgado 1978; Unite d'Evaluation 1978), and sources of meat, manure, and by-products. Apart from cattle, livestock ownership tends to be widely dispersed both between and within families. Cattle ownership, on the other hand, tends to be unevenly distributed, being concentrated toward the wealthier, often more influential families (Lowe in Dunsmore et al. 1976). Clough (1977) has emphasized that cattle ownership is a key criteria of wealth in Hausa societies in northern Nigeria, while another study undertaken in the same area indicated that only 22% of the farming families were found to own cattle (Norman et al. 1979). Haswell (1975) provides some evidence that the number of cattle in Gambia owned by farming families has been increasing over the years.

With the introduction of improved technology there is a significant change in the character of some of the capital used by farming families. The new types of capital are purchased in the market place rather than produced with local labor at the village level. Such capital includes most types of animal traction equipment, sprayers, inorganic fertilizer, etc. The use of such capital is likely to continue to increase as improved technology is adopted by farmers. This necessitates that farming families enter further into the market economy in order to pay for such capital items.

It, however; does not mean that traditional forms of capital will no longer be important. Indeed there is some evidence that livestock, for example, might become even more important. For example, there is evidence of the increasing utilization of organic fertilizer as population densities increase. Therefore, organic fertilizer is increasingly being recognized as an economic good (Delgado, 1978). Also, there Is often considerable complementarity between the two types of capital. The use of draft animals with animal traction equipment is one example.

The introduction of improved technology also increases both the level of capital investment required and the proportion of capital that has to be obtained through purchases in the market place, in both relative and absolute terms. At the same time, such capital increases the range of methods of producing a given product. This in turn increases the potential for heterogeneity developing among farming families at the village level.

8.2 Cash Expenses and Flow

Traditionally, cash expenses on agriculture were minimal. However, nonfamily labor is increasingly being hired on a daily or contract basis and is being remunerated in cash *or* kind. Cash payments become particularly common after some of the crops are harvested. The importance of labor as a major limiting factor in the SAT of West Africa is exemplified by the fact that, during the early stages of monetization, the payment for such an input tends to be a major component of total cash expenses. For example, one study in northern Nigeria revealed that 57% of cash expenses on agriculture could be attributed to hiring labor (Norman et al. 1979).[42] As improved technology is introduced, however, there are increased cash expenses on other inputs. Nevertheless, hired labor generally remains a principal component of cash expenses, especially if the power source is not changed.

A major problem with respect to allocating cash to agricultural activities is that the seasonal cash flow tends to be inversely related to the level of agricultural activity (Lowe in Dunsmore et al. 1976). The time when the level of agricultural activity is approaching its peak—usually between June and September—is also the period of major demand for expenses In agriculture, and this coincides

42. Also King (1976a), working In the same country, found the most comon use of production credit obtained from local sources was for hiring labor.

with the time when cash resources are at their lowest ebb (Matlon 1977). With the introduction of improved technology this problem is likely, initially at least, to be exacerbated.

The problem of variations in the seasonal cash flow is made worse by the fact that the business of farming and the family itself are not separated. As a result, extra pressures arise during periods of peak agricultural cash demand, because of the need to purchase food during the so-called hungry season (Section 13.2).

8.3 Savings and Credit

The accruing of savings and credit are obvious ways of overcoming problems of the seasonal cash flow.

Traditionally, savings have often been mobilized by reciprocal relationships among people and through selling livestock. Interestingly enough, only two references were found concerning traditional savings and credit clubs in the SAT of West Africa. By contrast, such institutions are quite common in the Forest ecological zone to the south. One of the cases identified involved women in northern Nigeria (King 1976b) and another was cited by Bouman (1977) as existing in Senegal. It would be interesting to determine whether in fact they are more common in the area and if not, why not. The lack of coincidence in the region between expenditure and income cycles appears to provide opportunities for the introduction of savings institutions. Unfortunately, however, there has been virtually no attempt to introduce institutional savings programs in the region. A small program in northern Nigeria appears to have had some degree of success (Huizinga et al. 1978a and b), while there has been some desire expressed to organize a program of a similar nature in Mali (Bank manager at Koutiala, personal communication). In general, emphasis has been placed on institutional credit programs rather than programs that recognize the complementarity between savings and credit. Placing the emphasis solely on institutional credit without a savings component limits the potential for developing self-sustaining credit programs.

Traditionally credit obtained from local sources has been primarily used for consumption purposes. In the light of the preceding discussion this is not surprising. On the one hand, cash expenses in agriculture traditionally have been minimal while, on the other, the hungry season, combined with substantial social obligations (e.g., naming ceremonies, marriage, etc.) and more recently the need to pay taxes, have all contributed to a bias towards credit for consumption instead of capital formation.

A point of contention in the literature is the rate of interest charged on loans obtained in the local society. Some have specifically mentioned high explicit interest rates (Vigo 1965). Others, such as Matlon (1977), have found low or even zero interest rates being charged on loans to farmers. Care needs to be taken in investigating interest rates, however. Three factors that might obscure the real or implicit interest rates are as follows.

a. Farmers in the region are likely not only to be reluctant to disclose the loans they have received but also the interest rates they are being charged. The reluctance to disclose the latter is because usury is officially frowned upon in Islamic societies.
b. Loans often involve reciprocal social obligations. For example, In return for a loan an Individual might be expected to work on the fields of the creditor at times when his labor has a high opportunity cost. This in effect is an interest payment, although it probably would not be articulated in that form in terms of the agreement drawn up for the loan. Therefore, it is unlikely that such obligations would ever be expressed explicitly as interest rates.
c. There is often a masking of the interest rate through paying back a loan in kind. For example, loans are often repaid at harvest, in kind, when the prices of the harvested crops are lowest.

There is emerging an increasing body of literature emphasizing the potentially exploitive nature of traditional credit systems (J.P. Dubois 1975; Clough, 1977) as community structures break down and individualism increases, with the concomitant increase in contact with external institutions (Watts 1978; Raynaut 1976). Clough (1977) hypothesizes that intervillage wholesalers store grains in rural areas and use urban credit to secure large profits from seasonal price movements. He suggests that they may also extract a flow of grain through harsh credit relationships with farmers in villages.

There may, therefore, be some confusion over the implicit or explicit interest rates charged for credit at the local level. However, it appears that the interest rate charged in any one transaction can be heavily influenced by its source, by the amount of collateral the borrower possesses, and the position of the borrower in the society. For example, King (1976b) mentions that a substantial amount of credit at the local level is borrowed from relatives or close friends. In such cases the interest rate appears to be zero or very low. Haswell (1975) has noted that lower interest rates are charged on loans given to people who own cattle.[43] Farming families in the region as a whole possess only usufructuary rights to the land. Asa result, in the eyes of the law such land cannot be used as collateral. However, at the local level, credit arrangements do sometimes involve the use of land. Pledging land in return for a loan is becoming increasingly common (Goddard 1972). Finally, the position of the person in the society also seems to have an influence on the interest rate that is charged. Clough (1977), for example, mentions that a low interest rate is charged on loans to wealthy and influential people.

Institutional credit programs have been implemented throughout the region in order to encourage the adoption of improved technology. This credit has been of two types: short-term (e.g., fertilizer, improved seeds, etc.)

43. Perhaps related to this is an observation by Hopkins (1975) who mentions that farmers prefer to borrow money rather than to sell livestock as an emergency source of cash.

and medium-term (e.g., animal traction equipment). Two criteria are often used in evaluating such credit: repayment rates and perhaps, less commonly, the equitability of access.

In terms of repayment rates it appears in general that high levels are achieved only when such programs are carefully coordinated with other external institutions and support systems, particularly the distribution of inputs and the marketing of products (King 1976b; Belloncle 1968). Certainly this has been true with respect to the introduction of oxen draft systems that are closely correlated with the cultivation of a viable cash crop (Section 11.2). One of the major concerns in institutional credit programs is the so-called misuse of credit for consumption purposes. Consequently, credit has often been given in kind in an attempt to prevent such misuse. However, this has not always been successful. Venema (1978) gives an example of the resale of fertilizer obtained on credit at two-thirds of its value in order to provide cash to meet urgent consumption needs. He also cites cases of groundnut seed that had been obtained on credit being collected by rich farmers from their debtors. There are also cases reported of medium-term credit being misused (e.g., selling of animal traction equipment and animals). The concept of raising interest rates on institutional credit, as advocated in the AID Spring Review (USAID, 1973) in order to better cover transaction costs and to discourage the misuse of credit either through selling the products or through lending to other farmers, has not been attempted in the SAT of West Africa as far as we know.

The success of "cooperatives" or"precooperatives" as instruments of government policies to increase equitability of access to credit has been quite limited. In large measure this may be attributed to the inconsistency between traditional village hierarchies and the "top-down" structures of many governmentally imposed "cooperatives" with democratic principles of cooperation (King 1976b; Gentil 1971a and b; Storm 1977) (Section 4.4.2).

Institutional credit programs necessitate farmers' participation in the market economy in order to obtain revenue for the repayment of credit. In India oxen are an integral part of the subsistence sector. But in the SAT of West Africa it is difficult to envisage that millet and sorghum, which are grown mainly as food crops, could provide a viable credit-base for oxen and equipment obtained through credit programs in areas where no cash crop exists. This is at present being tried (e.g., *Operation Mils* in Mali). But a lack of relevant improved technology, coupled with the present disadvantageous pricing policies, especially in the francophone countries, appear to make viability unlikely.

It is obvious that farmers have to link the concept of cash expenses in agriculture with the possibility of obtaining remuneration in monetary terms, although in theory funds for such purposes could come from off-farm employment. It was observed above (Section 6.2.1.3) that the more modern types of nonfamily labor, such as hired and contract labor, involving remuneration in cash are more comon for cash crops than for food crops, where the more traditional types of labor such as reciprocal and communal tend to be relatively more common. Also it is often observed that, while organic fertilizer may be applied to food crops, inorganic fertilizer is often reserved for export cash crops (Unite d'Evaluation, 1978),[44]

44. However, this point perhaps needs to be regarded with caution since, as emphasized above, improved technologies are not readily available for food crops. As a result, such crops are potentially less responsive to Improved Inputs such as inorganic fertilizer.

9

Goals and Management

9.1 Goals

Little rigorous empirical research work has been done on the goals of farmers in the SAT of West Africa. Ancey (1975a) highlights the problems of looking at African society with a simplistic desire to identify rigorously distinct and corresponding units of production and consumption for quantitative analysis, when the reality of life in an African village involves a continuous process of multidimensional relationships with different objectives applying to different levels of decision making. He notes that an understanding of these relations is further complicated by "semantic elasticity" that results in the continued use of terms for compound, household, farm, etc., which for societies in transition correspond to changed and changing levels of goal formation and decision making. From a study of 14 West African ethnic groups Ancey (1975b) compares 14 goals and their relevance to 9 different levels of decision making. The aim is to provide some perspective on the conflict and comparability among the objectives of various decision makers. Table 9.1 shows a modified version of his findings. It illustrates that, even within the family setting, a number of different goals are likely to be perceived as being important. For example, the goal of people working on individual fields is likely to be profit maximization, while that on common fields is likely to be food security. Also it is conceivable to have conflicting goals within the family in its role as a production unit on one side and a consumption unit on the other (Faye et al. 1977). Further complexities in goal identification are introduced as a result of time and relationships with other groups within the village. In short, conflicts and interdependencies make It extremely difficult to come to any conclusion as to the priority goals adopted by farmers. Indeed, it is likely that these will be both time- and location-specific.

In spite of the apparent complexity in terms of specifying goals, conventional wisdom in the SAT of West Africa has assumed that the goal of meeting food needs from farm production is important. With the advent of the notion of the "economic man", it has also often been assumed that spare resources over and above those required to meet the subsistence goal are devoted to profit maximization through producing products for the market. However, the literature also provides examples of the self-sufficiency goal being subverted, particularly as a result of changes taking place with respect to exogenous factors. The basic cause of this has been the transition from producing food crops to producing increasing amounts of export cash crops. A number of reasons have been given for bringing about this switch, including the following.

Table 9.1. Goals and decision making in the rural African milieu.

Level of decision	Goal[a] 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Individuals:														
Other males		X	X	X					X			X		
Wife/woman	X	X X		X			X		X			X		
Family head	X					X			X	X	X		X	X
Units:														
Production [b]		X										X		
Consumption [b]	X			X		X	X	X				X	X	
Social	X					X				X	X	X		X
Groups:														
Lineage										X	X			X
Village											X			

Source: Ancey (1975b) slightly modified.

a. 1 = self-sufficloncy; 2 = rnarketod production; 3 = nonagricultural income; 4 = net monetary income; 5 = total production value; 6 = interannual sacurity; 7 = intra-annual security; 8 = dlversiflcation of activities; 9 = leisure; 10 = prestlge, authority; 11 = cohesiveness; 12 = autonomy; 13 = satisfaction of social consumption objectives; 14 = land tenure prerogative

b. In this review theso taken together have been termed an "economic unit."

a. External pressures, such as systems skewed towards export cash crops (Lele1975), or the need for money to pay taxes (Campbell 1977; Nicolas 1960; Kafando 1972; Raynaut 1976; Jones 1970; Lewis 1978) or to buy consumption goods, have encouraged such change. Social sanctions against those who fail to provide enough food in the granary for the family until the next harvest appear to be lessening.
b. As discussed above (Section 6.1) the breakup of the family structure and the desire for increased independence on the part of individual family members has encouraged the production of export cash crops on individuals' fields (Rocheteau 1975a; Albenque 1974).
c. Economic necessity, even survival, occasionally necessitates subversion of the subsistence goal. For example, Matlon (1977) cites a case in northern Nigeria where the comparative advantage from growing groundnuts for cash was such that the only way very poor farmers in the community could provide for their families was to grow this crop and purchase cereal crops for food.

A number of programming models have been developed in the SAT of West Africa using different assumptions concerning goals. Some of the major ones are as follows.

a. Richard et al. (1976) use a profit maximization goal in a linear programming model to determine optimum combinations of land, labor, and materials for a given technology under differing assumptions of the date and size of the first and second rains. They also test the impact of new factors and price changes on the optimal plan and net cash income. The model makes use of official prices and assumes that production follows technical advice concerning land preparation, fertilizer use, plant density, thinning and weeding. However, this model computes optima and should not be confused with one which describes actual performance. The tendency to mistake the heuristic value of a model for a policy blueprint must be resisted.
b. Ogunfowora (1972b) and Norman (1970) have also assumed a goal of profit maximization, but in the results presented have always ensured that enough food has been produced to meet family needs. The coefficients used are based on an average farm in the Zaria area of northern Nigeria. The model incorporated a number of mixed cropping enterprises plus the possibility of introducing a limited range of improved technologies. The results basically show that the farmer could not significantly increase his level of livelihood by reallocating the resources he had currently committed to production. One of the major bottlenecks involved the weeding period in June and July. The implication of the analysis was that increased production could be brought about only through hiring more labor and/or the introduction of relevant improved technology. Distributional problems within the village setting were omitted from the analysis (see Section 13.3).
c. Bourliaud et al. (1977) also used a linear programming framework to simulate the behavior of farmers in Central Casamance, Senegal. They assumed a profit maximization goal and analyzed the role of uncertainty in agricultural decision making. They also assessed the potential for improved productivity through the introduction of new technology.
d. Hopkins (1975) has undertaken one of the more realistic programming exercises to date. She constructed a model that represents a typical farm in Senegal incorporating a larger range of production technologies, and included changes permissible at each stage of the production process. Although the first model run included soil types, rotations, seed type, land availability and composition, and household size and composition, the final model had a limited number of situations with resources at predetermined levels. The model was then used to generate a series of optimum solutions which the farmer could obtain in defined situations using certain combinations of crops and techniques. These solutions were then compared with observed behavior and with the recommendations put out by the development agency operating in the area at the time (i.e., SATEC). Game theory was used to introduce uncertainty into the farming situation. She found that resource constraints may prevent most types of farmers from adopting fully the recommended improved technological packages, and that better returns could be achieved by using available resources to farm larger areas less intensively and through expanding the range of crops grown.
e. Barnett (1979) worked on another model based on Senegalese data which attempted to introduce greater realism as far as goals were concerned, in modifying the model developed by Richard et al. (1976).[45]

9.2 Risk and Uncertainty

As with the preceding section, there is a lack of definitive research work on farmers' attitudes to risk and uncertainty. Obviously attitudes to risk and uncertainty will influence both the goals that farmers will follow and the types of improved technology that they are likely to adopt.

In order to investigate the impact of risk on innovation and the choice of crop combinations, most studies tend to use yield and price variation as a proxy for risk. In most of the literature reviewed, risk aversion is considered to be an important element in the decision-making process of families in the SAT of West Africa. However, evidence presented for this is usually of an indirect nature, Examples of strategies for minimizing risk include the following.

45. Delgado (1978) has done some linear programming work based on data collected in Upper Volta. This is discussed below (see Section 11.1).

a. The objective of minimizing price variability can be seen in the strategy of many families pursuing the goal of food self-sufficiency. By pursuing such a goal, they are eliminating the risk of having to rely on purchasing food in the market which, of course, is subject to considerable price variability. Other examples that appear to follow a strategy of minimizing price variability are planting cash crops late, after food crops are well established (Jones 1976), thereby supporting the goal of food self-sufficiency, and the tendency during drought periods to decrease the production of cash crops in favor of food crops.
b. Strategies designed to minimize variations in yields—or total production—are exemplified in the practice of growing crops in mixtures which sometimes consist of different species but also on occasion different varieties of the same species (Charlick, 1974; Kohler, 1971). Another strategy is to grow a number of crops rather than one or two, since not all crops are similarly affected by varying conditions in weather, insect infestation, and disease. Yet another strategy is the traditional preference for the spatial scattering of fields, especially in areas of low population density, in order to take advantage of microenvironmental variations (e.g., soil conditions, rainfall variations, disease attack, etc.) (R.E. Ford, personal communication).

Although the above strategies are claimed to provide evidence that families are risk averters in agriculture, it is difficult to be definitive about this. There are often multiple reasons for the strategies selected. For example, evidence given below (Section 10.3) shows that growing crops in mixtures is not only a risk-aversion strategy but is also consistent with the goal of obtaining a higher return per unit input of land and/or work. Also the practice of diversifying the number of crops grown by a family is consistent with the notions of rotating crops and providing the potential for a more even use of labor throughout the year.

No empirical studies were identified which can be considered analogous to that undertaken in India (Binswanger et al. 1977), in that they directly focus on risk and uncertainy in the SAT of West Africa. In order to use yield and price variation as a proxy for risk, it is necessary to have time series data which will show the effect of varying states of nature on yields and varying supply and demand conditions. Unfortunately virtually all the studies reviewed collected detailed input/output data for only 1 year.

Matlon (1977), examined risk through questionnaires administered to a sample of farmers in northern Nigeria. He attempted to elicit their opinions concerning the relative risks associated with each of the major crops. He derived a somewhat unconventional result. At the levels of technology being practiced by farmers, while the most profitable crops required higher levels of purchased inputs (e.g., seed and organic fertilizer), these same crops showed the least yield variability. He concluded that the lack of cash to purchase the improved inputs prevented the low-income farmers from growing the more profitable and less risky crops (e.g., groundnut, pepper). Instead, poorer households were forced to grow the less profitable and higher risk crop combinations (e.g., early millet and sorghum). However, by doing so they were still avoiding the problem of price variability which would have arisen if they had produced the more profitable cash crops.[46]

There is virtually no evidence from the studies reviewed that gives insight into the attitudes of the farming families towards risk in terms of adopting improved technology. However, in terms of changes taking place over time there are two important implications.

a. That the loss of the concept of collective security which was so important in traditional societies is enhancing the risk faced by the individual family.
b. The increased monetization of the economy and farming families' greater emphasis on cash crops is increasing their vulnerability to market forces and, indeed, to climatic variations, since grain stocks are kept at a relatively lower level than was normal under traditional cropping practices (H. Guggenheim, personal communication).

It therefore seems that the increasing influence of the outside world has made farming families more vulnerable to yield and price variations than before. It is important that those who are concerned to improve technology for development purposes should address the issue of stability of returns. For example, there has been a great deal of emphasis in recommending a move from mixed to sole cropping. The lack of acceptance of such recommendations in some areas may have been due in part to farmers' unwillingness to accept what they perceived as a more profitable but higher-risk technology compared with the traditional practice of mixed cropping.

9.3 Managerial Ability

There also appears to be little definitive research work undertaken concerning the management input in agriculture in the SAT of West Africa. As noted above, Jones (1976) has suggested that, historically, indigenous technological knowledge and managerial ability were closely connected with age. This does not mean that other individual characteristics did not influence managerial performance (Hedges 1963; Upton 1969). Knowledge concerning improved technological methods developed and introduced into the villages through external institutions is unlikely to be closely correlated with age. This has indeed been perceived by developmental agencies. But the lack of any formal education of many individuals in the farming commnities in the region, plus problems in providing a good level of extension support, has meant that

46. This appears to be somewhat inconsistent with the finding by Matlon (1977), cited in Section 9.1, that the very poor farmers were forced to grow groundnut in order to survive. Very poor families, in contrast with poor families, appeared to have no choice but to enter the market place and expose themselves to price variability.

sometimes the spread, and adoption, of improved technology has been slower and less efficient than its promoters considered desirable.[47]

There is often a temptation to perceive "bad" practices as illustrating bad managerial ability. However, as discussed below, it is important to distinguish between the innate managerial ability of a person and the ability to implement recommended practices (Palmer-Jones 1978b) (Section 13.3). As far as we are now aware, no definitive work exists in the area which isolates effectively the elements contributing to managerial ability. Work done by Matlon (Mation and Newman 1978) and Upton (1969) In Nigeria comes closest to this. Shapiro (1976) has done some significant work elsewhere in Africa.

9.4 Conclusion and Implications

The preceding sections have pointed out difficulties in coming to grips with the fundamental issues concerning the decision-making unit and the decision-making process. There are obviously strong linkages between the goals of farmers, their attitudes toward risk and uncertainty, and their managerial input. The linkages are made more complex by the fact that the farmer is working in a dynamic situation. In addition to interannual and intra-annual variations in the availability of labor for work on the fields, the amount of food in the grain store, etc., the farmer is also faced with variations in weather conditions. As a result the decision-making process that he employs will be sequential in nature. This provides additional complications in trying to understand the nature of the farming process.[46]

An understanding of the goal of farmers, theirattitudes toward risk and uncertainty, and their relationship to management decision making is a crucial ingredient in designing relevant Impoved technology. In order to arrive at such an understanding, an interdisciplinary approach will be required.

Many of the issues that are currently being addressed in ICRISAT's Risk and Uncertainty Project in India (Binswanger et al. 1977) are just as relevant in the West African setting. Ryan (1977) has indicated that, through the project designed in the Indian setting, it is hoped to ascertain if wealthier farmers are less risk-averse than poorer, small farmers; to ascertain if those living in areas of high rainfall variability are more risk-averse than those in areas where the rainfall is more dependable; and if risk aversion increases with the size of investment. As he notes, accepting any of these hypotheses would strengthen the case for differentiated technologies/policies to deal with risk: according to social/economic categories in the case of the first hypothesis; according to the climatic riskiness of the zone for the second hypothesis; or according to the size of the investment in the case of the third hypothesis. These are also important issues to be resolved in the SAT of West Africa.

47. There are many Issues that influence the spread and adoption of Improved technology. For example, there are issues of suitability or relevance of the technology, the availability of a satisfactory input distribution system, a market for the product produced, etc.

48. R.W. Palmer-Jones and E.F.I. Baker (personal communications) have undertaken an interesting experiment incorporating this concept. Specifically they examined mixed cropping using a sequential decision-making process based on variation during the season in weather conditions. It is very likely that a farmer at the beginning of the rainy season is not exactly clear as to the crop combination he will use on a specific field. Rather he is likely to base his decision on the pattern and intensity of the rainfall once the growing season gets under way.

10

Crop Processes

10.1 Cropping Practices

The practices of farmers have evolved over generations (Swift 1978; Johnson 1972) and reflect adaptations to the environment. However, relatively recent acceleration in population growth has upset the traditional adaptation process and its time requirements. The need to develop relevant improved technology is thus increased. This does not mean, however, that traditional practices should be ignored. It is indeed apparent that, while many traditional practices are firmly embedded in the farming systems and will be difficult to change, there are also many which can be used as building blocks in the development process. Unfortunately, indigenous practices have not been well documented and discussions which do *occur* are often descriptive rather than analytical. In addition, there is rarely an attempt to include all the technical, economic and social variables as explanatory factors in accounting for the presence of a particular crop practice.

10.1.1 EXAMPLES OF COMMON CROP PRACTICES

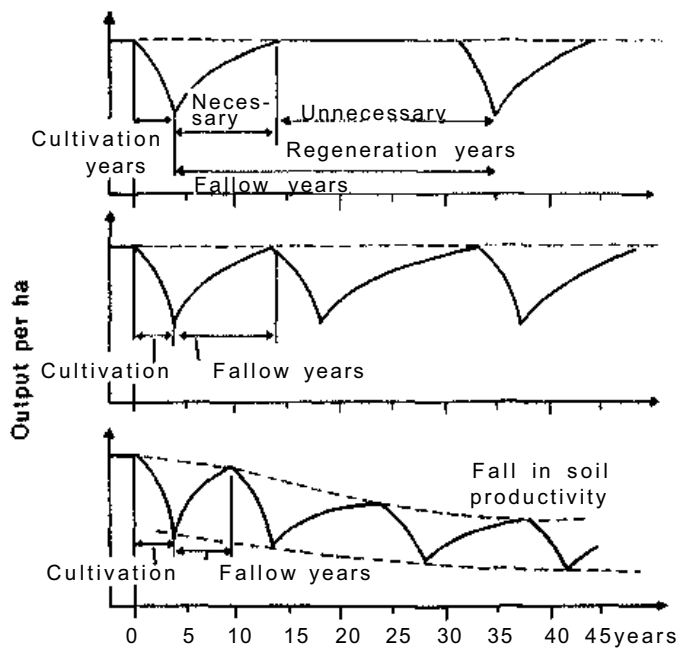
10.1.1.1 ***Burning.*** Burning of brush, crop residues, and even manure is quite common. Burning brush was traditionally associated with shifting cultivation systems (Ruthenberg 1971), which tend to be characteristic of areas with low population densities. Such burning is usually undertaken during the dry season. A number of reasons have been suggested for this practice.

a. It makes hunting easier.
b. It is advantageous in areas where cattle are kept. Over time, burning changes the ecology from forest and brush to grassland. It also allows the early fresh grass to develop quickly at the beginning of the rains as a result of the increased availability of nitrogen at that time.
c. For cultivation systems, burning helps to reduce the time required to clear the brush. As more permanent systems of cultivation develop, burning provides a means of incorporating residues into the soil. This can be a difficult operation when hand labor is the sole source of power.

The change in ecology from trees and brush to grass has serious consequences. Grassland systems do not have the same ability to remobilize nutrients and to accumulate organic matter as do brush and trees (Ruthenberg 1971;Charreau 1978). This, togetherwitha reduction in the length of fallow as increasing population densities force a change to more semipermanent systems of agriculture, increases the problem of maintaining soil fertility (Fig. 10.1).

10.1.1.2 ***Ridges, flat, and mounds.*** Crop production on rainfed land in the region is characterized by a combination of flat cultivation, ridges, and mounds. It is not clear why farmers choose a particular system. However, direct observation indicates that in heavier soils, higher precipitation areas and, sometimes, where slopes are steep, ridges dominate. Conversely, flat systems are likely to be dominant where soils are sandy and precipitation is lower. Systems using mounds can also be common where sandy soils and low precipitation levels are found. As noted earlier, weeds are often placed in mounds during the cultivation operations. These provide a concentration of organic matter. Seeds are then planted in these mounds at the beginning of the following year.

Considerable discussion has taken place concerning the relative merits of growing crops on ridges as compared with level fields. Dunsmore et al. (1976) and Charreau (1978) have listed the following advantages of growing crops on ridges.



Source: Gulllemin (1956).

Figure 10.1. Relationship between the length of tallow and soil productivity in shitting cultivation.

a. Land cultivation is more rapid, since only half of the land area has to be worked.
b. The topsoil, ashes, and organic material are concentrated around the root of the plant.
c. Ridges improve the drainage around young plants following heavy storms.
d. Early weeding is facilitated.
e. Groundnut is easier to lift from ridges than from level fields.
f. Contour ridging can prevent waterlogging and erosion.
g. In poorly drained areas, ridges can improve aeration and drainage.

A number of arguments have also been advanced against utilizing ridges. These include the following.

a. With variable rains at the start of the season the ridge may dry out and the young plants may become desiccated.
b. With sandy topsoils ridges are vulnerable to erosion—particularly after weeding—and this vulnerability may lead to the exposure of crop roots.
c. Water will concentrate in the furrows and cause serious erosion unless the ridge runs along the contour and is tied.
d. Ridging can result in an undesirable increase in the temperature of the soil and the crop root zone.
e. The water-holding capacity of the soil is reduced by ridging.

As noted above, weeding is one of the most critical bottlenecks in traditional systems of agriculture. Use of animal traction is often considered to be a means of overcoming this problem (Section 11.2). However, there are problems in facilitating weeding in both the ridge and the mound systems. Intrarow weeding, in practice, still has to be done by hand. With the ridge system it may be possible to combine interrow weeding with the application of herbicides along the ridge. However, for obvious reasons hand-cultivation systems would probably have to continue in the case of the mound approach.[49] The problem of completely mechanizing the weeding operation for crops grown on the fiat is not nearly so serious. For example, Charreau (1975) and STRC/OAU—JP26 (1972) have indicated that on light soils, in certain parts of Senegal, it is possible to use a row tracing technique which, with planting on the square, permits cultivation in both directions. Being able to mechanize both interrow and intrarow cultivation can reportedly cut down by as much as two-thirds the labor requirements for weeding millet, compared with the use of hand labor.

10.1.1.3 ***Soil fertility Indicators.*** It is obvious that, from experience, farmers in the region have derived indices of soil quality and recognize that different crops are suited to different soil types. Soils are differentiated not only by color but by texture. In addition, plant indicators are used as signs of soil fertility (Haswell, 1953; Benneh, 1973a). Few specific details of such Indicators were found in the literature, however. One problem recognized throughout the area is that of *Striga* infestation *(S. hermonthica* and S. *senegalensis).* Although farmers recognize its significance and realize it is often worse when the rains are early (R.E. Ford, personal communication), they have basically resigned themselves to its continuing presence. For one thing, the "ring" cultivation system (Section 10.1.2) cuts down the possibility of much flexibility through the rotation of crops. Also the *Striga* problem is aggravated when soil quality is low. Once again, farmers recognize this relationship and the importance of improving soil quality, but they are often powerles to do much about it (Section 11.1).

10.1.1.4 ***Tools.*** Although the linkage betwen tools and crop practices is perhaps not initially obvious it is apparent that the type of tool available will have an Influence on the crop practices adopted. For example, animal traction equipment permits earlier land preparation at the beginning of the rains than is possible with hand tools. Deeper cultivation, and the incorporation of crop residues is also facilitated. Hand tools have traditionally tended to be short-handled, but there is the interesting case of the il*er* that is a long-handled tool which cuts weeds 20-50 mm below the surface. It is widely used in areas with sandy soils. Raulin (1964) has documented the spread in its use across the West African region. It has definitely affected cropping in the region in that, while it decreases the difficulty of the weeding task, it is said to diminish soil porosity and structure because of the shallowness of the cultivation system, and it thereby decreases the length of time that a field can be used. It is therefore not surprising that the use of the il*er* has reputedly had a negative impact on yields (Meek 1925).

10.1.1.5 ***Rotations.*** Both explicit and implicit rotational systems are found in the region. Implicit rotational systems refer to the practice of growing crops in mixtures (Section 10.3). Where ridge cultivation systems are used ridges are often split every year (Echard 1964; Buntjer 1971). This means that crops grown on a particular piece of land will vary from year to year, although the same mixture may be present on the field as a whole. It is apparent that the value of using some rotation system is recognized by farmers. The shifting cultivation system comprises a fallow period to permit the regeneration of soil fertility after a certain number of crops have been grown. The use of organic fertilizer, as an alternative to fallowing, partially accounts for the "ring" cultivation system found throughout the region.

Although references abound concerning the adopting of rotations in traditional farming systems, the identification of explicit definitive rotations is made difficult because of the practice of mixed cropping (Section 10.3)

49. Indeed, it may well be that the mound system is completely Incompatible with a mechanization approach since Interrow cultivation eliminates the possibility of concentrating some of the organic matter derived from the breakdown of weeds.

and the spatial specialization of crops that is characteristic of the "ring" cultivation system (Section 10.1.2).

Nevertheless, Dunsmore et al. (1976) (Table10.1) have delineated a number of rotations found among farming communities in Gambia.[50] Also, there are a number of references concerning aspects of cultivation related to rotations. For example, Piault (1965) mentions that women in Niger recognize the value of growing a cereal after bambara nut, a legume traditionally grown by women. Jones (1976) mentions that farmers in Mali recognize the value of the residual fertility—resulting from putting fertilizers on their cottton—in influencing the yield of the succeeding crop.

Rotations obviously have played, and will continue to play, an important role In the research work undertaken in the region.[61] A number of considerations have motivated work in this area. Three of these are as follows.

a. Rotations have been recognized as a possible way of combating *Striga,* which is prevalent among cereal crops.
b. Rotating groundnut with other crops has been recognized as beneficial in reducing the possible incidence of rosette (*Cercospora arachidicola*) disease and in countering the effect of the successive cropping of groundnut—which causes an accelerated breakdown of soil structure with a consequent decrease in permeability and an increase in runoff and erosion.
c. Rising population densities increase the importance of maintaining soil fertility.

Table 10.1. Rotations found in Gambia.

	Cropping pattern[a]	% of fields[b]
Not recommended	G F G F G	44.9
	G C G C G	13.5
	G F F F F	11.9
	G D G D G	10.2
	G F G F F	3.2
	G F G C G	2.8
	D G C G C	2.5
	G C G F G	2.1
	G F F G F	1.8
	G D G C G	1.6
Recommended	G C G F G	2.1
	C G F G G	0.3
	G F G C G	2.8
	F G C G F	0.3

Source: Dunsmore et al. (1976).
a. G=groundnut; C = millef/sorghum; D=hunnry rice: F = fallow.
b. Total number of fields =1037.

In the light of the above concerns, a common rotation that emerges as a recommendation is groundnut or cotton: cereal: groundnut: fallow (Dunsmore et al. 1976; Charreau 1975). Wide-scale trials in southern Senegal over a period of 15 years established that this rotation, combined with a 2-year fallow period, was satisfactory in maintaining soil fertility (Dunsmore et al. 1976). However, it is also thought that a single year of fallow could be adequate if combined with deep plowing (i.e., 200-250 mm), the use of fertilizers, and organic and green manure (Dunsmore et al. 1976; Charreau 1975). There have been many attempts to encourage farmers in the francophone countries to do this. In the Unites Experimentales in Senegal such efforts have been combined with a rotation including a short-season cereal. The specific rotation recommended has been a 4-year one of fallow *or* early millet or maize: cotton or groundnut: sorghum or maize: groundnut (Faye 1977). However, for reasons mentioned below (Section 11.2), such attempts have invariably failed.

10.1.2 THE "RING" CULTIVATION SYSTEM

Throughout many parts of the savanna areas of West Africa, a system has traditionally been practiced that involves the permanent cultivation of some fields, usually near the compound—the place of residence—and the maintenance of fertility through manuring. Fields farther away are cultivated for a few years, after which soil fertility is restored primarily through fallowing (Table 6.4) (Marchal 1977; Hill 1972; Benneh 1973a).

A premium appears to be placed on the permanently cultivated fields located near the compounds. Evidence for this is as follows.

a. Permanently cultivated fields often tend to be smaller near residences, although there may be factors that offset this. For example, fields may be larger if the soils are of low quality (Unite d'Evaluation 1978); generally smaller if population densities are *very* high in the area; etc.
b. There is often a degree of crop specialization with food crops being emphasized on fields near the residence and cash crops are relatively more dominant farther away (Fig. 10.2). Such a trend is consistent with the goal of food self-sufficiency discussed above.
c. Common fields are relatively more frequent near the place of residence, while fields under individual management occur relatively more frequently farther away (Fig. 10.2; Table 6.4; Table 10.2[52]).This could be one of the reasons that food crops tend to be relatively more popular on fields near the compound, since growing food for family consumption is emphasized on the common fields.

50. They reported that the government-recommended rotation was found on only 3.6% of the fields sampled.

51. A useful summary of much of the work in Senegal is given by Charreau (1975).

52. Although the evidence for this becomes weaker with the growing of more cash crops (i.e., compare Tables 6.3 and 10.2).

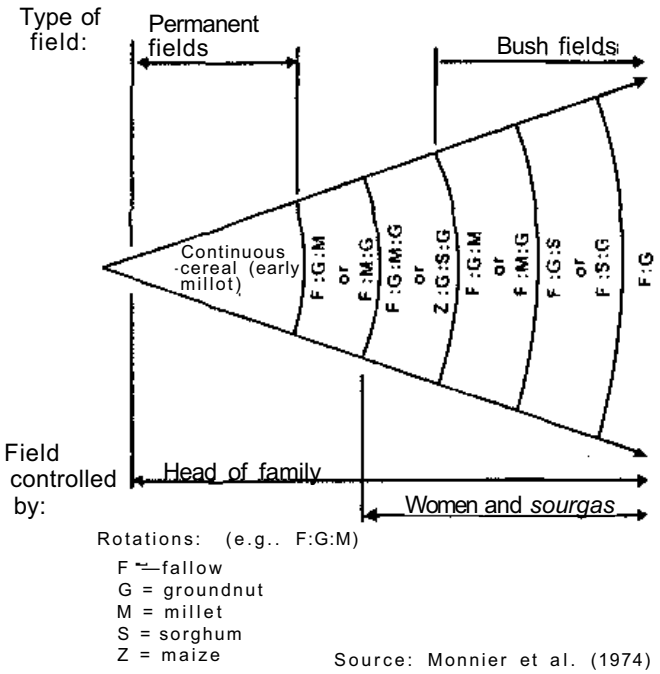


Figure 10.2. Fields around the residence, Senegal.

There are two important implications concerning the "ring" cultivation system.

a. Increasing land shortages concomitant with rising population densities are resulting in an increase in the production of permanently cultivated fields, and the remaining fields are being left fallow for progressively shorter periods (Fig. 10.3). Traditionally livestock herders and sedentary crop farmers have had some symbiotic relationships in which manure for fields is an important element (see Section 11.1). Although with the problems of continuing this complementary relationship in the face of progressive decreases in grazing land, there is also the question of whether such a relationship can provide the increasing amounts of organic fertilizer required to maintain soil fertility. It has been noted that, apart from a few exceptional areas such as that around Kano in northern Nigeria (Mortimore and Wilson 1965), the decrease in yields has not been forestalled.[53] This problem has been of particular concern in the francophone countries, where the introduction of animal traction has been seen as a means of alleviating such problems (Section 11.2).

b. In general there appears to have been an assumption on the part of researchers responsible for developing

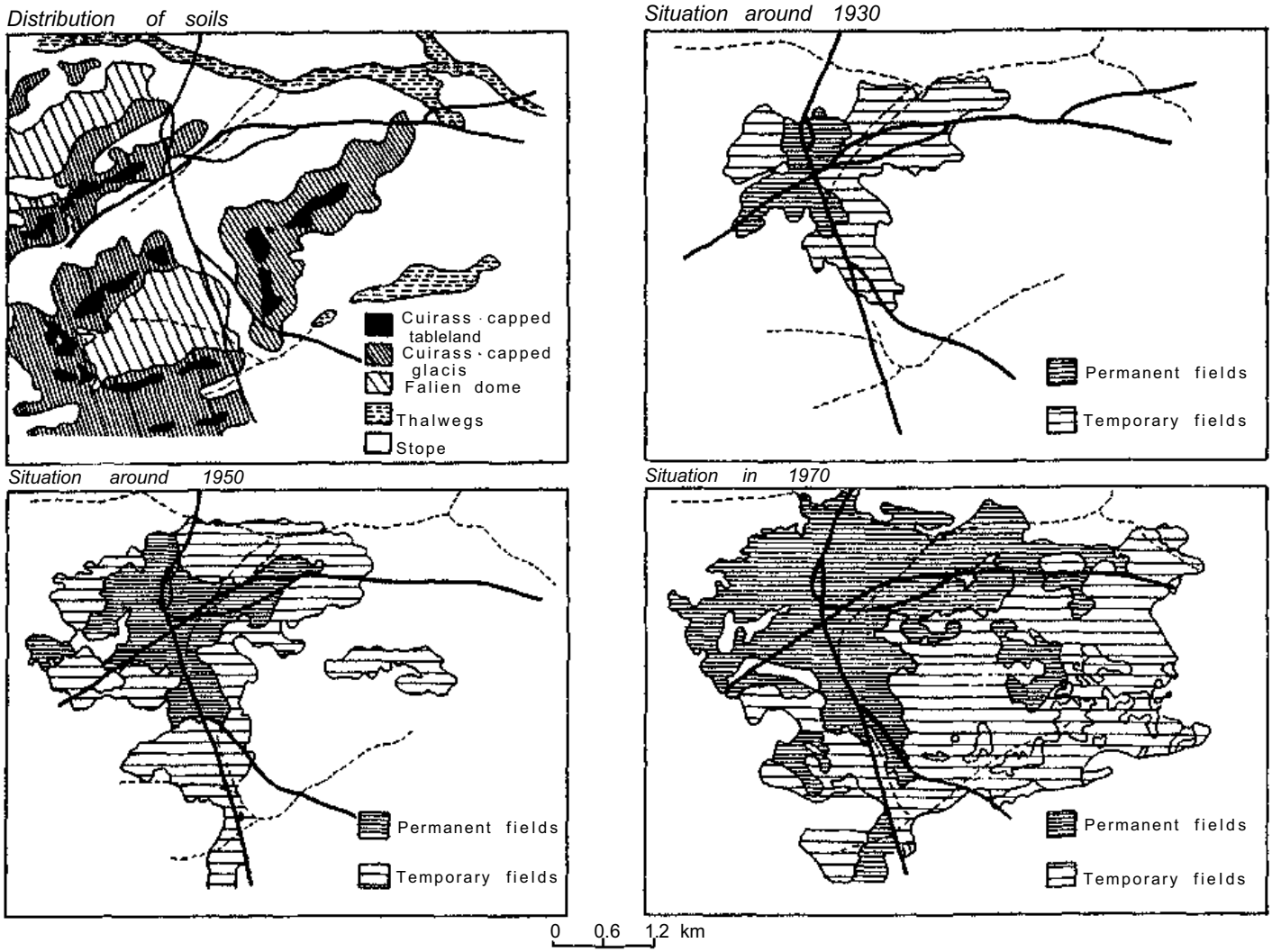
Table 10.2. Type of field and crop enterprise, Mali.[e]

Variable	Sirakeme		Chole		Daban		Kobiri	
	No oxen	Oxen	No oxen	Oxen	No oxen	Oxen	No oxen	Oxen
Percentage of:								
Permanent fields[b]:								
Common	88 (100)	31 (83)	19 (28)	19 (32)	15 (29)	- (-)	5 (17)	1 (5)
Individual	12 (100)	28 (44)	12 (38)	- (-)	37 (77)	3 (5)	34 (47)	32 (39)
Bush fields :								
Common	-	6	50	40	37	29	22	18
Individual	-	35	19	41	11	68	39	49
Sole-cropped- % of:								
Permanent fields	25	0	63	71	100	100	100	100
Bush fields	-	4	22	60	62	83	93	96
All fields	12	2	35	62	81	84	95	99
Mixed crops- % composition[c]:								
ML or SG/CW	72	43	31	58	40	-		
ML/SG	-	-	13	7	-	20		
ML/GN	14	-						
SG/GN		-	25	14	20	20	NOT AVAILABLE	
GN/CW	-	-	5	7	-	40		
GN/DH	14	52		-	40	20		
Others	-	5	26	14	-	-		

Source : Unito d'Evaluation (1978).

a. The figures in the table rofer to fields, not areas.
b. Figures in parentheses refer to the percentage of common or individual fields that are permanent.
c. ML = millet: SG=sorghum; GN = groundnut: CW=cowpea; DH = Deccan hemp.

53. There is a special relationship with the city In this area in which manure is transported from the city to surrounding agricultural areas.



Source : Marchal (1977).

figure 10.3. Evolution of the "ring" cultivation system at Yatenga, Upper Volta.

improved technology that all fields are viewed in the same way by farmers. The above observations concerning the "ring" cultivation system appear to repudiate this assumption, although the implications for develoment of relevant technology are unclear. One would expect, for example, that the fertility would be an important issue with reference to fields close to residential areas, which are also likely to have increased *Striga* infestation due to the continuous cropping of cereal crops. On the other hand, labor efficiency is likely to be more important in more remote fields, but mechanization problems are likely to be greater there because fields often have not been adequately destumped.

10.2 Factors Influencing Crops Grown

The range of possible cropping alternatives is determined by the physical (e.g., weather and soil conditions) and biological factors discussed above (Chapter 2). Table 6.3 shows the change in the composition of crops as one moves from the millet/sorghum domination in the north to a greater relative dominance of groundnut in the wetter south. What actually is grown is also partly determined by the human element and reflects both the "historical" subdimension and the "horizontal" dimension. The "horizontal" dimension includes both exogenous and endogenous factors. Most of the factors that influence the choice of crops grown have been mentioned in different contexts above.

Among the major exogenous factors that have had or currently have an influence are the following.

a. Custom or social reasons. Durand and Ferrler (1963) have observed that millet was at one time in certain areas limited to being a subsistence crop because of a cultural prohibition against marketing it.
b. External institutions. External influences, such as elements of compulsion and support systems geared specifically to cash crops (Ames 1959), have encouraged

the production of groundnut and cotton (Fig. 10.4). Stickley (1977) mentions that in the Eastern ORD of Upper Volta, when institutional credit was being given, farmers were requested to put one-third of their cultivated area Into cash crops. Another example of the influence of support systems is given by J. Murphy (personal communication), where farmers in the AVV project in Upper Volta are compelled to follow a specific systematic rotation delineated by the project management.

c. Population density. As population density increases, this will also influence the types of crops grown. In such situations, crops giving high returns per unit area, which may be grown in soils of low fertility, become relatively more dominant. For example, cassava is becoming more important in a densely populated area in northern Nigeria (Norman et al. 1979).

Among the endogenous factors influencing the crops grown are the following.

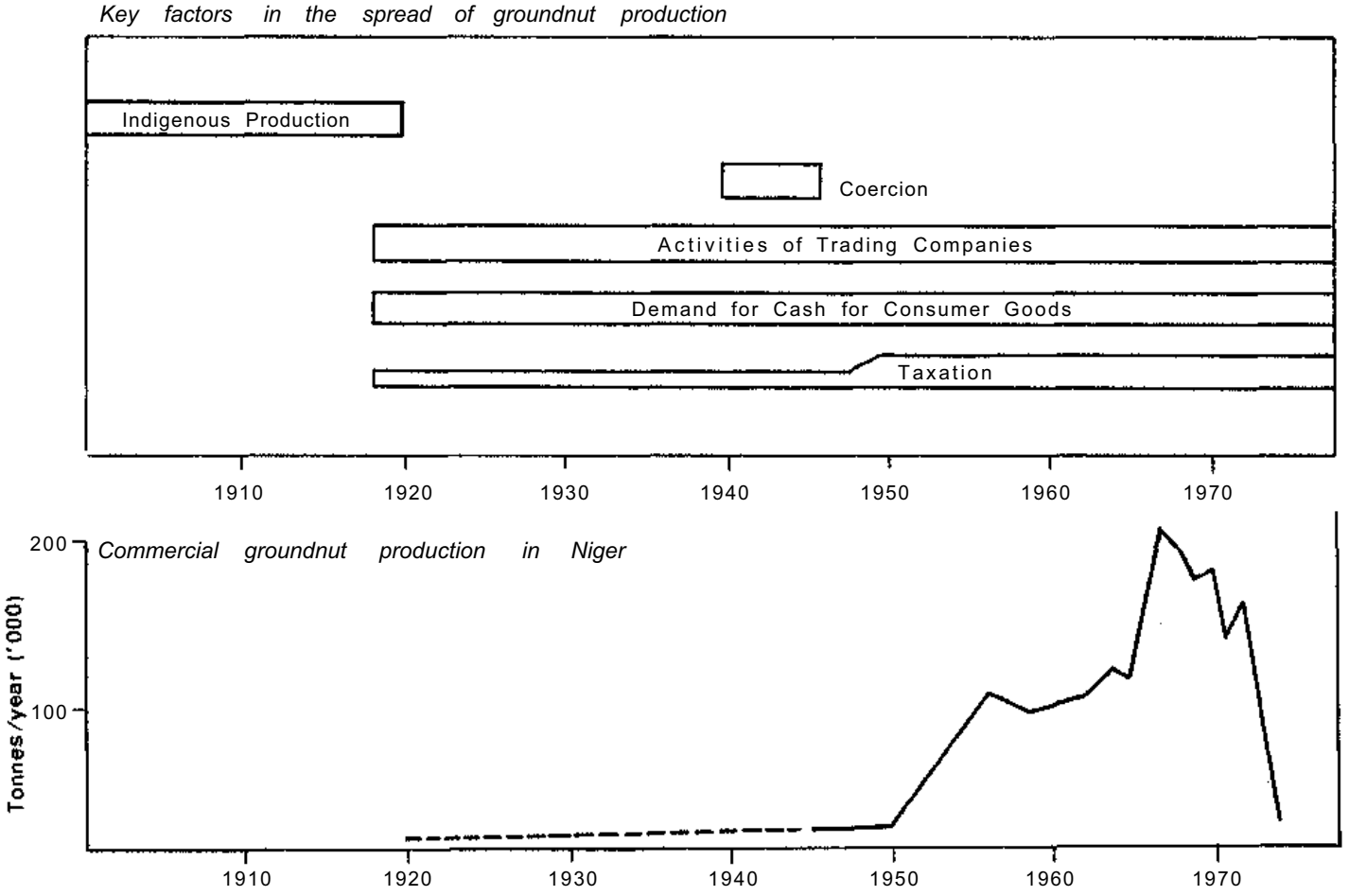
a. Goals. The subversion of a goal of food self-sufficiency to one of producing some export cash crops has been well documented (Section 9.1).

b. Factors related to the resource base. With reference to land, the location of the field, and whether it is an Individual or communal field, will Influence the type of crop that will be grown. Labor availability is, of course, another important factor. Such availability of labor may be both sex- and age-differentiated. For example, in Gambia the help of children has been important for scaring birds from ripening crops (Haswell 1975), while in part of Niger women are responsible for growing bambara nut (Plault 1965).

One of the best-documented studies illustrating the interaction of the various factors influencing what crops will be grown is provided by Haswell (1975), who studied a Gambian village over a period of 25 years. Her relevant findings[54] are the following.

a. Early millet and hungry rice, the traditional early-harvested crops that helped to shorten the hungry season, have decreased in importance because of the decreased availability of women and children to cultivate such crops (Section 13.2.2).

b. Due to favorable government policies, groundnut has increased in significance—both in terms of area



Source: Campbell (1977).

Figure 10.4. Groundnut production, Niger.

54. Some empirical evidence for these observations is give In Table 13.1 and Section 10.4.2.

cultivated and in the proportion of total production harvested,

c. Nevertheless, until the introduction of oxen in a government-supported program in the early 1960s, there was a downward trend in the area of rainfed land cultivated. This trend had commenced with an increase in swamp rice cultivation by women but, after the introduction of oxen, it was reversed. Although some of the increased area cultivated was cropped for groundnut, there was a resurgence of interest in growing late millet, particularly when mixed with groundnut. Weil (1970) has noted the trend back to food crops as a result of the introduction of oxen. However, the food/cash crop ratio for rainfed crops at the end of the 25-year period was still lower than at the beginning. Some of the slack had been taken up with the increased production of swamp rice—which has a much higher yield potential.

The preceding example shows the importance of understanding the dynamic environment in which the farming family operates when developing improved technology. It is necessary to assess its potential relevance, not only in terms of the target group to whom it is being directed, but also in terms of the external institutional support system required for its adoption. Furthermore, it is important to assess the possible ramifications of its adoption—for example, changing responsibility/reward ratios, particularly between the sexes in the family (Eskelien1977), increasing inequalities in the society, etc. These issues have often been ignored in technology development and its extension.

10.3 Mixed Cropping

10.3.1 SIGNIFICANCE

Traditionally throughout the region crops have been grown in mixtures. Simplistically, a mixture can be defined as the practice of growing two or more crops on a given piece of land at the same time. The different crops may be grown together for a short or a long time—a characteristic that has made an acceptable definition of crop mixtures a contentious issue. For the purposes of this review, any degree of overlapping in terms of time was considered to be mixed cropping.

Although there are considerable variations within the region, it appears there are two general conclusions that can be derived from reviewing the literature.

a. Millet and/or sorghum are very commonly grown in mixtures with cowpea. Charreau (1978) observes that, in the drier Sahelian area, millet in mixtures with cowpea dominate. When one moves into more favorable precipitation areas to the south, millet/sorghum mixtures and other crop combinations, including cowpea, become relatively more common. In the south the longer growing season permits the combining of crops with complementary growth cycles (Table 10.4). The overall dominance of the millet and/or sorghum combination mixed with cowpea is also underlined by data for Niger (Table 10.3) and by those published by Delgado (1978) for Upper Volta, where he found that such mixtures occupied about 83% of the cultivated area.

b. It appears that cowpea is almost always grown in mixtures and usually in combinations that include millet or sorghum. This observation comes from field observations throughout the region (e.g., for Mali (Unite d'Evaluation 1978), Niger (Table 10.3) and northern Nigeria (Table 10.4). A number of reasons can be advanced for such a practice but one of the most important is that, under traditional practices, seed yields of cowpea tend to be low due to the susceptibility of the crop to insect damage. There is increasing evidence that insect damage can be reduced by growing cowpea in mixtures (IAR, 1972).

In summary, there is substantial evidence that growing food crops in mixtures still dominates throughout the region. Surveys undertaken in three widely dispersed areas of northern Nigeria (Table 10.4) indicated that only 26% of the total cultivated area was sole-cropped. Although, for reasons mentioned below, the proportion of land devoted to crop mixtures in northern Nigeria might be somewhat higher than in some other areas in the

Table 10.3. Crop mixtures, Niger.

Areas and yields

Crop	% of area of crop in mixture	Yield (kg/ha) as	
		Sole crop	Mixed crop
Millet	52	308	318
Sorghum	89	288	187
Cowpea	100	-	53
Groundnut	62	NA	NA
Cotton	11	NA	NA
All crops	50	-	-

Frequency

Crop enterprise	Frequency (%)	
Millet/cowpea	58	
Millet/ sorghum	9	
Millet/red sorrel [a]	3	
Millet/groundnut	2	
Sorghum/cowpea	2	
Total two-crop mixtures[b]		76
Millet/sorghum/cowpea	16	
Millet/sorghum/red sorrel	6	
Total three-crop mixtures[b]		22
Total four-crop mixtures		2

Source : Niger, Ministere de l'Economie Ruralo (1973).

a in French red sorrel is oseille.

b. Includes other crop mixtures not specified by name In the table.

Table 10.4. Crops, and crop enterprises, northern Nigeria.[a]

	Sokoto		Zaria		Bauchi		Overall average	
% of adjusted[a] hectares grown[b]:								
Millet and late millet	32	(15)	20	(2)	21	(25)	25	(11)
Sorghum	17	(3)	29	(27)	48	(57)	30	(29)
Groundnut	2	(28)	11	(16)	12	(50)	8	(31)
Cowpea	26	(0)	11	(2)	9	(4)	16	(2)
Cotton	0	(89)	9	(31)	0	(100)	3	(71)
Others	23	-	20	-	10	-	18	-
Total adjusted hectares grown	2498		2422		1826		2249	
% of cultivated hectares sole-cropped	9		23		46		26	
Value of mixed cropping index[c]	2.73		2.43		1.75		2.30	
Major crop enterprises as % of total hectares cultivated:								
Sorghum	1		8		27		10	
Millet/sorghum	1		23		21		14	
Millet/sorghum/cowpea	35		4		6		16	
Millet/sorghum/cowpea/red sorrel	12		-		-		4	
Total number of crop enterprises	75		200		60		112	

Source: Norman et al. (1979).

a. For adjusted hectares the area of each crop in the mixture was found by dividing the area for the crop mixture by the number of crops in the mixture.
b. The figures in parentheses represent the % of the total adjusted hectares that was sole-cropped.
c. A higher value indicates the preponderance of more crops in the mixtures. The method of calculating it is discussed elsewhere (Norman 1972).

region, it appears that the neglect in investigating the characteristics of mixed cropping is regrettable.

10.3.2 RATIONALIZATION

Why is the practice of growing crops in mixtures so common? Farmers surveyed in northern Nigeria gave a number of reasons. The major reason could be interpreted as being the need to maximize the return from the most limiting factor. Such a reason is consistent with the goal of profit maximization. Fewer farmers gave the need for security as the main reason for growing crops in mixtures. In addition, a number of farmers mentioned that it was traditional to grow crops in mixtures. The desire for security probably does, in fact, account for the traditional popularity of mixed cropping (Norman 1974).

Analysis of data on mixed cropping in northern N igeria (Tables 10.5 and 10.6) indicates that, while the yields of individual crops were depressed when grown in mixtures, such reductions were more than offset by other crops in the mixture. The result was a higher return per hectare for crop mixtures, although the labor differential between mixtures and sole crops was reduced when the labor put in during the labor bottleneck period was considered. In spite of the higher labor inputs, the returns per annual man-hour and, to an even greater extent, per man-hour put in during the labor bottleneck period, were higher for crop mixtures than for sole crops. The latter results indicate that mixed cropping helps to alleviate the problem of the labor bottleneck period, which in this case was for weeding. Finally, the results show that growing crops in mixtures under indigenous levels of technology in the areas studied was not only more profitable but also more dependable (Abalu 1976).[55]

In addition to the general conclusions specified above, data for two of the most common crop mixtures grown in different ecological areas were analyzed. In Table 10.7 data concerning these two crop mixtures—i.e., millet/ sorghum and millet/sorghum/cowpea—are compared with reference to the areas around Sokoto and Zaria in northern Nigeria. The results indicate that, in the drier area of Sokoto, the average number of plant stands per hectare was much lower, reflecting the farmers' response to the poorer soil moisture expectations in the area—where lower total precipitation is combined with greater

55. An unfortunate omission during the data collection was information on the soil types. Casual observation did not appear to indicate that crop mixtures were relatively more common on the better-quality soils, but this was not empirically verified. If, in fact, this were true, then the Intrinsic superiority of crop mixtures could be questioned.

Table 10.5. Comparison of sole and mixed crops on rainfed land, northern Nigeria.[a]

	Sokoto		Zaria		Bauchi		Average % change from sole crops to crop mixtures
	Sole crops	Crop mixtures	Sole crops	Crop mixtures	Sole crops	Crop mixtures	
Labor (man-hours/ha):							
Annual	425.8	485.6	362.3	586.4	564.9	597.5	27.2
Labor peak period[b]	232.5	238.0	122.3	157.9	247.4	247.4	10.5
Yield (kg/ha):							
Millet	736	686	-	367	727	393	-26.4
Sorghum	652	122	786	644	840	729	-37.5
Groundnut	429	188	587	412	392	217	-43.5
Cowpea		56	-	132		52	-
Value of production (₦)per:							
Hectare	31.65	40.80	37.96	61.36	29.50	33.73	34.9
Annual man-hour	0.15	0.30	0.32	0.27	0.20	0.20	28.2
Man-hour put in during peak period	0.32	0.79	0.86	1.04	0.59	0.62	56.8
Net return (₦/ha), labor:							
Not valued	30.74	38.94	36.79	59.48	30.74	35.76	34.9
Costing hired labor	28.27	36.13	33.41	54.02	28.64	31.18	32.8
All costed	17.96	24.36	18.31	29.60	14.80	18.68	41.2

Source : Norman et al. (1979).

a. The weighting system used in deriving the figures used for comparison in the table is discussed elsewhere (Norman 1974).
b. Peak periods were: June — August in Sokoto; June and July in Z aria; and July— September in Bauchi.

variability in its distribution at the beginning and the end of the growing season (Table6.13).[56]The lower number of stands per hectare found to exist in the Sokoto area consisted of a much higher proportion of millet stands compared with other constituents in the mixture, reflecting the comparative advantage that millet enjoys in the drier areas. Further support for this observation is that the yield per stand of millet was higher in the drier area, and the yields per stand of other crops were correspondingly lower.[5'] In the light of these observations, a higher yield of millet per hectare was obtained in the Sokoto area compared with the Zaria area, while the yields of other crop constituents were correspondingly lower. In total, the overall value of production per hectare was lower in the Sokoto area relative to the Zaria area, although the returns per man-hour were very similar. This is due partly to the fact that the man-hour input per hectare was lower in the Sokoto area.

The above analytical summary gives substantial empirical support for the reasons given by farmers for growing crops in mixtures. It also indicates the remarkable adaptation that has taken place in designing crop mixtures that are compatible with both the technical and the human element.

10.3.3 CHANGES AND IMPLICATIONS

The status of crop mixtures in the SAT region today is a function of the interaction of both the "vertical" and "horizontal" dimensions. The results of surveys done in various parts of northern Nigeria reflect an environment in which no animal traction and few improved inputs are used. As a result, the cropping systems probably have changed very little over the generations.

However, two significant changes have taken place in the francophone countries that have had an impact on the significance of mixed cropping. These are as follows.

a. Development operations oriented toward export cash crops (Section 4.4.1), with their concentrated support systems, including extension, have no doubt had such

56. It may also be a response to the lower fertility of the soil compared with the Zarla area. Such an observation would be contrary to that found by Lagemann (1977), who concluded that in the much wetter area of eastern Nigeria (i.e., outside the semi-arid region), farmers tend to plant more densely when the soil fertility declines. The difference between that practice and the one suggested In this review could perhaps be explained in terms of the much higher potential for soil moslture stress in the semi-arid region.

57. Nevertheless, one point that should be emphasized is that, although In seed terms yields of individual crop constituents might be depressed, other parts of the plant can still have considerable economic value to the farmer. This applies particularly to the haulm of cowpea which Is a good livestock feed. Estimates of the value of the haulm were omitted from the analysis of the individual crop enterprise.

Table 10.6. Dependability of return from sole and mixed crops grown on rainfed land, northern Nigeria.[a]

Value of production (₦) per:	Variable	Sokoto		Zaria		Bauchi	
		Sole crops	Crop mixtures	Sole crops	Crop mixtures	Sole crops	Crop mixtures
Hectare	Median	30.15	40.03	36.08	59.11	29.18	31.38
	Interquartile range	6.18-44.48	27.43-54.61	21.10-53.40	37.26-83.92	13.49-41.56	2.10-48.95
	L or M[b]	29	33	24	17	43	42
Annual man-hour	Median	0.06	0.10	0.07	0.09	0.06	0.07
	Interquartile range	0.01 - 0.11	0.07 - 0.16	0.03 - 0.17	0.07 - 0.14	0.03 - 0.08	0.04 - 0.10
	L or M	13	33	32	48	44	38
Peak period man-hour	Median	0.08	0.23	0.29	0.33	0.12	0.16
	Interquartile range	0.02 - 0.20	0.12 - 0.36	0.09 - 0.43	0.20 - 0.65	0.01 - 0.20	0.09 - 0.29
	L or M	14	33	44	40	40	40

Source: Norman et al. (1979).

a. Abalu (1976) has shown for the Zaria study area that crop mixtures contribute to income stability.
b. L = % of the crop mixture observations that were Less than the median (50% observation) for sole crops.
M = % of the sole crop observations that were More than the median (50% observation) for crop mixtures.
The L value appears under sole crops and the M value under crop mixtures.

58. A fairly common crop mixture in northern Nigeria is the planting of groundnut along ridges with rows of millet and/or sorghum planted across the ridges in rows widely apart (e.g., about 5 m). Such a system apparently exists to some degree in other parts of the region but has decreased in significance as a result of the changes discussed above. It is also interesting to note that apparently the popularity of this system in northern Nigeria increased to some extent in the years immediately after the drought of the early 1970s. It appears that this was a risk-aversion strategy.

Table 10.7. Comparisons between two mixed cropping enterprises, northern Nigeria.

	Millet/sorghum		Millet/sorghum/cowpea	
	Sokoto	Zaria	Sokoto	Zaria
Man-hours/ha	505.1	611.1	568.5	734.4
Numbers of stand/ha	10,626	22,506	16,272	28,260
Ratio of millet to other stands	1.0/0.9	1.0/2.0	1.0/0.5/0.4	1.0/2.0/1.0
Yield (kg/stand):				
Millet	0.16	0.05	0.09	0.05
Sorghum	0.04	0.05	0.03	0.05
Cowpea	-	-	0.02	0.02
Yield (kg/ha):				
Millet	892	370	772	400
Sorghum	186	768	124	714
Cowpea	-	-	63	167
Value of production (₦) per:				
Hectare	49.94	66.05	46.26	76.33
Annual man-hour	0.11	0.12	0.13	0.13

Source: Norman et al. (1979).

an impact. The recommendations for growing cash crops involve growing them in sole stands and, as a result, the significance of such crops in mixtures had decreased. In contrast, in northern Nigeria cash crops are still frequently grown in mixtures (Table 10.4),[58] although Stubbings (1978) notes a trend (in one of the

Integrated Agricultural Development Projects recently initiated with the World Bank's support) of sole crops becoming relatively more dominant. He speculates that this may be due to the impact of the extension service in encouraging farmers to plant crops in sole stands.

b. The introduction of animal traction in some development operations reduces the possible combinations of crops that can be grown. For example, it is not possible to grow crops both on the ridge and in the furrow, as is sometimes found in the hand-labor systems practiced in northern Nigeria (Norman 1972). However, animal traction does not appear to eliminate the potential for mixed cropping under practical farming conditions (Unite' d'Evaluation 1978). Nevertheless, it is likely that, over time, the impact of animal traction has negatively influenced the relative dominance of crop mixtures in the region.

The question thus arises as to whether it is necessary for research workers *to* emphasize mixed cropping. Studies in India have revealed that high-yielding varieties have increased the significance of sole cropping (Jodha, 1977). It is tempting to conclude that the adoption of improved technology will and should lead to the demise of mixed cropping. However, emphasis on research work in the mixed cropping area can be justified for a number of reasons.

a. Crops such as millet, sorghum and cowpea, that come under the mandate of ICRISAT, are still mainly grown in mixtures throughout the region. These systems of mixed cropping appear to be well adapted to the technical and human environment. The apparent increased vulnerability of farmers In the region, as a result of increased contact with the outside world, has been repeatedly cited. It appears that research work *on* food crops in a mixed-cropping framework could help to counterbalance past neglect of the rationales and advantages of mixed cropping.

b. There is increasing empirical evidence emerging at both ICRISAT and the Institute for Agricultural Research, Samaru, in northern Nigeria that demonstrates the potential for growing crops in mixtures where improved technology is used (Andrews 1972; Kassam 1973; Baker 1975 and 1979; Kowal and Kassam 1978). Most of the work to date demonstrates that the adoption of such systems involves making good use of an improved technical environment. Such systems may also be better adapted than sole-cropping systems to the human environment in the region. The move toward sole-cropping patterns has not always been due to the intrinsic superiority of sole crops under Improved technological conditions. In many cases, pressures exerted by extension services, and the fact that technology development has often been associated with the idea of growing crops in sole stands, have also been quite important influences. There is also no evidence to suggest that mixed cropping is incompatible with mechanization involving animals. In fact, Andrews (1972) has demonstrated that slight modifications to cropping patterns can lead to compatibility between the two.

In concluding this section, we wish to emphasize that care needs to be taken in choosing the criteria for evaluating the results of research work on improved crop mixtures. Obviously, the criteria employed should reflect those that are important to the farmer. For example, one criterion that appears to be important in many parts of the region is the multiple use of products. In some areas, crop residues from cowpea used as livestock feed[59] appear to be a more important product than the grain which is used for human consumption. Research work that concentrates simply on increasing grain or seed yields may not result in an improved technology that is relevant for many farmers. It is encouraging to note that research programs in the region increasingly appear to recognize this possibility.

10.4 The Economics of Crop Processes

10.4.1 PROBLEMS

Little information has been collected at the farm level which could be used for individual crop enterprise analysis. Much of the information available in the francophone countries was either simulated under experimental conditions or simply involved analysis of the farm business in aggregate. In addition, it proved to be virtually impossible to undertake any meaningful comparative analysis. The reasons for this were as follows.

a. Different levels of technology and practices. Where data had been collected, individual crop enterprise details were seldom carefully specified, making it difficult to draw definitive reasons for differences in the results from different studies. In addition, although mixed cropping is recognized as being common, hardly any analysis exists concerning crop enterprises under mixed cropping.[60] Indeed, the significance of mixed cropping is often mentioned, but analysis is then carried out as though the enterprises were sole crops.

b. Measurement and computational problems. Few studies have involved the collection of labor flow data. This limits the possibility of allocating labor to individual crop enterprises. Another problem which exists is that, even if the data collected reflect one level of technology, there is no recognition of the heterogeneity that exists in terms of factors that can influence the return from its application. Critical information such as

59. Stalks of some cereals can also be Important.

60. Studies undertaken in northern Nigeria provide most of the available data on such enterprises. Such Information can be found in published form in Malton 1077; Norman 1972; Norman et al. 1976.

timing of operations, soil type, incidence of disease, etc., are often not collected. Matlon and Newman (1978) note that, in Matlon's study in northern Nigeria, an attempt was made to collect information from the farmers concerning the problems that they—the farmers—experienced in growing particular crops. Unfortunately, during the analysis it was found that the farmers who had the most problems were the ones who obtained the highest yields! This is not surprising in the sense that one would expect such farmers to be more observant; but it does imply the need for more direct objective measurements in order to collect such data. In terms of analyzing the results of different crop enterprises, another major problem inhibiting comparative analysis is that of differences in weighting labor contributed by individuals of different ages and sex. Yet another analytical problem arises because many of the inputs and, indeed, often high proportions of the product, do not pass through the market system. As a result, different researchers use different implicit costing and valuing techniques.

Relevance. Even if the above problems did not exist, questions can still be raised about the relevance of the results. Studies undertaken at the village level often have only a 1-year time span. As a result, cross-sectional information obtained from such studies does not reflect stability of returns as determined by interannual variations in weather conditions. Also, often only average input/output information is given for different crop enterprises, thereby obscuring possible important distributional differences in both determinants and returns. Finally, individual crop enterprise analysis is not by itself sufficient to ascertain its value. An important component in assessing an enterprise's relevance is its compatibility with the whole farming system.

The above problems limit the usefulness of analyzing the economics of different crop processes. Instead, the following sections present examples from the literature which illustrate specific points that have been or are to be emphasized in other parts of this review. At the same time, we wish to note that, in places, the analytical rigor is not at the level that we consider to be desirable.

10.4.2 ADJUSTMENTS BETWEEN CROPS

The data in Tables 10.8 and 10.9 give some empirical evidence supporting the reasons behind the trends in adjustment among crops that were suggested to be occurring in Gambia (Section 10.2). Although hungry rice and early millet were traditionally useful crops for overcoming the problems for the hungry season, the yields per hectare were low compared with most other crops grown on rainfed land. Since such crops were grown on some of the best land near the compounds, and the women and children were responsible for cultivating them, it was not surprising that, when the government built causeways, women switched to working on swamp rice where the return per hectare was much greater. Another point to note from these data is that the emphasis on groundnut production was not surprising since this crop appeared to give a higher return per hour of work and per hectare than other crops grown on the rainfed upland. Indeed, it is likely that this gap becomes even greater with the introduction of oxen. The data in Table 10.9 indicate that the use of oxen, together with the improved practices, lead to an increase in labor productivity on an annual basis as well as on the basis of labor during the July bottleneck period.

Table 10.8. Yields and returns per unit input, Genieri, Gambia.

Crop	Description	Yield (kg/ha) Year			1949			
		1949	1962	1973	Average hours required per ha[a]	Yield (kg of commodity per hour of work)	kg of rice equivalent[b] Per ha	Per hour
Late millet	Grain	256	350	329	544	0.47	153	0.28
Early millet	Grain	319			660	0.49	191	0.29
Sorghum	Grain	177			166	1.07		
Hungry rice	Grain	115			116	0.99		
Groundnut :								
Compounds	In shell	541	996	893	658	0.82	287	0.44
Stranger farms	In shell	432			360	1.20	229	0.64
Rice :								
Upland	Paddy	340	477	676	2051	0.17	340	0.17
Swamp	Paddy	991	1003	1506	1534	0.65	991	0.65

Source : Derived from Haswell (1975).

a. Apart from the rice crop where the work is done bv womon the other work is done by men.

b. These calculations were based on the relative price ratios given by Haswell (1953).

Table 10.9. Comparative financial analysis of groundnut production, Gambia.

Groundnut	Yield (kg/ha)	Labor input (man-days) Total	July	Output (kg/man-day) Total	July	Variable costs per ha (D)[a]	Value output per ha (D)	Gross margin (D) Per ha	Per man-day Total	July
Oxen[b]	2004	114	22	17.59	91.1	88.92	454.9	366	3.21	16.6
Manual[b]	2117	178	43	11.87	49.2	66.20	480.6	414	2.33	9.6
Control	1361	109	25	12.48	54.4	38.29	308.9	270	2.48	10.8

Source : Lowe (in Dunsmore et al. 1976).

a. Variable production costs include seed dressing, fertilizer (subsidized), and bags. The oxen "package" costs include a depreciation component for oxen equipment spread over the average "package" area in the farming system. Casual labor is not costed. Costs are given in dalasis, the Gambian currency (D).

b. Using improved technological package.

10.4.3 EFFECT OF ANIMAL TRACTION ON LABOR TIME

Animal traction has been perceived as a means of increasing labor productivity, particularly during bottleneck periods. Table 10.10 shows the time taken to cultivate groundnut and cereal crops in Senegal and Mali. The figures have to be viewed with caution since they are not related to yields. However, in general, the data indicate a relatively greater reduction in labortime per hectare in the cultivation of groundnut in comparison with cereal crops when animal traction is used. This perhaps is not surprising, since animal traction has often been introduced as part of a "package" that emphasizes export cash crop production. Comparison of the relative efficiency of oxen versus hand-cultivation methods on individual operations Is quite difficult. Where data are available, details about the equipment available to farmers are not. Table 10.10 indicates that, in Senegal and Mali, the weeding operation benefited most from the utilization of oxen.This is at variance with observations elsewhere, where claims have been made that the equipment introduced to farmers does not always help ameliorate the effects of the weeding bottleneck periods (see Section 11.2), although it can reduce interrow weeding time.

10.4.4 COMBINATION OF LAND-INTENSIVE IMPROVED PRACTICES AND ANIMAL TRACTION

Tables 10.11,10.12, and 10.13 indicate results from testing improved technologies in the cultivation of maize, cotton and sorghum in northern Nigeria. A sample of farmers using oxen was used to compare improved technologies and indigenous practices. While data were not collected from farmers using hand labor only, estimates were made on the basis of ratios derived from other studies in the area. It is useful to consider a few major points of relevance to this review.[61]

a. Implementing the recommended practices involved the use of substantially more labor, whether the operations were done with hand labor only or with oxen. The major increases involved harvesting the higher yields. As a result a new bottleneck was created. Although the biggest absolute increases in hours occurred during the harvest period, the highest relative increases were recorded during the June-July weeding bottleneck period. Indeed, as suggested above (Section 6.3.2), the critical significance of timing at this period may mean that this is a more severe constraint than that which occurred at harvesting. Although the final results indicated that net returns per hectare for the improved technologies were higher, in terms of return per man-hour and per man-hour in the June-July labor bottleneck, the record was mixed.[62]

b. Changing the power source from hand labor to oxen appears to have a positive effect on labor productivity. Oxen plus equipment are used in the region primarily for land preparation and for some interrow cultivation with ridging equipment. However, the problem of intrarow cultivation remains; consequently hand weeding is still a major operation even when oxen are utilized. Curiously enough, oxen are not generally used for evacuating crops from the fields in the region. This is related to the fact that many farmers who own oxen do not possess carts. The pattern of use for oxen thus tends to result in a different labor distribution during the farming year compared with that for labor. Figures 6.4 and 6.6 indicate that the use of oxen tends

61 More detailed discussion of the individual crop technologies studied may be found in: Norman in Kowal and Kassam 1978; Beeden, Hayward and Norman 1976; Norman et at. 1979.

62 It should be emphasized, however, that these are not the only criteria for assessing the relevance of Improved technologies. Questfons such as the stability of returns, and whether the improved technologies fit in with the farming system as a whole, are discussed in the references cited above.

Table 10.10. Labor required to grow groundnut and cereals, Mali and Senegal.[a]

Activity	Groundnut: Senegal (hours/ha) Oxen	Hand	% change	Groundnut: Mali (days/ha) Oxen	Hand	% change	Millet and sorghum: Senegal (hours/ha) Oxen	Hand	% change	Millet and sorghum: Mali (days/ha) Oxen	Hand	% change
Land preparation	136	169	-19.5	18.3 (1.7)	19.8	- 7.6	66	38	+ 94.7	14.6 (1.3)	11.0	+32.7
Planting				9.4 (0.9)	12.7	-26.0	8			5.1 (0.6)	4.0	+27.5
Weeding	110	376	-70.7	26.7 (0.5)	30.4	-12.2	86	256	- 66.4	23.6 (1.8)	25.8	- 8.5
Guarding				3.8	7.8	-51.3	----	----		2.0	1.8	+11.1
Harvesting	210	210	---	44.1 (0.6)	56.6	-21.4	64	62	+ 3.2	35.6 (0.8)	30.6	+16.3
Preparation for sale				---	---	---				---	---	---
Total	456	755	-39.6	102.3 (3.7)	127.3	-19.6	224	356	- 37.1	80.9 (4.5)	73.2	+10.5

Sources: Ruthenberg (1971) and Unité d'Evaluation (1978).

a. Figures in parentheses denote the number of days in which oxen were used.

to accentuate the harvesting bottleneck relative to the one in June and July. The data in Table 10.13 indicate that the use of oxen does result in a substantial Increase in labor productivity compared with hand power, and that this increase is further augmented when combined with land-intensive technology, such as the improved technological packages that were tested with the farmers (see Table 10.12). This conclusion is consistent with the data obtained in Mali by the Unite d'Evaluation (1978) which noted the beneficial effect of combining equipment with fertilizer. The importance of combining improved land-intensive technological packages with the introduction of oxen has, in fact, been one of the cornerstones of the implementation of animal traction in many francophone countries (Section 11.2). Conceptually, their ideas include more than those mentioned in the present section. Residue incorporation is omitted from the present discussion but is discussed below.

10.4.5 DETERMINANTS OF YIELD

Various studies have provided useful information about individual factors affecting yields. However, most published analysis lacks rigor, making it difficult to conclude that the effect of a factor on yield has been uniquely identified. Nevertheless, the following observations' are often made concerning major influences on yields.[63]

a. Groundnut and cotton respond to early planting (Haswell 1953; Unite d'Evaluation 1978; Beeden, Norman et al. 1976). Cash crops are thus placed in a competitive position with food crops, since critical labor bottlenecks tend to occur at the beginning of the rainfed agricultural season.
b. Both cereal and cash crops benefit from timely and good weeding.[64] This gives extra significance to the weeding bottleneck, although it does not appear to have received the attention it deserves from research workers.
c. In terms of rotations, yields of groundnut are adversely affected when the crop in the preceding year was also groundnut, compared with the alternatives of cereals or fallow (Dunsmore et al. 1976; Unite d'Evaluation 1978).

The above discussion highlights the need for a more detailed investigation of factors which influence yields.[65] Improved technological packages are often compared

63. These observations concern results obtained only from studies under practical farming conditions. Very useful information under simulated conditions, such as that reported by Charreau (1975), is not considered in the current discussion.
64. Haswell (1953) comes to the interesting conclusion that higher planting population densities could counteract to some extent the negative influence of bad weeding.
65. Other determinants mentioned less commonly were that cereals grow well under leguminous trees such as *Acacia albida* (Lunlng 1963) while such crops are also more responsive to plowing than is groundnut (Monnier 1974).

Table 10.11. Economics of sole-crop enterprises involving the use of two levels of technology and animal traction, northern Nigeria.[a]

Variable	Sorghum		Cotton		Maize
Level of technology	Indigenous	Improved	Indigenous	Improved	Improved
Yield (kg/ha)[b] : 1973	436 ± 172	1161 ± 385	454 ± 122	658 ± 125	2867 ±516
1974	845 ± 112	1530± 245	364 ± 128	778 ± 127	2927 ± 589
% covering costs: 1973	83	100	88	79	100
1974	89	100	100	100	100
Inputs (per hectare):					
Fertilizer (N:P:K)	0:0:0	95:46:0	0:0:0	27:22:0	189:49:49
Labor (man-hours)[c]	199.4	337.3	275.8	430.4	354.0
Inputs costs (₦/hectare)					
Nonlabor costs	11.71	40.92	9.22	31.00	65.90
Labor (% hired)	20.53 (55.8)	34.72 (61 .6)	23.41 (60.3)	36.07 (76.4)	36.32 (54.8)
Net return (₦/hectare)	45.02	81.62	19.68	40.73	190.36
Net return (₦/man-hour):					
June-July	0.93	0.74	0.31	0.31	1.68
Excluding harvesting	0.43	0.52	0.11	0.16	1.29
Total	0.21	0.22	0.06	0.08	0.51

Source : Norman et al. (1979).

a. The two levels of technology refer to land-intensive components and not to differences in power source. The same applies to Tables 10.12 and 10.13.
b. For the economic analysis the average of the results for the 2 years is presented.
c. Excludes threshing and time spent travelling to and from the field. The conversion ratios to convert hours to a base using only hand labor used in Figures 6.4 and 6.5 and Tables 10.12 and 10.13 are discussed elsewhere (Norman et al. (1979).

Table 10.12. Change in labor requirements and net returns from adopting improved technological packages, Daudawa, northern Nigeria.

Variable	Hand power only		Oxen power	
	Sorghum	Cotton	Sorghum	Cotton
Increase in man-hours per hectare (% increase):				
June-July	67.0(108.8)	46.2(46.7)	54.6(119.9)	55.1(100.5)
Harvesting	98.4 (93.5)	92.5(74.7)	94.1 (92.6)	92.4 (74.7)
Total	159.6 (66.3)	132.7(34.5)	137.9 (69.2)	154.6 (56.1)
Increase in net return in ₦ per hectare (% increase)	23.68(46.2)	23.01(125.8)	36.61(81.3)	21.05(107.0)
Change in return/man-hour (₦):				
June-July	-0.28	0.08	-0.19	—
Excluding *harvesting*	-0.03	0.06	0.09	0.05
Total	-0.04	0.03	0.01	0.02

Source: Norman et al. (1979).

Table 10.13. Decrease in labor requirements when oxen power is used instead of hand power. Daudawa, northern Nigeria.

	Indigenous technology		Improved technology		
	Sorghum	Cotton	Sorghum	Cotton	Maize
Decrease in man-hours per hectare (% decrease):					
June-July	16.1 (26.1)	43.7(44.4)	28.4(22.2)	34.8(24.1)	59.6(35.7)
Harvesting	3.4 (3.3)	---	7.7 (3.8)	---	90.7(29.7)
Total	41.5(17.2)	108.4(28.2)	63.1(15.8)	86.5(16.7)	172.3(32.7)
Change in net return in ₦ per hectare (% change):	-6.23(-12.2)	1 .40(7.7)	6.70(8.9)	-0.56(-1 .4)	6.94(3.6)
Change in return/man-hour (₦):					
June-July	0.12	0.14	0.21	0.06	0.63
Excluding harvesting	0.06	0.05	0.18	0.04	0.50
Total		0.02	0.05	0.01	0.18

Source: Norman et al. (1979),

with indigenous practices, but the comparison is made on the basis of a package rather than on the differential impact of specific components in the package. Many farmers can be expected to be unwilling or unable to adopt improved technological packages in their entirety. Therefore, knowledge of the impact of individual package components, in conjunction with traditional practices, could be useful in helping extension workers to give practical advice to farmers who, for one reson or another, cannot or are unwilling to adopt the whole package.

11

Crop-Livestock Interaction

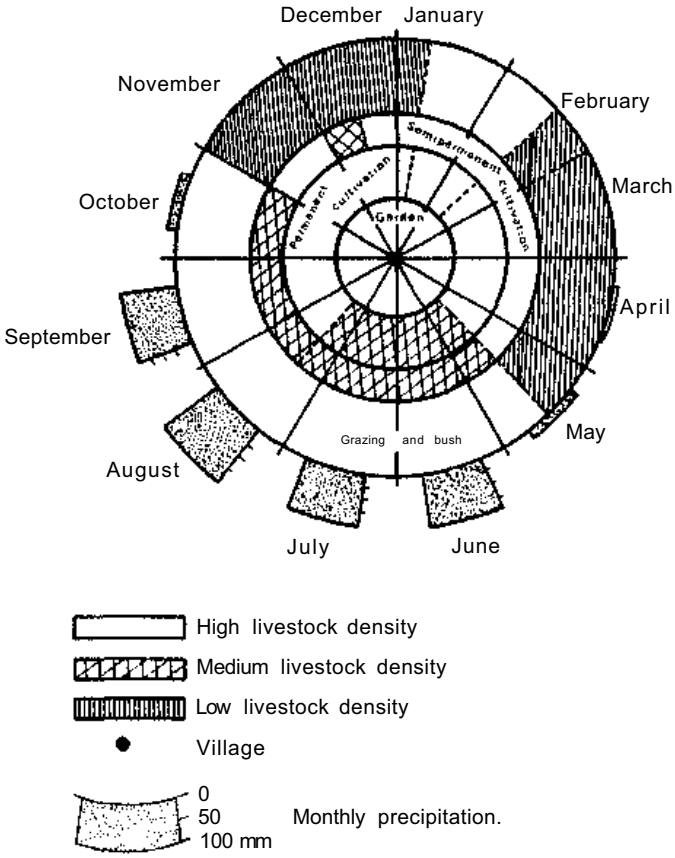
11.1 Other Than Animal Traction

As previously noted, the potential benefits of some degree of integration between crops and livestock has long been recognized in the SAT of West Africa. These benefits include: permitting the more efficient use of land unsuitable for crop production; providing manure; providing sources of power, income, savings and investment; and providing alternative uses for crop residues and products.

Livestock ownership and management functions are sometimes separated, the latter being in the hands of herders—usually members of the Fulbe[66] ethnic group—who also own cattle in their own right. Delgado (1978), for example, found that 60% of the cattle in 14 of the Voltaic Fulbe herds surveyed in 1977 belonged to non-Fulbe proprietors. Hopkins (1975) in Senegal also documented the system of paying herdsmen to look after the cattle belonging to a number of families. It is obvious that such differentiation of management and ownership functions can cause problems In the improvement of livestock husbandry (Eriksen 1978).

In spite of the apparent dichotomy between the day-to-day management of livestock and crop cultivation, there has traditionally been a symbiotic relationship between livestock herders and crop farmers in which crop residues for the livestock and manure for the fields are important elements. Such relationships have traditionally developed in areas with relatively low population densities. These relationships were well integrated with the "ring" cultivation system discussed in chapter 10. Delgado (1978) found that on average 151 kg/ha/year of manure were applied to fields near the compound, while only 5 kg/ha/year were applied in the bush fields. A typical relationship between herders and cultivators is that described by Guillard (1965) in northern Cameroon, illustrated in Figure 11.1.

Because of increasing population densities, the relationship between herders and cultivators is becoming strained (Baier and King 1974; Horowitz 1972; Bernus 1974; Raay 1975; Diarra 1975).[67] Increases in the total area cultivated,[68] together with a decrease in the amount of land fallowed, is decreasing the availability of areas for livestock grazing. At the same time, the need for manure to maintain soil fertility Is increasing. Haswell (1975) notes an increasing awareness by farmers of the value of manure for improving yields from crops. The figures in Table 11.1 for various parts of northern Nigeria illustrate the increases in organic manure applied by farmers as population density increases.



Source: Guillard (1965)

Figure 11.1. Distribution of cattle on the village land during different seasons, Golonpoul, northern Cameroon.

66. Also known as Fulani, Peuhl, and Fulla.

67. Of course similar conflicts have occurred In earlier times In many other parts of the world.

68. Both on rainfed land and also on lowland—where cattle are traditionally grazed during the dry season but which is now Increasingly being used for intensive Irrigation schemes (e.g., Mali, Senegal, Gambia, northern Nigeria).

Table 11.1. Manure application, northern Nigeria.

Characteristic	Sokoto[a]		Bauchi[b]	
Population density	High		Low	
% owning cattle	38%		19%	
Cattle owners	Yes	No	Yes	No
Average number of cattle	3	--	10	--
Land (ha/year):				
Cultivated	4.1	3.3	3.2	2.7
Fallow	0.1	0.1	2.8	1.3
Per resident	0.8	0.6	0.5	0.5
Man-hours per cultivated ha/year	539	679	570	524
Organic manure applied (tonnes/year)				
Total	16.3	11.4	4.6	0.6
Per cultivated hectare	4.0	3.4	1.4	0.2

Source: D.W. Norman [unpublished data] .

a. Average of three villages,
b. Average of two villages.

The above trends contribute to increasing conflicts betwen herders and cultivators (Delgado 1978). This has not been helped by the drought conditions which prevailed in the early 1970s (Campbell 1977). It is one of the paradoxes of the ever-decreasing land/labor ratios that the increasing conflict between devoting land to crop or animal production inhibits the increasing beneficial effect that livestock can have in preventing the decline in soil fertility. For long-run ecological stability it is of paramount importance that developing competitive relationships be reversed and a symbiotic relationship reestablished.

If symbiotic relationships can be reestablished, is it likely that the levels of manure required to sustain soil fertility can be realized? There appears to be a great deal of variation in the amount of animal manure required to permit permanent cropping. For example, Guinard (1967) has indicated that in the West African savanna areas, 10 tonnes/ha/year of manure are required to permit the permanent cropping of millet or sorghum. On the other hand Faulkner and Mackie (1933) found that in northern Nigeria 2.5 tonnes/ha/year are sufficient to maintain yields in most areas. In any case, it is doubtful that these levels of application could be sustained with the current relationship between herders and cultivators.[69]

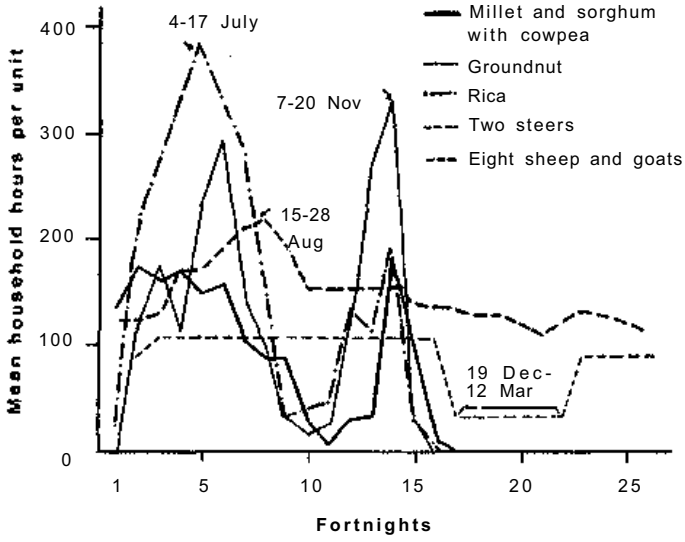
One interesting point which emerged from surveys done in northern Nigeria was that higher rates of manure were applied to the fields of cattle owners (Table 11.1). This occurred despite that fact that the size of farms of cattle owners tended tobe larger than those of farmers not owning cattle. It appears that such ownership permitted some control to be exercised over the manure input. In many areas, animal manure is becoming more of an economic good. Delgado (1978) gives the example of herdsmen being unwilling to corral their cattle on the fields of cultivators since they believed the remuneration they received was not sufficient to offset the value of corralling the animals on fields that they themselves cultivated.[70]

The question which thus arises is whetheror not cattle could be more firmly integrated into the cultivation system by the cultivators themselves, undertaking both ownership and management functions. This would imply a fundamental change in farming systems in the region. Delgado (1978) has investigated this possibility in some depth. He found that the high opportunity cost of seasonal labor in producing food grains, the desire for self-sufficiency in millet production, and the high seasonal labor requirement for grazing and supervising animals, all militated against cultivators managing the animals they own themselves. The absence of permanent leys and the high population densities would require that adults, rather than children, supervise the animals during the rainy season when crops are growing. As can be seen in Figure 11.2, this would result in considerable conflict between crop production and the livestock enterprises.

Delgado (1978) developed a linear programming model using the assumption that the farmer wishes to maximize his income. The results of the model indicated

69. In the special case of the urban fringe surrounding Kano, Nigeria, Mortimore and Wilson (1965) have however reported farmers applying up to 5 tonnes/ha.

70. It should be noted that herdsman on occasion do have their own fields, particularly in areas that are densely populated (e.g., Gambia, Upper Volta).



Source : Delgado (1978).

Figure 11.2. Mean household hours allocated to crop and livestock activities over time (crops are per hectare totals), Upper Volta.

that the farmer would be rational in entrusting the cattle to the Fulbe regardless of assumptions concerning grain production. He estimated that the opportunity cost of labor required to maintain steers on the farm was 1.2 ha/year of grain. He therefore concluded that two options arise. One is to improve the entrusting system for cattle with the Fulbe herdsmen. The other requires labor-saving innovations for the peak labor periods of food grain production. This latter would provide the possibility of introducing cattle into the farming system with both ownership and management of them fully integrated. One area which has been relatively neglected in research in the region is the role of small ruminants (Eddy 1978). Often, they are better integrated into the farming systems than are cattle.

The issue of crop-livestock interaction in the preservation of soil quality remains important. Ruthenberg (1971) concluded that the more rapidly the commercialization of production is achieved, the less farmers worry about conserving soil fertility. There is considerable evidence that soil mining is taking place at an increasing rate. Whether they like it or not, farmers are increasingly being forced to trade-off the short-run benefits of survival against considerable long-run social costs.

11.2 Animal Traction

As distinct from the situation in the SAT of India, animal traction in the West African context has a history of less than 50 years (Hasif 1978). The introduction of animal traction can contribute to labor productivity through the use of equipment designed to Increase the efficiency of labor at seasonal bottleneck periods. At the danger of oversimplification, the more traditional idea of draft power as an aid in increasing the area of cultivation (i.e., extensification) has often been overshadowed, particularly in the francophone countries, by the concept of its being used as a way to increase the productivity of land (i.e., intensification) through manure application, deep plowing to facilitate the burial of crop residues, etc.

Animal traction in West Africa has included not only oxen but also donkeys and horses on lighter soils. Its successful introduction has been closely linked with the commercialized economy and the production of an export cash crop as a source of revenue with which to pay for the equipment and sometimes the animals. This has been complemented by a strong support system (i.e., by external institutions) in the form of an input distribution system, institutional credit, and extension input, as well as the provision of a market for the product.[71]

In general, animal traction has received much more emphasis in the francophone countries. This is true not only with respect to research and studies (i.e., particularly at the CNRA, Bambey, Senegal) but also with respect to adoption. Among the problems experienced with animal traction programs are the following.

a. Implementation. There is frequent mention in the literature of the problems of training animals and the lack of experience on the part of operators. For example, animals often have to be retrained at the beginning of each year, while it takes the operators 2 to 3 years to get used to handling the animals, particularly for some of the more skilled operations such as interrow cultivation carried out during weeding periods (Wilde 1967; D. Wilcock, personal communication). Another problem mentioned is the difficulty which farmers not owning potential draft animals have in acquiring the money to pay for them. Often credit foranimals is not included in institutional credit programs. In a survey undertaken in the Eastern ORD of Upper Volta, it was found that only 20% of the farmers could have obtained draft animals without the institutional credit program that, in that area, included a component for draft animals (Barrett et al. 1978).[72] It is perhaps significant to note that data from Mali (Unite d'Evaluation 1978) indicate that families owning animal traction equipment tended to have more cattle than those who did not own such equipment. Finally, several references indicate that equipment for animal traction was often not available on time (Jones 1976) or it was inadequate in terms of design-necessitating a high level of repairs and other services (Lowe in Dunsmore et al. 1976; Rocheteau 1975a).

b. Maintenance. Problems of feeding, housing, health, protection, and availability of labor to maintain the animals are often mentioned (Venema 1978). Veteri-

71. The complementarity between oxen and Improved land-intensive technological packages has been noted above (Section 10.4.4).

72. A study undertaken in the OACV area of Mali also Indicated that farmers wanted Institutional credit for oxen (Unite d'Evaluation 1977).

nary services are often poorly developed, while the problem of finding sufficient food during the dry season means that draft animals are often run with the cattle herds. This contributes to poor health and increases the need for retraining. Extension programs often recommend the use of supplemental feed grains in order to bring animals into good condition at the beginning of the rains when their work loads are heaviest. Such recommendations are rarely followed (Well 1970). This is not surprising in view of the opportunity cost of scarce grains during the hungry season. The work-load problem becomes particularly acute in the southern part of the region where N'Dama cattle are commonly used. These cattle, although resistant to tsetse fly, are small in configuration and therefore possess potentially less draft power than the larger animals found in other parts of the region,

c. Utilization. Efficient utilization of animal traction requires that fields be little fragmented and that they be destumped in order to prevent damage to the equipment. Staff of the Unites Experimentales in Senegal have specifically addressed these issues by giving incentives to farmers to destump their fields and by encouraging the consolidation of fields (Section 7.2) (Faye and Niang 1977). However, often these conditions are not fulfilled, resulting in the reduction of work efficiency. Another problem often mentioned is the introduction of equipment that does not help overcome the most pressing bottleneck. For example, Tiffen (1971) reported, in a study done in northern Nigeria, that the weeding bottleneck was the major constraint. Unfortunately, the ridging equipment which was introduced—primarily for land preparation—was not really suitable for weeding. Asa result, increasing areas of land were planted, accentuating the weeding bottleneck. Jones (1976) noted that farmers in Mali in the late 1960s rarely used animal-drawn implements in weeding operations. The time involved in the plowing operation was reduced by half as a result of using the implements, but it was not possible to double the area cultivated because of the weeding bottleneck on sorghum and millet. Therefore, the area cultivated increased by 20%.

Various norms have been established for animal traction. The figures in Table 11.2 indicate the norms established for different operations in Senegal. The table also gives figures indicating what occurred in practice. It appears that the norms are overoptimistic in the light of the realities that farmers face. The reasons for the difference are not clear, although Inadequate maintenance and the farmers' lack of experience are no doubt factors. Another problem that occurs in the utilization of draft animals is the seasonal variability in the tasks they are expected to perform. Several references are made to the potential significance of the cart as a way of increasing the utilization of draft animals throughout the year (Zalla 1976). Yet this equipment is

Norms (a)

Table 11.2. Norms and actual area managed by animal traction. Senegal.

Animal	Ha
1 donkey	3.0
1 horse	4.5
1 pair cows	6.0
1 pair oxen	8.0

Source: Ramond et al. (1976).

Norms (b)

Animal	North and Central Regions	Sine-Saloum	East Region
1 horse	8 ha	6 ha	4 ha
1 pair oxen	16 ha	10 ha	8 ha

Source: Charreau (1975).

Actual areas, in Sine-Saloum. for one pair of oxen (ha)

Variable	Land preparation	Sowing	Weeding	Hilling up cotton	Plowing	Groundnut lifting
Theoretical norm[a]	8	8	20	1	2	4
Actual practice	5	4	11	0.4	0.4	2

Source: Venema (1978).

a. C NRA standards.

often not available under Institutional credit programs, in spite of the fact that it can provide a very significant source of income and is, according to one study, the only part of the draft animal program in Niger which has met with any real success (Charlick 1974). Using draft animals to undertake operations on farms of other families is another possibility. However, this does provide the potential for exploitive relationships to develop. Charlick (1974) cites G.Nicolas as finding that most farmers in the survey he undertook in Niger used the equipment primarily for rental purposes rather than for cultivating their own land. It appears that renting out equipment in the francophone countries has never been discouraged. This is in contrast to the animal traction programs implemented in northern Nigeria where farmers were officially forbidden to do contract work for other families (Alkali 1969). The government feared that participating in such work would have a negative impact on the condition of the animals.

d. Economics and exploitation. The economics of animal draft power is now increasingly being drawn into question, even for families that previously had large farms and lived in areas where export cash crops could be produced." In recent years, prices of cash crops have increased relatively less rapidly than those for animals and equipment (Steedman et al. 1976; Traore and Toure 1978) (Table 11.3). This slows down the adoption of animal draft power, and diminishes the beneficial interaction between crop production and livestock management. It also creates a danger of further aggravating the dual economy that is developing between those farmers who have oxen and equipment and those who do not. Jones (1976) cites work done by J. Gallais in the interior Niger delta. In that area, land preparation was not a bottleneck. When the plow was introduced, however, individual families not owning plows still requested that their land be plowed by neighbors who owned plows. They paid for this in terms of manual labor during the bottleneck periods of weeding and harvesting. As a result, they were forced to cultivate less land themselves. The plow owners, by being able to obtain labor at the bottleneck periods through plowing other peoples' field during the period when labor was not a limiting factor, were able to increase the

Table 11.3. Economics of animal traction. Mali.

a. *Costs and returns from growing cotton per hectare, assuming normal life of equipment*

Variable	Malian Francs		In terms of kg of seed cotton	
	1972	1976	1972	1976
Gross return	53 900	82 500	1100	1100
Costs:				
Fertilizer	9 150	21 100	187	281
Insecticide	5 200	7 020	106	94
Small tools	350	1 000	7	13
Oxen	2 414	3 867	49	52
Equipment	6 715	13 077	137	174
Total nonlabor costs	23 829	46 064	486	614
Net return:				
Not costing labor	30 071	36 436	614	486
Costing labor	3 621	-21 064	74	-281

b. *Unit product cost of inputs, in tonnes of seed cotton*

Input	1972	1976
Fertilizer and insecticide	0.29	0.37
Multipurpose tool bar	0.65	1.13
Cart	0.93	1.13
Sprayer	0.34	0.38
Oxen (pair)	1.22	2.00

Source: Institut d'Economie Ruralo (1977).

73. The cost of oxen has often given rise to recommendations for the greater use of donkeys, particularly on lighter soils.

areas they cultivated. Ernst (1976) found a similar situation in Mali, where 3-5 days of labor were expected in return for 1 day of plowing. This is but one example of the introduction of a new technology contributing to economic disparities. That a great potential exists for exploitive relationships developing is obvious, especially if repayment is demanded in terms of labor at times when its opportunity cost is high,

e. Deep plowing. Incorporating residues through deep plowing has been the cornerstone of land intensification policies in the francophone countries (Wilde 1967). Recommended frequencies for deep plowing vary from 2 to 4 years, depending on the soil condition and the rotation being used by the farmer. Charreau (1978) notes several advantages of deep plowing: improving water infiltration and soil porosity; encouraging the conservation of soil moisture and, most importantly, contributing to soil fertility through the incorporation of organic matter from harvest residues or fallow into the soil. Deep plowing is recommended at the end of the rainy season, since the rainy season is short and it is necessary to plant as soon as the next rains start. Problems arise because there is only a short period between the end of harvest and the time at which the ground becomes too hard for plowing. In addition, deep plowing is a time-consuming operation. J.Faye (personal communication) indicates that four people are required to line up the residues, another person works the plow, while yet another individual leads the oxen. Such a team takes 3 days to plow 1 ha, therefore requiring 18 work days (but not necessarily man-days) per hectare. It is not surprising that this intensification policy has not been successful to date (Hopkins 1975). Contrary to program objectives, farmers have tended to use draft animals as a means of extensification rather than intensification (P. Milleville, personal communication; Hopkins 1974; Czarnocki 1973). There is substantial empirical evidence verifying this observation. For example, in Gambia, Lowe (in Dunsmore et al. 1976) and Peacock (1967) observed that males who are responsible for growing groundnut increased the area of groundnut cultivated per male adult by 18-40% after obtaining oxen.

Because of the above problems, a number of alternatives are being tried in the Unites Experimentales in Senegal (Faye 1977). One possibility is to combine deep plowing and an early-harvested crop. Maize in particular has good potential for this. It is harvested relatively early and gives high yields. These characteristics permit more time for the plowing operation and also provide the possibility that revenue can be used for contract plowing with tractors (J. Faye, personal communication). However, the tractors currently being used can handle only 2 ha/day. Two other possibilities are also being tried. One is the utilization of larger tractors which, although very expensive, permit the possibility of plowing longer into the dry season. The other strategy involves using tractor-drawn choppers that chop the plant residues and cut down the manpower required for plowing with oxen.[74] The problem of both these strategies is the necessity to use tractors. One can question the present feasibility of using tractors extensively in the region. The history of government-run tractor-hire units in the region shows that prospects are not very promising (Weber 1971; Kolawole 1974).

11.3 Summary and Implications

The discussion on livestock in the preceding two sections can be reduced to two major problems.[75]

a. The traditional spatial and seasonal integration between livestock herders and cultivators is being threatened. With higher population densities and increasing requirements in terms of both the quantity and quality of grazing land, the traditional complementarity between cultivated and pastoral areas in the region is increasingly threatened.
b. The rising population density is worsening the problem of maintaining soil fertility.

Part of the answer to the problem of soil fertility lies in continuing the interaction between crops and livestock. However, it is doubtful that, in the near future, cultivators will be willing or able to accept the considerable private costs of both the ownership and management of livestock—particularly of cattle, involving the use of permanent pasturage systems and/or stall feeding on the farm itself.[76] The use of common pastures is likely to continue into the foreseeable future, and current cultivator/livestock herder relationships are likely to remain unchanged, even if considerable social cost results from the degeneration of grazing areas. The challenge is to develop ways in which the integration of livestock and crops can be furthered in a manner consistent with the needs and objectives of a wide range of farming system participants. Those responsible for developing programs directed at improving cropping systems must consider both grain production and crop by-products that can be grazed in the field. Thus, in some areas, short-strawed

74. Alternative possibilities with such chopped material would be to spread it over the surface, make it into compost, or feed it to animals to obtain manure.

75. Another problem, not discussed In this review, is an apparent shortage of draft animals in many areas. As a result the use of cows, for example, is increasingly being advocated (e.g., Senegal).

76. Indeed, this would make the problem of livestock herders even worse and brings Into question the long-run viability of areas in the region that are suitable only for grazing. As indicated above, cattle in the dry season have traditionally been moved southwards into cultivated areas In the search for food.

cereal varieties may not always be acceptable to farmers.[77] Considerable attention should also be given to grain legumes—specifically, cowpea—which may give stable and low yields of grain but result in high forage yields.[78]

77. Indeed, when population densities become very high—at the expense of trees and bushes—an increased use of such stalks for fuel also often results.

76. Also mentioned above was the problem of insect attack on cowpea (Section 10.3.2). The insect problem becomes serious in terms of seed yield. Thus, a great deal of research has been undertaken on spraying regimes. However, if the main criterion in the research program were high forage-yielding potential, spraying the crop would not be required. In addition, there is a possibility of being able to continue growing cowpea in mixtures—which is dominant at the present time.

12

Off-Farm Employment

12.1 Introduction

The significance of off-farm employment has often been ignored in farm-level studies in the SAT of West Africa, although time devoted to, and income derived from, off-farm occupations can be very important. Additionally, alternative uses of time produce an opportunity cost for labor which will have significant implications in defining the relevance of new technologies.

The following are important determinants of the quantity, composition, and timing of off-farm employment.

a. The level of livelihood derived from.agriculture.
b. The seasonality of rainfed agriculture and the associated problems of seasonal hunger during the rainy season and underemployment during the dry season.
c. The location of the village.
d. The demands (e.g., skill, time) of the occupation.

The discussion in the literature concerning off-farm employment—which in the current context is considered to include time devoted to any occupations other than those directly related to crop production—can be divided into three parts. These are timing, composition of off-farm jobs, and permanent migration.

12.2 Timing

The potential conflict betwen farm and off-farm occupations will, of course, be related to the season. Jobs required to relieve seasonal hunger problems or to fulfill social obligations—such as payment with labor for plowing done with oxen at the beginning of the rains—and jobs requiring a year-round commitment—such as looking after livestock and jobs with a regular clientele—provide important sources of income but also conflict with family farm operations. This is particularly applicable to the first two types of jobs specified above since these are basically survival-oriented. Families who have individuals engaged in jobs that require a year-round commitment are likely to have made some adjustments in their farming operations. On the other hand, work undertaken during the dry season is generally unlikely to conflict with agricultural activities except in places where lowland is cultivated. An illustration of this appears in Table 12.1, which shows that the availability of lowland for cultivation during the dry season has decreased the amount of time devoted to off-farm employment.

12.3 Composition of Off-farm Employment

The composition of off-farm employment is influenced by the skills and capital which individuals possess, the time of year, and the location of the village.

The data in Table 12.1 illustrate the potential significance of the location of the village. In the village close to Zaria there was a tendency for families not owning cattle to undertake jobs in the modern sector. Such jobs, usually of an unskilled nature, were more remunerative than those in the traditional sector. At the same time, many of the traditional crafts had been taken over by full-time specialists in the urban area and therefore farmers could not compete on a part-time basis. In contrast, activities in the traditional sector were able to flourish in the village most remote from the urban area, since there was less competition. There was also an emphasis on trading, which had diminished in the case of the village closest to the urban area. The middle village is omitted from the discussion because of the presence of lowland which permitted the cultivation of sugarcane during the dry season, thus inhibiting work in off-farm activities.

In villages located in unfavorable areas, or where there is a long dry season (Chambers and Longhurst 1978), there is a tendency for individuals to go on short-term migration (see Fig. 6.2,e) (Ravault, 1964; Roch 1976). Individuals participating in such migration tend to be males between the ages of 15 and 44 (Sutter 1977; Faulkingham 1977). Usually this causes few problems, although Faulkingham (1977) does report cases where this meant that onions grown in the dry season in Niger had to be cultivated by younger people in the family. The types of jobs obtained vary enormously, and include: cutting and selling firewood, pushing handcarts, and helping in harvesting crops in areas further south (e.g., cocoa in Ghana and the Ivory Coast) (Beats and Menzies 1970; Faulkingham 1977). The tourist industry is one that complements rainfed agriculture in Gambia. The height of the tourist season occurs during the dry season and, consequently, many individuals in farming families engage in work connected with tourism (Pell 1977).

A problem comes when off-farm occupations, particularly those involving migration during the rainy season (e.g., the stranger-farmer system in Gambia and Senegal), resultin increasing the dependent/worker ratio. Haswell (1975) notes the increasing problem of middle-age males going on migration, thereby depleting the labor force in the village.

12.4 Permanent Migration

Permanent migration usually results from the low levels of livelihood obtainable from agriculture in the home area and/or the attractiveness of other alternatives (e.g., cities,

Table 12.1. Off-farm employment of male adults, northern Nigeria.[a]

Variable	Dan Mahawayi	Doka	Hanwa		
			Whole	Cattle owners	
				No	Yes
Accessibility to Zaria	Poor	Average	Good		
Lowland cultivated (ha)	0.24	0.45	0.16	0.26	0.06
Days per male adult:					
Farm	140	159	121	125	118
Off-farm	123	39	104	86	124
Total	263	198	225	211	242
% of days of off-farm work devoted to:					
Traditional:					
Primary[b]	...	...	47	...	84
Manufacturing	21	29	6	11	2
Services	40	27	15	21	10
Trading	35	25	2	4	0
Total	96	81	70	36	96
Modern:					
Services	4	19	30	64	4
% of income obtained off-farm[c]	25	14	55	35	65

Source: Norman (1972).

a. April 1966-March 1967.
b. Consists of looking after cattle.
c. Ratio of rates of pay per day for work in the traditional service sector, traditional manufacturing sector, and modern service sector was 1:1.3:2.

settlement schemes) (ORSTOM 1975). A detailed examination of this type of migration is obviously beyond the objectives of this review. However, permanent migration is a significant feature of the region even though the process is increasingly complicated by national political boundaries. The multitude of ethnic groups have also interfered with the even distribution of population throughout the region. Consequently, there are areas that are very densely populated and others that are thinly populated. In spite of these restrictions, there has been considerable migration from certain areas. Forexample, it has been suggested that as many as 2 million Voltaics may be living outside Upper Volta—mostly in the Ivory Coast (Kohler 1972; Songre 1973). The question often arises as to how much benefit the home community obtains from such permanent migration. The problem of increased dependency ratios is often mentioned (Ancey 1974). This could in theory be offset by remittances from the migrant to the home family. There appears to be some confusion in the literature as to how significant these remittances are. The few references that do exist concerning migration in the region appear to indicate that, in general, such remittances are rather low[79] unless the migrant has a good skilled job in an urban area (Haswell 1975; ORSTOM 1975). However, Caldwell (1968) presents a viewpoint at variance with this by arguing that rural-urban migration in Ghana has raised rural living standards.

79. S. Amin (Campbell 1977) has stressed the loss of potential GNP that occurs as a result of Individuals migrating from the landlocked Sahelian countries to countries having coastal areas.

13

Level of Living and Inequality of Income Distribution

13.1 Components and Distribution

Rigorous comparison of the levels of living reported in different studies is virtually impossible for a number of reasons.

a. There is the problem of deriving income figures in areas where many of the farm inputs and products do not pass through the market place. -
b. There is a time and locational specificity of such figures since they are not often related to the cost of living.
c. Incomes from all sources are very rarely reported.

Haswell's (1975) studies in Gambia indicated that real production levels have risen over the last 25 years (Table 13.1). Presumably, this reflects in part the impact of improved technology, particularly for groundnut. Although this information alone is insufficient to permit a conclusion that the average level of living has risen, throughout the SAT of West Africa, indirect evidence, such as the proliferation of metal roofs, iron beds, transistor radios, and bicycles, is indicative of some increase in levels of material welfare.[80] Significant deviations from

Table 13.1. Growth of agricultural production, Genieri, Gambia.

Variable	Crop production expressed in kg of rice equivalent per person per year[a]		
	1949	1962	1973
Food crops	165	216	262
Cash crops	75	128	224
Total agricultural production	240	344	486
	% of total production contributed by individual crops		
	1949	1962	1973
Food crops:			
Late millet	2.0	0.6	2.6
Early millet	0.4	-	-
Sorghum	0.2	-	0.2
Hungry rice	1.6	1.4	1.0
Upland rice	6.4	5.8	4.8
Swamp rice	57.9	54.9	45.4
	68.5	62.7	54.0
Cash crop:			
Groundnut	31.5	37.3	46.0

Source: Haswell (1975).

a. Clark (1962) observes kg equivalents are useful when gains form a large proportion of total production but it becomes less satisfactory when grain for human consumption is only a fraction of the total value of production.

80. We make no attempt to judge whether these Increases are satisfactory, especially when compared with the nonagrlcuitural sector. However, the increases in rural/urban migration that appear to be taking place suggest that such increases may be insufficient.

trends toward improved levels of living are found in times of drought, as occurred in the early 1970s.[6'] Various strategies that have encouraged or even forced farmers into the market economy have, it is claimed, made them more vulnerable to drought (Lewis 1978). Hence, such strategies potentially increase the annual variation in levels of living, with the possibility of undesirable consequences, unless incomes can be raised substantially above subsistence levels.

An important component of income that is missing from figures given by Haswell is the time spent in off-farm employment. Figures obtained from surveys undertaken in northern Nigeria indicate that the off-farm income component can be significant. The figures in Table 13.2 show that incomes derived from farming were less variable than off-farm sources of income. However, when incomes from all sources were considered, there was greater equality in the distribution of incomes. In terms of the distribution of incomes, poorer farming families earned a higher proportion of their income as farm laborers for other families than did higher-income farmers. This is presumably related to the need for sources of income to overcome seasonal hunger problems. In terms of the composition of nonagricultural employment, Mation (1977) found that the higher-income farmers worked at occupations that received high remuneration. It was apparent that occupations requiring high levels of capital and cash outlay were biased towards the higher-income farmers. The trading of local crops and livestock were examples of this type of occupation. This is signifi-

Table 13.2. Variation within a village setting, Kano.[a]

Variable specification	Income Category[b]					Gini coefficient
	Lowest decile	Second decile	Middle quintile	Ninth decile	Highest decile	
Cultivated area (ha) per:						
Household	2.2	2.4	2.4	2.7	3.2	
Resident	0.24	0.29	0.41	0.60	0.51	
Average income (₦) per:						
Family	177.73	234.21	316.57	394.01	626.59	0.3146
Resident	19.12	28.22	54.27	87.56	99.46	0.2828
Breakdown of income per resident:						
Own farm	80	75	77	60	64	0.3183
Off-farm:						
Hired farm laborer	8	4	5	4	1	0.5306
Nonagricultural	12	21	18	36	35	0.6097
Cash:						
% of household income generated in or converted into cash	60	51	50	53	55	
% of net cash earned by source:						
Own farm	63	48	53	30	35	
Off-farm:						
Hired farm laborer	14	8	8	3	2	
Nonagricultural	23	44	39	67	63	
₦ per consumer:[c]						
Harvest value of:						
All crops	31.75	41.25	72.50	106.25	137.50	
Food crops	13.75	25.00	46.25	60.00	71.25	
Retained food crops	8.75	17.50	35.00	46.25	53.75	
Available food[d]	33.75	41.25	53.75	81.25	90.00	

a. The data wore derived from a study undertaken by Motion (1977) in throe villages in the southern part of Kano province. 1974-7S.
b. The income per consumer man-equivalent was calculated for each family and the resulting distribution divided into deciles and quintiles.
c. It was estimated that the cost to feed a consumer at a rate of 2954 calories per day equals ₦47.50 Per year.
d. Includes retained food plus food purchases.

81. Discussions concerning drought are considered to be beyond the scope of this review. However, references concerning various aspects are the following: Campbell (1977), Berg (1976a and b), V.D. Dubois (1975), Horowitz (1976), and Ware (1976).

cant when exploring the possibility of exploitive relationships developing vis-a-vis the poorer farmers in the villages.

Apart from Matlon's (1977) research in northern Nigeria, little rigorous empirical work has been done on the distribution of incomes. Raynaut (1977) in Niger has examined the distribution in millet and sorghum production per *actif* and income from agriculture per *actif* (Table-13.3), but his research does not consider off-farm income. Hill (1972) and Matlon (1977) have suggested that, while there is a degree of heterogeneity among farming families in northern Nigeria, the laws of inheritance, a relatively egalitarian land tenure system, the availability of surplus land, the traditional hand-power based technologies, and the community-mindedness of the ruling elites, all contributed to the moderately even distribution of incomes in traditional society. However, Matlon (1977) also presents evidence supporting comments made above that the degree of equality is inversely correlated with village size, population pressure, and the degree of involvement in export cash crop markets.

This evidence implies that there is a trend toward increasing inequality of income distribution at the village level. Examples presented above indicate the possibility that certain types of improved technology, such as animal traction, Introduce potential for the development of exploitive relationships within the village. Even improved technological packages that are Intrinsically neutral to scale may still enhance the development of income inequalities at the village level. Such technology may in fact not be neutral in terms of its potential adoption because of the support systems that are often geared towards the better endowed/more influential farmers. Such potential for increasing income inequalities increases as individualization develops at the village level (Haswell 1975).

The potential for improved technology to reinforce income inequalities as a result of its differential adoption and the resultant potential for developing exploitive relationships, obviously needs to be viewed with concern. If the societies in the SAT of West Africa have a genuine concern for the goal of growth with equality, it is extremely important for national and international organizations concerned with technological development to address themselves to developing strategies that will not further enhance inequalities.

In the following two sections, possible reasons underlying the fact that the differential adoption of technology can further enhance these inequalities are considered.

Table 13.3. Cereal production per* actif, *Niger.

Production (kg)	% of farms[a]
201 - 300	8
301 - 400	12
401 - 500	11
501 - 600	13
601 - 700	15
701 - 800	11
801 - 900	8
901 - 1000	4
1001 - 1100	8
1101 - 1200	4
1201 - 1300	1
1301 - 1400	1
1401 - 1500	4

Source: Raynaut (1977).

a. Total number of families = 147.
b. 52% of the families had less than five members. Such a family of five would have an average of two actifs. Therefore on average the dependent/actif ratio would be about 2.6:1. Assuming an annual consumption of 200 kg/capita this would mean the necessity of producing 500 kg/actif to be self-sufficient. With these dubious assumptions 31% of the families were not self-sufficient.

13.2 Self-Sufficiency and the Hungry Gap

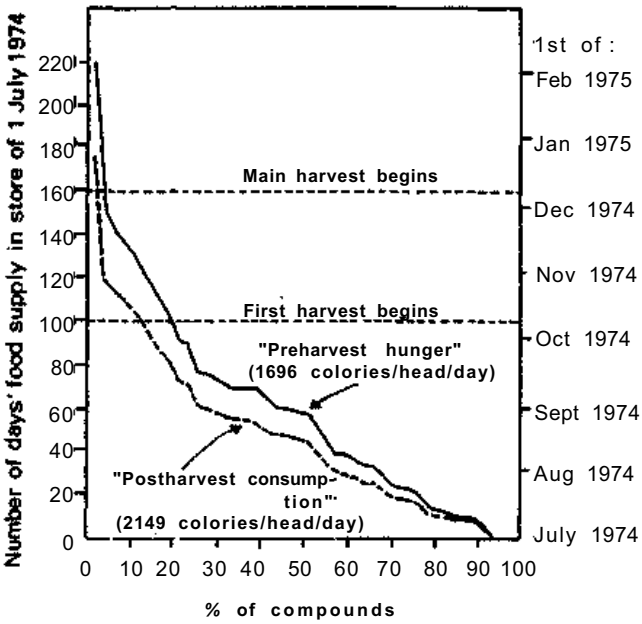
The relationship between seasonal variations in the level of living, referred to as the hungry gap or *soudure,* is frequently mentioned in the literature (Hunter 1966; Benneh 1973b; Raynaut 1973; Kafando 1972). As noted in Section 8.2, food availability is often at its lowest level when the demands of the agricultural cycle are highest. The severity of this period of low food-availability is inversely dependent upon the supplies of food remaining from the previous harvest, the ability to purchase food during this period, and the success of early-maturing crops.

13.2.1 FOOD RESERVES

Haswell's (1975) observations in a survey of one village in Gambia, presented in Figure 13.1, indicate the precarious state of the village food supply on 1 July 1974. For only 20% of the village, enough food grains from the previous year's harvest remained in store to provide sufficient[82] food until the next harvest. The variation in production per family is implicit in the figures derived by Raynaut (1977) shown in Table 13.3. At the same time, the figures given by Matlon (1977) in Table 13.2 indicate that it is the poorer farmers that tend to be less self-sufficient, implying, therefore, that they have insufficient food reserves to support themselves through the hungry season.[63]

82. The estimate of sufficiency was based on preharvest season, per day consumption figures (Table 13.4).

83. WIlhelm (1976) has observed that families with small farms tend to be less self-sufficient. Such families are also usually among the poorer ones.



Source: Haswell (1975)

Figure 13.1. Supply of food in* store *on 1 July 1974, from the previous harvest at Genierf, Gambia.

Verneuil (1978) mentions that in precolonial times granaries held up to a 4-year supply of cereals.[84] The vulnerability of families throughout the region to the drought of the early 1970s was increased by the declining reserve levels which have accompanied the breakdown of traditional social arrangements (Meillassoux 1974). Atthe same time, the vulnerability of poorer farmers to the effects of "normal" hungry seasons has increased.

While some of the remaining traditional mechanisms for reciprocal obligation served to cushion the results of the drought, national and international involvement in bearing responsibility for reserves was also heightened. As governmental involvement in the holding of reserve stocks grows, the tendency to centralize storage stocks does also. While centralized reserves may offer access to potential economies in the administration of relief efforts, the need for them can be expected to increase if they serve to replace traditional family- and village-level reserves. Guggenheim (1978) has documented a decrease in the number of traditional granaries in Mali. If such decreases are general across the region, they may increase the exposure to problems of seasonal hunger.

13.2.2 EARLY-MATURING CROPS

Traditionally, an important way of lessening the effect of the hungry season was to grow early-maturing crops such as hungry rice and early millet. However, increased emphasis on cash crops has encouraged the demise of such relatively low-yielding crops (Section 10.4.2). Additionally, changes in responsibilities within the family, and in the availability of labor, appear to have had an Impact in certain areas (Section 10.2).

13.2.3 FOOD PURCHASES

Purchases of food provide another means of alleviating the effects of the hungry period. However, families which are not self-sufficient generally require food purchases when cash resources are lowest (Lowe in Dunsmore et al. 1976) and prices highest (CRED 1977). As noted above, the potential Is great for exploitive relationships in which poorer farmers become the victims of traders, money lenders, etc. For the poorer individuals in the society, funds for purchasing food often have to be obtained by working in off-farm occupations at the time when the demands on their own fields are highest (Section 8.2). Jobs pursued by low-income people are often lower-paid than those pursued by higher-income people, due to the former having fewer skills, less capital to invest (Section 13.1) or less influence, or because they have to meet work obligations as a result of being in debt. Greater debt may, in fact, be incurred during the hungry period as a result of the need to borrow food or money for consumption purposes. Hierarchical trading systems are used to enable this to take place.

The potential for the development of exploitive relationships has been a recurrent theme of this review (Clough 1977; Watts 1978; Palmer-Jones 1978b; Raynaut 1976; Verneuil 1978). Chambers and Longhurst (1978) have pointed out the contribution of the "seasonal screw" to the low-income poverty trap (Matlon 1977). The improverishment of certain groups in a society can become even more severe when means of production other than labor are used to buy survival. For example, in severe times agricultural materials purchased on credit are often sold at very low prices.[85] Another example is the pledging of land. Such strategies can lead to a "ratchet effect" (Chambers and Longhurst 1978) of a downward spiral. In other words, survival commitments in one year lead to a lower potential income and a higher level of indebtedness in the next year. This "ratchet effect" can be reinforced by shock events such as drought (Charlick 1974) or the death of a worker in the family (Chambers and Longhurst 1978). This is conducive to dualistic development, in which some families possess the means of production and the ability to survive the hungry period and others do not. The former progressively obtain more control. As Chambers and Longhurst (1978) suggest, the hungry gap, although perhaps not the only cause of rural poverty, certainly provides the milieu in which poverty is sustained and deepened.

84. Guggenheim (personal communication) has found even longer storage periods in the Dogon area of Mall.

85. Verneuil (1978) says that such a practice is common in the Slne-Saloum area of Senegal.

13.2.4 PHYSICAL EFFECTS

The effects of the hungry gap on the human physical constitution have not often been examined in detail. Hasweli (1975) provides one of the few studies in which interdisciplinary work with medical personnel was undertaken. It was thus possible to correlate the agricultural cycle with nutritional levels. The data shown in Table 13.4 indicate that the level of calorie and protein consumption during the peak of the agricultural cycle tends to be low, while Table 13.5 illustrates the resulting, loss in weight that tends to occur because of this reduced intake in relation to the increased working burden (see also Hunter 1966). At the same time, a potential for further debilitating effects is created as the changes of contracting nutritionally related diseases are increased and the body's resistance to other illnesses is decreased (Chambers and Longhurst 1978; R.E. Ford, personal communication). The literature reviewed indicates that the scenario sketched above Is typical of the region as a whole, although a study done by Simmons (1978) in northern Nigeria appeared to indicate satisfactory levels of calorie consumption there during the hungry period. This is probably related to a reasonable supply of food reserves, and to opportunities for deriving sufficient levels of income from other sources, in the area studied by Simmons.

Table 13.4. Calories and protein consumed per head per day by season, Gambia.

	1948		1949	
	Calories	Protein (g)	Calories	Protein (g)
Dec-Feb	2167	55	2149	60
Feb-June	1653	49	1575	44
June-Aug	1747	54	1696	45
Aug-Dec	1502	43	1623	49

Source : Grant (1950).

Table 13.5. Average weight of male and female adults by season, Gambia.

Time	Male (kg)	Female (kg)
1947:		
July	58.5	50.3
September	57.3	49.2
October	55.3	46.7
November	56.7	49.0
1948:		
March	59.4	51.3

Source: Platt (1964)

Nonetheless, it appears from the preceding discussion that, in general, it is unlikely that an Increase in the productivity of labor during peak labor periods will be possible for many farming families without improvements in their nutritional levels and/or perhaps a change in the power source.

13.3 Allocative and Technical Efficiency

Why have distributional inequalities in terms of societal power, inputs and incomes not received the attention they deserve in the West Africa setting? As discussed above (Sections 3.3 and 3.4), two of the basic reasons are: insufficient knowledge of relevant data collection and analytical techniques, and disciplinary insularity. For example, much of the work undertaken by agricultural economists has been based on a neoclassical marginalist framework involving transferring, with little modification, ideas, philosophies and approaches "learned" in the so-called capitalist societies (Palmer-Jones 1978b). A "neoclassical" approach has been used to argue that farmers allocate their resources for production in an economically efficient manner. As a result, it is often argued that they have a goal of profit maximization and that the only way to improve their level of well-being is through the development of improved technology (Norman 1970).

Unfortunately, the preoccupation with allocative efficiency has detracted from the importance of also looking at technical efficiency as a determinant of economic efficiency. In an analysis of differences in allocative and technical efficiency among farmers in an area of northern Nigeria, Mation and Newman (1978) found that poorer households were disproportionately represented among the least technically efficient producers. Technical efficiency was found to decline rapidly if the planting of sorghum and late millet, as well as the first weeding, were delayed. The degree of intercropping, as reflected by a greater number of crops per mixture, was found to be positively associated with greater technical efficiency. Matlon and Newman (1978) point out that the identification of differences in technical efficiency is neither a necessary nor sufficient condition for the demonstration of interfarm differences in managerial ability. Such an inference is valid only if farm managers face the same range of production choices and also the same external constraints. The latter include both the technical element and the exogenous factors of the human element. The "historical" subdimension (i.e., the income and liquidity position which the farmer inherits from previous periods) acts as a determinant in the farmer's access to resources and thus influences the production and employment strategy the farmer adopts.

In analyzing the management practices by families in different income groups, Matlon and Newman found that the degree of intercropping was the single management factor in which the poorer households exhibited more technically efficient behavior. For the crops examined (i.e., millet, sorghum, and cowpea) poorer families tended to plant somewhat later than other families. Rather than

indicating a lack of managerial competence, this later planting may have been deliberate on the part of such families who conceivably were short of both cash and seed.[86] The greatest difference in technique between the low- and high-income farmers was found to be in weeding. Low-income farmers performed their first weeding 6 weeks after the start of the rains—almost 2 weeks later than high-income farmers. Low-income farmers also performed fewer than half of the second and third weedings undertaken by other families. Once again, it is tempting to attribute these differences to management and/or motivational differences. An alternative explanation would be that the urgent demands of the hungry period (Section 13.2) made It necessary to work at off-farm occupations to provide the means for sustenance and to repay debts.

The implications of the above discussion are very important and return us to an underlying theme of this review, i.e., trends in distribution. Differences in technical efficiency, which can be caused by a number of Interdependent factors, go far beyond economic variables to embrace both technical and noneconomic (i.e., sociological) variables. If this disparity is not recognized, and corrected by appropriate strategies, the result may be increased inequality. The need for interdisciplinary research work, drawing together the expertise of technical scientists, anthropologists/sociologists and agricultural economists In correctly diagnosing interdependencies and in developing appropriate strategies to respond to them, cannot be overstated.

86. Farmers who plant early in the rainy season risk the necessity of replanting if the first heavy rains are followed by too long a dry spell.

14

Conclusions and Recommendations

14.1 Central Themes

The economies of the SAT of West Africa are in a state of transition. As a result, every action or purposeful inaction will hold implications for determining the path of development and level of living of different groups of people in the society.

This review has repeatedly emphasized the importance of two factors (i.e., increasing population densities and the gradual emergence of the region into the world economy), underlying the transitional process. One major effect has been the erosion of traditional informal institutions based on collective interdependence, stability, security, and survival. As a result, relationships within communities, instead of being self-contained and sharing in philosophy, have become increasingly dependent upon the outside world and have become more individualistic in orientation. Our conviction of this trend—which unfortunately we have not been able to prove empirically—has, we believe, been partially responsible for the changes in the quantities, characteristics, qualities, and distribution of the factors of production, processes, and resulting welfare, all of which have been discussed in detail above.

14.2 The Recommended Approach

Although much of the material we have reviewed in this publication is valuable in increasing our understanding of the production environment of farming families, its impact in terms of the improved welfare of those families has been limited. Thefarming systems research approach that is currently gaining popularity provides a potential for overcoming this lack of effectiveness. We strongly endorse the adoption of such an approach to future research. It is beyond the scope of this review to discuss the nature of the approach in detail.[87] However we would like to make a few comments in support of the use of this approach[88] in the SAT of West Africa.

a. The review has stressed the heterogeneity that exists at the farm level which also appears to be growing over time. Superimposed on differences in the technical element is increased differentiation in terms of the human element. Bearing in mind the concerns of institutions such as ICRISAT, that the needs of the poorer farming families must be addressed (ICRISAT 1976, 1977), it is obvious that this hetereogeneity must be explicitly recognized and strategies designed to help them. The farmer-based "bottom-top" approach characteristics of farming systems research helps ensure this by designing strategies to help such farmers through the identification of their specific needs. Since problems identified can be technical or socioeconomic in nature, an interdisciplinary team approach is essential.

b. The limited resources—time, finance, and manpower—available for socioeconomic research in the SAT of West Africa make it essential that they be used efficiently. Farming systems research, with its specific aim of improving the welfare of farming families,[89] and its current emphasis on developing cost-efficient methodologies, is specifically concerned with this issue.

c. Improving the welfare of farming families through increasing the productivity of the existing farming systems is served by two types of developmental strategies: first, the development of relevant improved technologies together with, secondly, complementary policies (institutions)[90] that increase the welfare of farming families in ways that are useful and acceptable to them and society as a whole.

Farming systems research, we believe, provides a method for developing relevant Improved technology. Based on observations above, its components should definitely include the following.

a. Compatibility with the technical element and the exogenous and endogenous factors (i.e., "horizontal" dimension) in such a way that, through increasing the productivity of resources in relation to their relative

87. A review of the current state of the arts of farming systems research has recently been produced (Gilbert et al. 1980).

88. ICRISAT is one of the institutions that has endorsed the farming systems research approach.

89. This is in contrast to many of the more conventional socioeconomic studies in which finding out what the situation was, was an end in Itself.

90. The policy issue is beyond the scope of this review but, obviously, as we have stressed, it is of critical importance In Influencing the livelihood of farming families.

scarcities, the level of livelihood is improved ("net livelihood intensity" in the terminology of Chambers (1978)].

b. The recognition of the heterogeneity of farmers (i.e., "heterogeneous" dimension) in terms of both resource base and of social and/or economic power (i.e., product of both the "historical" subdimension and "horizontal" dimension). Through adapting technologies to the different types of farmers, equality considerations can be fulfilled.
c. A recognition of the possible future repercussions of the adoption of improved technology (i.e., "prospective" subdimension) not only in terms of environmental instability, but also in terms of an unequal distribution of benefits. The proper design of technologies and policies (institutions) should ensure that such abuses will not develop.

Farming systems research can be effective only if there are strong two-way linkages between farmers, agricultural scientists—technical and social—and policy making/implementing agencies. This implies the development of national research institutions, both to help build up local expertise through providing training possibilities for nationals, and to enable coordinated work to be undertaken on the institutional aspects so important in the development and dissemination of relevant improved technology.

14.3 Specific Research Topics

At various points in this review we have suggested topics of a socioeconomic nature that would be worthy of further research. However, we stress that the criterion for selecting the topics should be based more on whether they might help or hinder the improvement of the livelihood of farming families, rather than their academic interest. Also, the major focus of the research should be undertaken within the context of farming systems research with its related connotations of interdisciplinary work with technical scientists, and its locational specificity.

Some specific topics that—depending on the location—could be important are as follows.

a. Topics relating to methodology. Cost- and time-efficient methods need to be developed to study the relationships between technical, economic and noneconomic variables in the West African context. Analogous techniques need to be developed to look at the relationships—interdependent and exploitive—between different groups of farming families in society, and to analyse the ex-ante private and societal consequences of implementing different developmental strategies.

b. Topics relating to the design of relevant improved technology. Some major examples include the following.

   i. Investigation of risk aversion (see Section 9.4). Are wealthier farmers less risk-averse than poorer, smaller farmers; does risk aversion increase with the size of investment; etc.?
   ii. Investigation of a series of topics which might be closely related to each other, namely, seasonal hunger, cash flow and technical efficiency, and health and labor productivity.
   iii. Investigation of the potential for improving the level of livelihood through increasing technical efficiency, or by developing improved technology because farming families are allocatively efficient.
   iv. Determination as to whether criteria should be the same for crops to be grown on permanent or bush fields, and common or individual fields.

c. Topics relating to the evaluation criteria for relevant improved technology. These need to relate to the following.

   i. The present interest of the individual farming family. The evaluation criteria should be those relevant to it, and therefore need to be determined. What they will be will vary, but they may include a return to labor at a certain time of year (such as a seasonal peak), evaluation in terms of multiple/joint products, etc.
   ii. The future impact from both a private and a societal viewpoint. For example, within families or society is there increased differentiation in terms of the benefits of the change; is soil productivity declining; etc?

d. Topics with strong technical connotations, such as mixed cropping for food crops, maintenance of soil fertility, animal traction, herbicides, storage, etc.

e. Topics relating to institutional questions such as cooperatives, credit programs, etc.

The range of topics given supports our contention above that it is essential to have an interdisciplinary team of technical scientists and agricultural economists, plus inputs from anthropologists/rural sociologists, operating within a farming systems research mode, if cost-efficient approaches to future research work are to stand a reasonable chance of improving the welfare of farming families.

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