TECHNICAL CHANGE AND THE SMALL FARMER IN HAUSALAND, NORTHERN NIGERIA*

by

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TEXT

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iv	2	Fadama	*Fadama*
v	31	Acre	Hectare
ix	22	Adamo	Adamu
6	6	resistent	resistant
30	10	gandu	*gandu*
43	23	beccome	become
46	12	duiring	during
48	19	in livestock	in such livestock
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50	23	2.0	11.5
52	18	5 percent	7 percent
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63	5	50	57
67	16	consumer	consumed
68	15	variables	variable
70	14	1,800 pounds	800 kilograms
70	20	in technical elements	in the technical element
89	28	Ogunbile	Ogungbile
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108	1	dealth	dealt
108	3	10 acres	5 hectares
114	5	Ogunbile	Ogungbile
116	18	the Central Close-Settled	the Sokoto Close-Settled
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		11	(14.9)	(15)
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		13	(19.0)	(19)
		18	four inches	10 cms.
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		12	Doha	Doka
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Table 5.4	98	12	32.01	23.01
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Appendix A.1	123	7	0.3635 0.3997 0.3568	0.3419 0.3316 0.5517
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1. INTRODUCTION

1.1 Background

Agriculture plays a major, indeed a basic, role in the economy of Nigeria. Prior to the discovery of oil, agricultural output provided the prime source of foreign exchange. Furthermore, agriculture has always been the major employer of the bulk of the population. The geographical area which will receive most of the attention in this paper--the area popularly known as Hausaland--has a population that is predominantly rural based, about 73 percent of its inhabitants deriving their living from agriculture [Ministry of Economic Planning, 1966]. It is therefore not surprising that rural development is a key element in governmental policies for the economic development of Nigeria.

The importance of increased agricultural production has been recognized by the Nigerian government as can be seen in its support of a number of agricultural research institutes over the years. In northern Nigeria, agricultural research work by technical scientists was initiated by the Department of Agriculture in 1924. In 1957, this technical research became the responsibility of the Research and Specialist Division of the Ministry of Agriculture of the former northern region of Nigeria. The Institute for Agriculture Research and Special Services (IAR) was established when this division was transferred from the Ministry of Agriculture to Ahmadu Bello University (ABU) in October 1962.

The research mandate of the Institute has primarily covered the northern states of Nigeria. The research priorities of the Institute are determined by an interactive process between government representatives and individuals at IAR itself; but the government has the final responsibility in delineating research priorities. Historically, the technical disciplines have dominated the Institute. But, in 1964 a substantial grant was provided by the Ford Foundation to ABU to encourage research in the social sciences. One of the major objectives of this funding was to facilitate an interdisciplinary approach to solving problems of rural areas. Later, as the program developed, the funding was progressively taken over by ABU, and positions for social scientists were incorporated into the core budget of IAR.[1]

In drawing up the research program that was undertaken by the social scientists in IAR, two basic factors were taken into account [Norman, 1974a]. In the first place, rural development programs in the northern part of Nigeria have usually emphasized working with the farmer in his traditional setting rather than moving him to irrigation schemes, settlement schemes, etc. The farmer's voluntary participation in the developmental process and the work being undertaken largely within the traditional setting necessitated research that sought to obtain an understanding of the problems and constraints faced by farmers at the

[1]The organizations under which the social scientists were located were originally the Rural Economy Research Unit and later the Department of Agricultural Economics and Rural Sociology. The disciplines that were initially represented were Rural Sociology, Agricultural Economics, and Geography while later on Agricultural Extension took the place of Geography. The Rural Economy Research Unit also helped develop research expertise similar to that being developed in other parts of ABU outside the Department of Agricultural Economics and Rural Sociology.

village level. Such information can provide a valuable input into developing improved technologies that are relevant for farmers. In the second place, there was a definite bias toward a micro- rather than a macro-oriented research orientation. There were a number of reasons for this: (a) there was a paucity of accurate data at the village or micro level in the northern states; (b) the work of technical researchers and extension specialists at IAR could best be complemented by micro-research of social scientists; and (c) macroeconomic research expertise was available at other Nigerian universities and research institutions.

In the light of these considerations, the social science research program which evolved consisted of four phases [Norman and Simmons, 1973]:

1. Positive phase--determining what farmers are doing
2. Hypothesis-testing phase--determining why farmers do things a certain way
3. Normative phase--determining what farmers ought to do[1]
4. Policy phase--determining how the changes suggested under phase three should be brought about. This phrase may also involve a consideration of phase two to determine whether the suggested policy is in conflict with the farmers' reasons for doing things in the traditional way.

Phases one and two were primarily concerned with village studies and were called basic studies. Later, increasing emphasis was placed on change studies, which emphasized phases three and four. The

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[1]Phase three implies an interaction between the change agency and the farmer.

change studies were articulated by testing the relevancy of improved technologies, evaluating specific programs designed to encourage change, and testing various developmental strategies on a small scale.

In order to carry out such a research program, it is essential to have cooperation between disciplines. The desirability of cooperation among various social sciences has long been recognized. However, only recently has the desirability of cooperation between the social and technical sciences been recognized. There was some cooperation among the social science disciplines during the first two phases of the work; cooperation between social and technical disciplines became more common in the third and fourth phases. These latter phases also involved considerable cooperation with government agencies.

1.2 The Scope of the Paper

This paper reports results on only a small part of the total research program undertaken by social scientists at IAR and ABU. Although this paper focuses on a study of Hausaland, this area is ecologically similar to areas in other countries of West Africa, from Senegal to the Cameroons. Therefore, it is anticipated that, with relatively small adjustments, the methodological approach used in conducting the studies and the empirical results derived from them may have some applicability to other countries in the same ecological zone in West Africa.

The general objectives of this paper are as follows:

1. To present a comparative analysis of the economics of small-farm agriculture in three areas of Hausaland, i.e., Sokoto, Zaria, and Bauchi.

2. To assess the profitability and relevance of three improved technological packages (i.e., for cotton, sorghum, and maize) for small farmers in the Daudawa area northwest of Zaria.

3. To discuss the implications of the results for research workers and policy makers in Hausaland and in the Sahelian countries with a similar ecological base.

1.3 The Farming System

A farming system includes inputs of land, labor, capital, and management which are applied to one or more of three types of production--crops, livestock, and off-farm enterprises--in order to produce products and income. The functioning of the farming system requires that a number of interrelated decisions be made about the quantities, qualities, and ratios of the inputs to be used and the desired quantities and combinations of products. These decisions are influenced by the total environment in which the farmer operates. This total environment can be divided into two parts [Norman, 1976b; Institut d'Economie Rurale, 1976]: technical and human factors. Technical factors refer to the natural environment and its conditions--either beneficial or harmful--that define the physical potential of the farming system. Human factors, determine how the technical factors will be utilized and modified in order to realize the actual farming system.

1.3.1 Technical Factors

The technical factors include both physical factors of the environment--water, soil, solar radiation, temperature, etc.--and biological factors--crop and animal physiology, diseases, insect invasion, etc. Technical scientists develop technology to improve the potential of the farming system. Examples include irrigation research to alleviate scarcity of water or drought, fertilizer to improve soil quality, and new plant varieties which are early-maturing and resistent to disease.

1.3.2 Human Factors

Traditionally, human factors have received little attention in agricultural research. However, it is being recognized that the irrelevance of much of the improved technology is due in part to a lack of consideration of the impact of technology on the human factors. These factors can be considered from both an exogenous and an endogenous point of view.

The exogenous factors that affect the human element include, first, the general social environment. These factors are largely outside the influence or control of the individual farmer, but they influence what he can do. The first of these exogenous factors is the community structure, the way the society is organized at the village level. This factor evolves in a unique way within each community. At a broader level are the infrastructural factors which affect the input into the farming system and the output produced. In developing countries, exogenous factors are linked to the government and are influenced by the government. For example the government can affect inputs by swaying the opinions of farmers, perhaps through the extension staff. It can provide farmers with the means of purchasing improved technology through a credit program. Finally, the government can assure that improved input distribution is available when needed and to the proper degree to produce desirable results.

In addition to affecting the input, these infrastructural, or exogenous, factors also affect the product of the farm system. The most obvious area in which the government can play a role is in the marketing process and pricing. The extent of this influence will vary. The government can control prices directly through setting prices through marketing boards, etc. Indirectly, the government can affect the size of the market by improving roads, transport systems, and so forth.

Finally among the exogenous factors affecting the human element are geographic considerations. The location of the village will affect the market for its produce and off-farm employment opportunities for its people. The density of the population will affect the size of the farms, hence the type of improved technologies that will be suitable.

In addition to the exogenous factors discussed above, there are also endogenous factors. These factors relate directly to the individual farmer as the decision maker. Each farm household has access, in some measure and quality, to the four basic inputs into the farming system: land, labor, capital, and management. The farmer must decide how to utilize these inputs and the exogenous, government-related inputs to improve his production. Subject to his constraints and attitudes, the farmer allocates his inputs to the type of farming system he desires in order, as nearly as possible, to attain his objective.

In this paper, the primary focus is on the farmer, on what he does and how he makes his decisions, in other words, on the endogenous factors. The other factors--the conditions of the natural environment, improved technology, government policy, and government input--define the boundaries of the farmers' actions, even though within these boundaries the farmer has considerable choice to act consistent with his goals. Therefore, the interrelationship between the exogenous factors and the endogenous factors must be carefully considered. This relationship is basic to introducing improved technologies which are relevant.

Government policies in the northern part of Nigeria have hitherto favored the introduction of small changes over large areas rather than large changes over small areas. Traditionally, government agencies have provided the support services on the input side, such as extension, input distribution, and credit programs. Improved inputs, particularly fertilizer, have been subsidized, while cash-crop marketing has been controlled through marketing boards. The taxing function implicit in pricing policies for cash crops has in recent years been removed, while there is a gradual movement toward setting minimum prices for food crops. A recent development has been the introduction of IBRD-financed integrated agricultural development projects in specific areas where the level of support services is much higher than was possible traditionally.

1.4 Description of Hausaland

Hausaland is the name given to the area where people of dominantly Hausa/Fulani origin live. This area constitutes nearly 30 per cent of Nigeria--274,000 square kilometers [Ministry of Economic Planning, 1966]. The northern and western boundaries of Hausaland in Nigeria are with Niger and the Republic of Benin respectively, while the southern and eastern boundaries correspond approximately to the latitude 10 degrees north and nine degrees longitude east.

1.4.1 The Technical Environment

Two major ecological zones can be identified in Hausaland. They are the Northern Guinea Ecological Zone, which is located in the southern part of the area, and the Sudan Ecological Zone, located in the northern part [Keay, 1959].[1] The two ecological zones have a number of characteristics that have a profound influence on the agriculture practiced in each. The Northern Guinea Ecological Zone is dominated by a basement complex which is granitic in origin. In the Sudan area, the underlying rocks tend to be primarily of sedimentary origin. In the south, leached ferruginous soils are typical, while in the north and northwest, the change in the underlying rock results in soils that are more sandy in nature and therefore contain a lower proportion of silt and clay. The general land form is undulating in nature, although the southeastern part of the area tends to be of higher altitude (460 to 920 meters), becoming lower in the north and northwest towards the Sokoto River basin area. The general landscape is broken occasionally by mesas and lateritic strewn ridges, which can rise up to 60 meters above the general surface. In addition, a number of small rivers,

[1]The Sub-Sudan Ecological Zone, which was differentiated by Clayton [1957], has, for the purposes of this paper, been included under the heading Northern Guinea Zone. It has, in fact, a rainfall more similar to that of the Sudan Zone, but the length of the rainy season is similar to that of the Northern Guinea Zone [Klinkenberg, 1975]. Therefore, it is transitional in nature.

sometimes with broad valleys, dissect the general surface area, particularly in the north and northwestern part. In these valleys are located heavier hydromorphic soils of clay texture that are poorly drained. These often are cultivable during the dry season. However, such land is available only in very limited quantities.

The temperatures in the area are fairly homogeneous, although there are some distinctive features in regard to rainfall. The temperature ranges from a minimum mean monthly temperature of 13°C, in Bauchi, to a maximum mean monthly temperature of 40°C, in Sokoto. Thus temperature itself is not a limiting factor in terms of growth. Rainfall is, of course, the major limiting factor. The whole area has a distinctive rainy season with a unimodal peak in August and a seasonal length of four to six months. However, there are a number of distinguishing features in the amount of rain as one moves from the Northern Guinea Ecological Zone into the Sudan Ecological Zone. The total rainfall decreases toward the north (Tables 1.1 and 1.2). Rainfall of 900 to 1400 millimeters is characteristic of the Northern Guinea Ecological Zone, while a total of 500 to 900 millimeters is more characteristic of the Sudan Zone. The length of the rainy season also decreases as one moves north. Kowal and Knabe [1972] have calculated that the length of the rainy season decreases one day for every 5.5 kilometers one moves north. This decrease results in a corresponding decline in the length of the growing season in the north (Table 1.2).

There is considerable annual variation in the amount and distribution of rainfall as shown in Table 1.2. Of even greater concern is the

Table 1.1. CHARACTERISTICS OF THE THREE STUDY AREAS

Study Area	Location		Ecological Zone	Population Density of Province (persons/sq. km.)	
				1952	1963
Sokoto	13° 01'N	5° 15'E	Sudan	30	49
Zaria	11° 11'N	7° 38'E	Northern Guinea	18	31
Bauchi	10° 17'N	9° 49'E	Northern Guinea[a]	13	24

Sources: Kowal and Knabe [1972]; Ministry of Economic Planning [1966].

[a]Bauchi is technically in the sub-Sudan Zone.

Table 1.2. CLIMATE IN THE STUDY AREAS[a]

Study Area	Mean Monthly temperature		Total Rain in mms (c.v.)	cv in Monthly Rainfall	Length of Rainy period (days)	Growing Season			Months when Water is Surplus	Rain for Individual Months in mms (cv)				
										Start		Peak		End
	Min.	Max.				Length (days)	Start	End		April	May	Aug.	Sept.	Oct.
Sokoto	15.0	40.0	29.6	137	120	150	June 1-10	Oct. 21-30	July-Sept.	11 (255)	42 (148)	250 (59)	134 (72)	23 (223)
Zaria	13.9	35.0	43.9 (14.9)	115	160	190	May 11-20	Nov. 1-10	June-Sept.	37 (133)	132 (80)	281 (56)	230 (53)	36 (193)
Bauchi	12.8	36.7	43.4 (19.0)	127	150	180	May 21-30	Nov. 1-10	June-Sept.	33 (157)	91 (90)	346 (46)	185 (56)	37 (164)

Source: Kowal and Knabe [1972].

[a] The symbol cv is the coefficient of variation. The start of the rains and the start of the growing season is defined as the first ten-day period in which the amount of the rainfall is equal to or more than 25.4 mms followed by a subsequent ten day period in which the amount of rainfall is at least equal to one-half the evapotranspiration demand. The end of the rains is assumed to occur when the water storage in the top four inches of soil is used up. Water-surplus months are defined as those in which rain exceeds evapotranspiration and soil water storage.

irregularity of the rains at the beginning and at the end of the rainy period. The harsh climatic regime of Hausaland, particularly with respect to the short growing season and limited and unstable rainfall, places considerable restriction on the types of crops that can be grown in the area.[1]

1.4.2 The Human Environment

Individuals of Hausa/Fulani origin constitute 75 per cent of the population in the Hausaland area of northern Nigeria and 28 per cent of the population of Nigeria [Ministry of Economic Planning, 1966].[2] However, as Hill [1972] has pointed out, the concept of Hausa is a linguistic and not an ethnic term and refers to those who, by birth, speak the Hausa language. Therefore, individuals of a number of different ethnic origins use Hausa as their first language, including many of Fulani origin who are settled farmers. The dominance of the Hausa-speaking group is illustrated by the fact that an estimated 15 million people speak that language in the northern part of Nigeria and the Hausa are the largest linguistic group in sub-Saharan Africa. In

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[1]The climate and geology of the area interact to produce savanna woodland vegetation in the Northern Guinea Zone. Grasses consist mostly of _Hyperrhenia/Andropogon_ species, while the main trees are _Isoberlinia_ species. The density of population in this area is variable (Table 1.1), and in some parts the natural ecology is still visible. However, in the northern part of the Sudan Zone where the population density is higher much of the land is continuously cultivated. The natural vegetation, where it does exist, consists of _Andropogon gayanus_, which is the dominant grass, together with _Combretum_, _Acacia_, and _Commiphora_ species, which are the most common trees.

[2]Individuals of Hausa origin are also found in Niger, while Fulani (i.e., Fulbe, Peuhl) are distributed throughout West Africa.

spite of the differences in ethnic origin, Hausa people as a whole have a high degree of cultural, linguistic, and religious uniformity. Hill has noted that the differing patterns of socioeconomic organization are a function of the rural and urban life styles rather than of ethnic differentiation. The area has a traditionally strong hierarchical authority structure under the leadership of an emir or sultan at the emirate level. The power structure is held by the Fulani, the group which achieved a degree of dominance after the *jihad*, or holy war, in 1804. However, there has been a high degree of cultural assimilation of the Fulani with the Hausa people, and this has prevented the continuance of ethnic exclusivity [Hill, 1972].

People of Hausaland live mainly in the rural areas and can be differentiated according to three major modes of living. The first are the Fulani, who practice varying degrees of transhumance [Van Raay, 1969] and move throughout the area with their herds of cattle, sheep, and goats. The second are the *magazawa*, who are settled farmers who have not accepted the Islamic religion and are still basically animists. Usually they live in isolated settlements and are a distinct minority in the area. Finally there are the settled farmers, both Fulani and Hausa, who have accepted the Islamic faith and live in nucleated settlements. These people constitute the majority of the population of Hausaland. The main focus of this paper will be on these settled farmers, particularly with respect to their agricultural practices.

2. METHODOLOGY FOR VILLAGE STUDIES

2.1 Selection of Areas and Villages

The data analyzed in this paper were collected from three different areas in Hausaland which were centered on the towns of Sokoto, Zaria, and Bauchi. These three areas, as emphasized earlier, are fairly homogeneous culturally. However, two geographical characteristics differentiate them (Tables 1.1 and 1.2): Sokoto has a lower rainfall together with a shorter rainy season; the population density is high in Sokoto and much lower in Bauchi.

Within each area, three villages were purposively selected and considerable effort was made to ensure that these villages were representative of others in the same general location. Although it is difficult to select representative villages, we believe that this selection process is simpler in situations where hand labor is the main power source. In such situations the potential for wide variations in input and product combinations is considerably circumscribed [Clayton, 1964].

Two of the main criteria employed in the selection of the survey villages were as follows:

1. The villages should differ in their ease of access to the main city in the area. This criterion also implied that the villages were of different population densities, because in all the areas the population

density was positively correlated with the ease of access to the main city. The underlying basis for the adoption of this criterion was the concentric ring theory of von Thünen, later reformulated by Schultz [1951]. This more sophisticated version, which considers both the factor and product markets, reasons that farmers' incomes will tend to be higher near urban areas because of the greater efficiency of the factor and product markets.[1]

2. The village in each area that represented an intermediate degree of access to the major city should have a relatively higher proportion of land which could support crops during the dry season (i.e., fadama, or river bottom land). The purpose for selecting this village was to capture the differences in farming systems that evolve when there is a possibility of extending the agricultural season into the long dry season.

The villages selected in each area together with some of their characteristics are listed in Table 2.1.

In addition to the surveys carried out in the three areas discussed above, a study was made of the relevancy of three improved technological packages in the village of Daudawa (11°38'N, 7°9'E), located about eighty kilometers from Zaria.[2]

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[1]Other criteria that were used in selecting suitable villages are discussed in detail elsewhere [Norman, 1973].

[2]The improved technological package for cotton was also tested at four other sites in the general area of Zaria [Norman, Hayward, and Hallam, 1974]. However, the major emphasis in this paper is devoted to the results obtained from Daudawa, where, in addition to cotton, improved technological packages were also tested for both sorghum and maize.

Table 2.1. CHARACTERISTICS OF VILLAGES INCLUDED IN THE SURVEYS IN THE THREE STUDY AREAS

Study Area	Village	Hectares Resident[a]	Percent of Land Fallowed	Percent of Land Fadama	Amount of Potential Farm Land[b]	Key[c]	Size of Sample	Sampling Percent-age	Survey Year
Sokoto									
	Takatuku	0.58	5.2	2.8	1	HN	31	23.9	April '67
	Kaura Kumba	0.49	1.0	38.8	1	HI	31	16.0	to
	Gidan Karma	1.16	3.7	2.0	2	HR	38	32.2	March '68
Zaria									
	Hanwa	0.27	2.5	5.5	2	IN	38	43.2	April '66
	Doha	0.52	26.8	12.2	3	II	44	28.8	to
	Dan Mahawayi	0.76	21.2	8.4	4	IR	42	38.5	March '67
Bauchi									
	Bishi	0.60	17.6	0.0	5	LN	40	37.0	April '67
	Nasarawa	0.47	28.0	16.2	5	LI	37	39.0	to
	Nabayi	1.04	48.2	0.0	6	LR	39	49.4	March '68

[a]Due to the difficulties in defining village boundaries and measuring the village area, these figures represent the hectares of farmland per resident. An example of land use around one of the villages (Gidan Karma) is given in Figure 2.1.

[b]This is a subjective ranking of land in the village areas which is not at present farmed or fallowed but could potentially be cultivated: 1 indicates very low availability while 6 indicates a considerable amount of bushland that could potentially be cultivated.

[c]To help clarify presentation in the text, each village is identified with two letters: the first indicates population density (high, intermediate or low) and the second signifies location with respect to the main city in the area (near, intermediate, or remote).

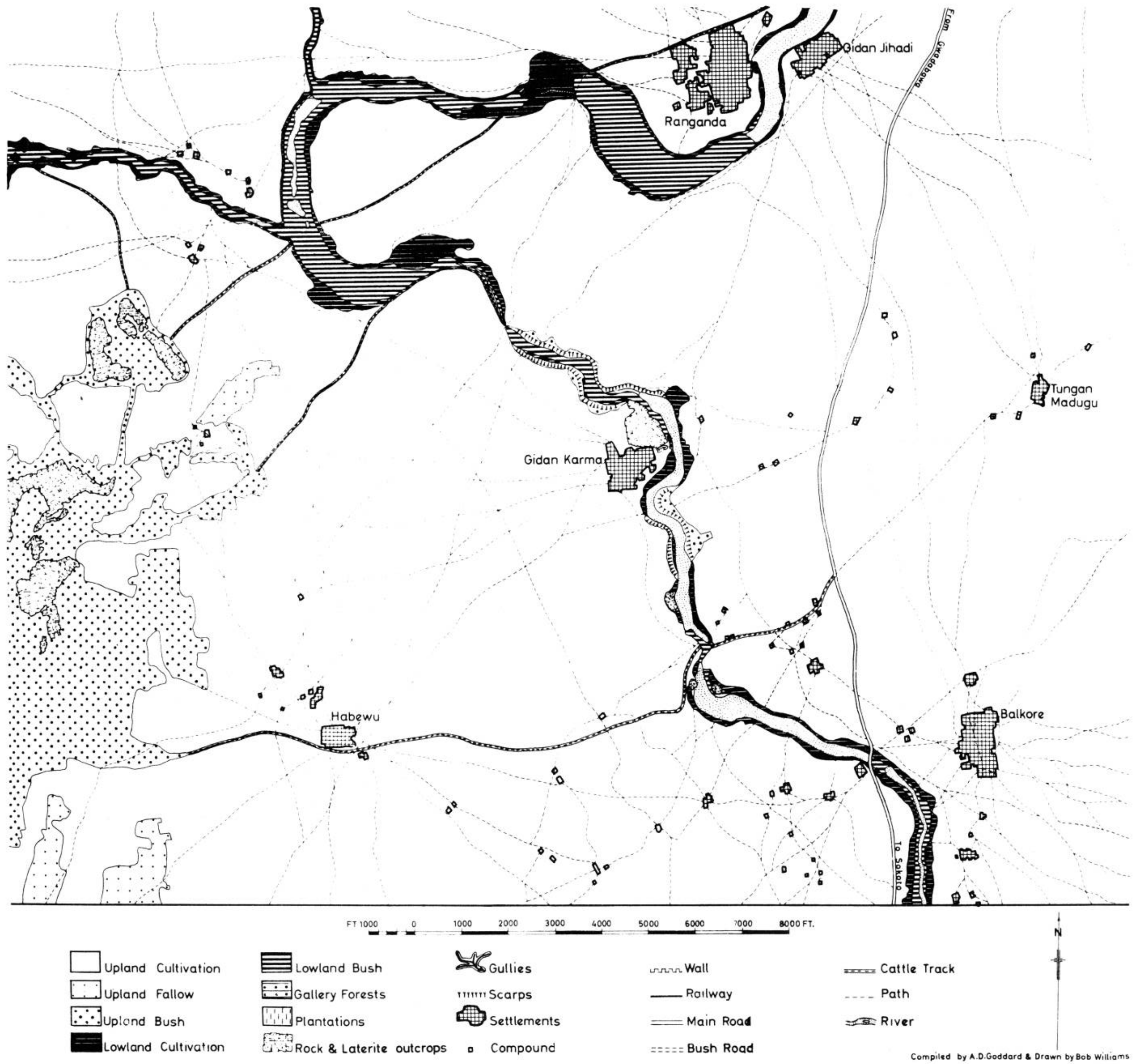

Figure 2.1 Land Use Surrounding Gidan Karma Village, Kware District, Sokoto Province

2.2 Selection of Farm Families

The prevalence of the extended family system in the region provided a major problem in defining a fixed family unit.[1] A farm family was defined as a unit with the same composition throughout the year and with consumption and work units being synonomous in so far as possible. Ultimately, we define a family as "those people eating from one pot."[2]

Initial field work in each of the villages involved undertaking a census of the inhabitants. From the frame of farm families which resulted, a random sample was selected for the detailed study. The sizes of the samples in the villages ranged from 31 to 44 (Table 2.1).[3]

2.3 Strategy for Data Collection

A combination of strategies was used in collecting data at the

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[1] Hill [1972] and others have documented the fact that the family unit can vary in composition from season to season.

[2] In Hausa, this is interpreted as "suna ci daga tukunya daya." This definition is, in fact, identical to that adopted by the Federal Office of Statistics in the agricultural sample surveys. This definition, though not ideal, was the best that could be practically applied. The words "pot," "family," and "household" are considered synonomous in the paper.

[3] These sizes reflect the number of records on which the analysis was based. They do not reflect those which were not completed (very few were in this category) or those which were rejected in the analytical stages because of inconsistencies in the data (a more common problem). The size of sample that was selected in each village was based on the number of farming families which two enumerators could handle. Also involved in the size of sample was the notion that a reasonable statistical level of precision could be obtained on most variables through sample sizes of 30 to 50 [Zarkovich, 1966].

farm level. The characteristics of the variables determined whether an interview or direct measurement approach was used. If an interviewing approach was used, characteristics of the variables also determined whether a structured or unstructured questionnaire was used and whether data needed to be collected at frequent or infrequent intervals.

Details concerning the approach used, the questionnaires, and the numerous problems encountered in collecting the data are discussed in considerable detail elsewhere [Norman, 1967-72, 1973, 1977b; Kearl, 1976]. In general, emphasis was placed on direct measurement, structured questions and interviewing each farm family twice a week.[1] Detailed day-to-day information was collected on farm inputs (i.e., labor, land, seeds, fertilizer, tools, and animals), output, marketing, and farm activities of family members, etc. Direct measurement methods were used to collect information data on cultivated area and crop yields. Thus information was collected on all facets of the farming system.

The farmers included in the studies of improved technological package in Daudawa village all had expressed an interest in participating in the programs of new technology. Therefore, the sample of farm families

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[1]It should not be assumed that the approach used in these studies was optimal. We would advocate a number of changes in future studies. Consideration of the conflicts between reducing sampling errors or measurement errors and fundamental differences between registered single-point and nonregistered continuous types of data lead us to recommend two levels of samples. The first one would be a fairly large sample concentrating on minimizing sampling errors and collecting single-point registered types of data, while the second sample would be much smaller, would emphasize minimizing measurement errors, and would concentrate on collecting nonregistered continuous types of data. The latter approach was used by Matlon [1979] in his recent study in one part of Hausaland.

who were interviewed could be biased toward the better farmers. However, the wide variation in attitudes and performance of farmers adopting the technologies appeared to indicate that there was not a serious bias in the selection of farmers [Beeden, Norman, Pryor, Kroeker, Haus, and Huizinga, 1976].[1] The studies in Daudawa involved the collection of data on fields where the improved technological package was used; data were also collected on other fields where the farmer used his indigenous practice and technology for cultivating the crop (Table 2.2). Advice was given to the farmers about when to undertake the various operations on the improved plots and improved inputs were supplied on credit. Since all the work was undertaken by the farmer, he did not always follow the time schedule recommended by the extension agent. The extension staff and the inputs for the project were provided by the Kaduna State government.

2.4 Layout of Paper

Due to the complexity of the farming systems, there were many analytical problems.[2] In order that the results of the studies of the

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[1]Indeed, it is suspected that the main reason that most farmers wanted to participate in the project was to have access to the improved inputs in the technological packages. During the years in which the technological packages were tested, the input distribution system was somewhat deficient, particularly with respect to shortage of fertilizer. Therefore, it is likely that the desire to participate in the project would not be confined simply to the more progressive farmers in the society. We recognize that the approach used can be legitimately criticized, and we advocate that a more random sampling procedure be used in future studies of a similar nature.

[2]Methodological problems involved in analyzing the data are discussed in considerable detail in Norman, 1967-72, 1973; Norman, Fine, Goddard, Pryor, and Kroeker, 1976.

Table 2.2. IMPROVED TECHNICAL PACKAGES INTRODUCED IN DAUDAWA VILLAGE, 1971-74[a]

Type of Package	1971 Hectares	1971 Nos. farmers	1972 Hectares	1972 Nos. farmers	1973 Hectares	1973 Nos. farmers	1974 Hectares	1974 Nos. farmers
Maize:								
Improved	-	-	-	-	8.2	19	8.8	20
Sorghum:								
Improved	-	-	-	-	18.9	19	22.0	12
Indigenous	-	-	-	-	15.9	24	22.3	9
Cotton:								
Improved	12.9	5	26.0	13	27.4	19	27.9	23
Intermediate	45.7	21	22.0	11	12.4	8	22.4	12

[a]Most of the analysis in Section 5 is actually based only on the results for 1973-74.

three areas can be presented in an orderly manner, the following format is used:

1. Presentation of an overview of farming in the Hausa region as a whole.

2. Assessment of differences in traditional farming in the three study areas.

3. A brief summary of the influence of village location, land type, cattle ownership, and family structure on the performance of farm families.[1]

To simplify as far as possible the presentation of the results, a weighting system was employed in which each village was weighted equally in terms of the relationships mentioned under the above items. In terms of assessing the relevancy of the improved technological packages, the analytical problem was much simpler. In addition to much smaller sample sizes (Table 2.2), the data collected and analyzed involved only a comparison of the improved technological package with indigenous practices for the same crop. Thus there was no attempt to analyze the whole farming system.

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[1]Both Matlon [1979] and Hill [1968] have stressed the heterogeneous nature of farm families together with the potential dangers that could result from using average figures rather than looking at distributions. Although the breakdown implied in this section implies some disaggregation, space limitations do not permit a detailed discussion of these nor a detailed analysis of the distribution of resources and incomes. These are discussed to some extent elsewhere [Norman, 1967-72; Goddard, Fine, and Norman, 1971; and Norman, Fine, Goddard, Pryor, and Kroeker, 1976c]. It is unfortunate that the distributional question did not receive more emphasis during the data collection phase since more recent work by Palmer-Jones would appear to indicate that this could well be becoming an increasingly important issue. See also Norman, Ouedraogo, and Newman, 1979

3. DESCRIPTIVE PROFILE OF TRADITIONAL FARMING IN HAUSALAND

This section provides an overview of agriculture in the three study areas of Hausaland. Resource availability and use are first considered, followed by a discussion of production and income. What emerges is a profile of an agriculture that, in the late 1960s, was still largely based on traditional practices.

3.1 Land

Land tenure in Hausaland has a double ancestry--both in the traditional African concept of communal ownership and in Islamic land law, which recognizes individual tenure [Goddard, 1972]. At present, people have usufructuary rights to the use of land within the community where they reside [Abalu and Ogungbile, 1976]. This implies that land ownership is still largely vested in the community and that the individual residing in the community has no right to alienate the land he holds. Goddard [1972] has identified four possible factors which can lead to inefficient land use under such a system. These are:

1. Lack of security of land title may discourage farmers from making long-term improvements in the land. Also, communal tenure implies that no individual has the right to mortgage or sell the land without the consent of other members

2. There is a restriction on the geographic mobility of farmers resulting in considerable inequality of land distribution among areas

3. Population pressure leads to a progressive subdivision of the

farm of each land-holding group. Therefore, farm sizes tend to become smaller over time, which, along with the lack of relevant improved technologies, in some areas results in declining standards of living [Oluwasanmi, 1966]

4. Family land is partitioned on inheritance. In the study areas, an average of 76 percent of the land area is held by this system of land transference (Table 3.1).[1] The principal effect of this system of land transference has been increased fragmentation of farms (e.g., see Figure 3.1 of Gidan Karma). The average family farm of 3.9 hectares in the three study areas consists of more than six different fields.[2]

Fragmentation of the land has a number of advantages in traditional agriculture. These revolve around the notion of greater equitability--for example, in distributing land of different soil types, minimizing the effect of microvariations in rainfall, particularly at the beginning and end of the rainy season, and minimizing the inconvenience of field location since most families live in nucleated settlements. The disadvantage of excessive fragmentation under traditional agriculture is that a disproportionate amount of time is spent in farmers' walking between the residence and the various fields.[3] However, Goddard [1972]

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[1]The tables in this section, in addition, include some information for each study area. However, discussion of differences among study areas is deferred to Section 4.

[2]A farm is defined in the paper as the sum of the acreage over which the farming family possessed usufructuary rights during the survey year. A field was defined as a unitary piece of land farmed by one family unit.

[3]Cleave [1974] has reported that in some parts of Africa, up to 30 percent of farmwork is spent in farmers' walking to and from fields.

Table 3.1. CHARACTERISTICS OF LAND TENURE IN THE THREE STUDY AREAS[a]

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Details of farm in hectares:[b]				
Farm size	3.9 (3.3)	3.9 (16.8)	3.9 (31.3)	3.9 (17.1)
Gona	3.5 (2.8)	3.5 (16.9)	3.7 (30.6)	3.6 (16.8)
Fadama	0.4 (101)	0.4 (18.3)	0.2 (42.7)	0.3 (23.7)
20:80 percentile points on farm size[c]	2.3:6.1	1.7:5.2	1.6:5.5	1.9:5.6
Average number of fields	5.8	6.2	6.8	6.3
Land tenure:				
Land inherited (%)	70.1	64.9	92.3	75.8
Land mobility index[d]	2.64	2.41	2.84	2.63

[a]In the comparative analysis apart from Tables 3.4, 3.8, 3.9, 3.10, 3.12, 3.13, 3.14, 4.1, and A.4 each village is weighted equally in the average for each area and in the overall average. Sample sizes for the individual villages are given in Table 2.1.

[b]Figures in parentheses represent the percent of land fallowed.

[c]That is 20 percent of the farms are less than first figure and 20 percent are greater than the second.

[d]The method of calculating the index is presented elsewhere [Norman, 1967-72]. The value of the index can vary from 1 to 3. A low value implies a preponderance of more mobile types of tenure (i.e., purchase, rent, lease, etc.).

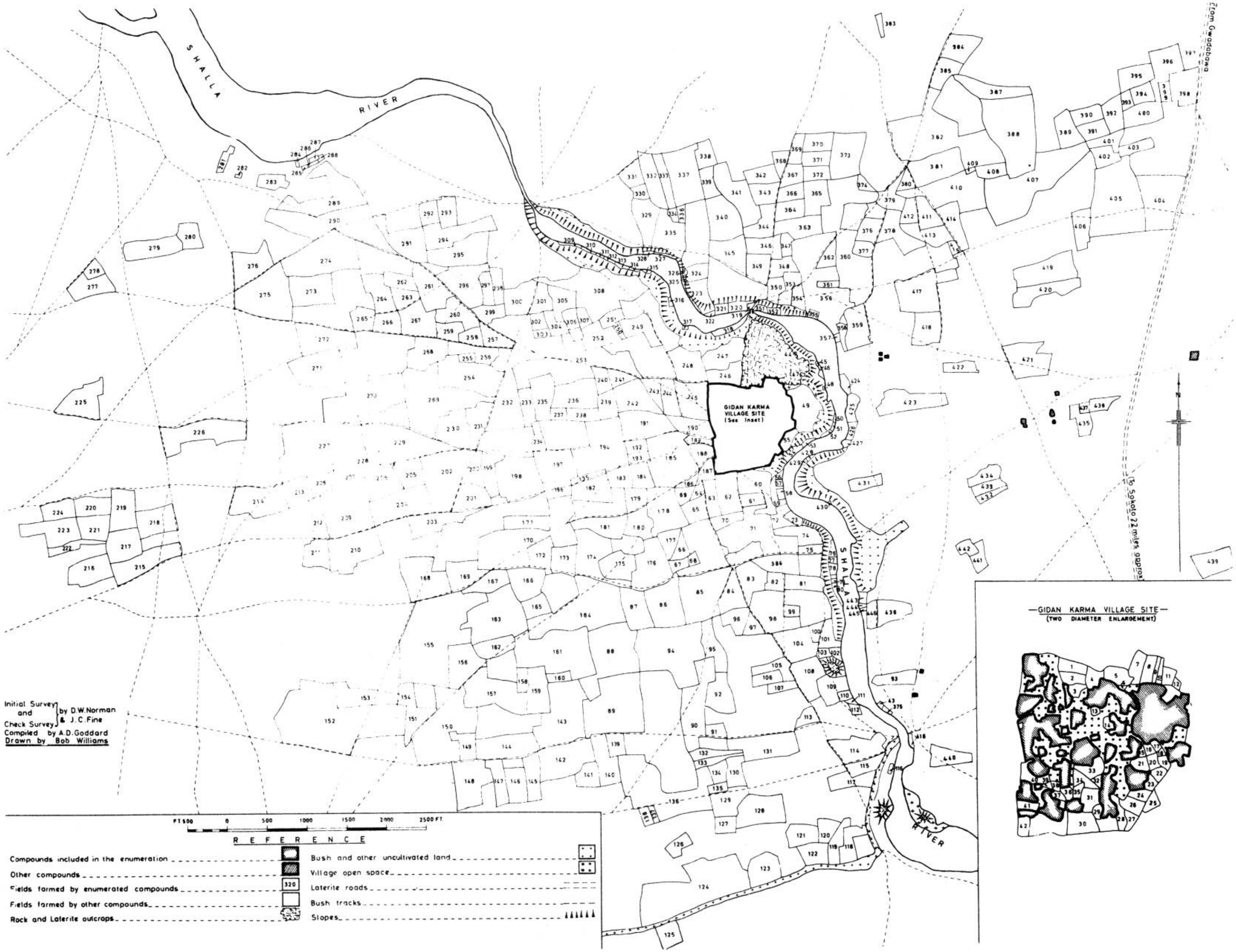

Figure 3.1 Gidan Karma Village, Kware District, Sokoto Province, Field Boundaries with Serial Numbers

found in more densely populated areas, where excessive fragmentation is becoming a problem, that farmers of larger holdings are consolidating their fields through various land transactions such as exchange, sale, or purchase. Fragmentation could cause problems when certain types of modern systems of agriculture are introduced. For example, land improvement and conservation measures may be more difficult because of the need for cooperation among neighbors, and small fields may prevent the introduction of mechanization.[1]

The above description of the land tenure arrangements would imply that land is fairly equitably distributed within villages. There was, however, somewhat more inequality in distribution than would have been expected, although much less than in some societies. The average value of the Gini coefficient for the nine villages varied between 0.20 and 0.56 (Table A.1). However, when cultivated land alone was considered, the coefficients were reduced to a range between 0.20 and 0.49, which indicated a more equitable distribution of land. In the region as a whole, an average of 17 percent of the land was fallowed.

Two types of farmland can be differentiated: first, rainfed upland fields (i.e., gona), which support crops of relatively lower value per unit of land area, such as millet, sorghum, groundnuts, cowpeas, cassava, and cotton; second, lowland fields (i.e., fadama), which support more

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[1]This is not meant to imply that mechanization (e.g., oxen and equipment and tractors) will necessarily be desirable. Delgado [1978] has noted this problem with respect to the introduction of mixed farming (i.e., oxen and equipment) in Upper Volta. In Senegal, the Experimental Units have tried to ensure that farmers adopting mixed farming have field sizes of at least one hectare [Richard, 1978].

labor intensive crops of relatively higher value per unit of land area, such as sugarcane and, to a lesser extent, rice and calabash.

Gona land is by far the most dominant, accounting for 92 percent or 3.6 hectares of the average farm (Table 3.1). Crops on gona land are primarily grown in mixtures. Gona land near residential areas is usually permanently cultivated, soil fertility being maintained through the addition of organic fertilizer; farther away from the residences, land that is fallowed is more common. Slightly less than 17 percent of the gona land was fallowed.

Fadama land permits year-round cultivation because the water table is located close to the surface. Crops on fadama are usually grown in sole stands or in a double cropping system. One would logically expect fadama land to be cultivated very intensively. However, a number of factors determine whether such land is used intensively. For example, there may be a lack of labor required for cultivating such land because of off-farm employment opportunities during the dry season; there may be flooding during the rainy season or lack of market outlets. Many of the crops produced on fadama land are primarily cash crops which are of low value per unit weight and therefore expensive to transport. As a result of these problems on the average almost 24 percent of the fadama land was in fallow (Table 3.1).

3.2 Labor

3.2.1 Family Size and Organization

The average family consisted of six to seven individuals constituting about five consumer units (Table 3.2).[1] Families can be divided into two types of units: a simple or iyali family unit, which consists of one married man with his wives and dependent children, and a composite family or gandu, which is composed of two or more male adults, usually married, together with their wives and children.

In general, simple family units were found to be more common than composite families. In the study areas, an average of 38 percent of the farming families were organized under the gandu system. Both Buntjer [1970] and Goddard [1969] have observed that traditionally the gandu family was the preferred type. One of the reasons why the gandu system is declining is because the head of the composite family has considerable authority [Hill, 1972]: he supervises the farming activities on most of the family fields,[2] and he instructs the family members about what and how much work should be done. At the same time he has some obligations: he is responsible for providing food for the family and for paying any taxes. According to Buntjer, there is an increasing tendency of family members to resent the power of the head of the composite family. Also, in the composite family unit, young married male adults are not in a position to undertake a management role as far as farming activities

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[1]The consumer units were based on dietary requirements suggested by Food and Agriculture Organization [1967]. The weighting systems employed were as follows: male adult (more than 14 years old) equals one consumer unit; female adult (more than 14 years old) equals 0.73 consumer unit; an older child (7 to 14 years old) equals 0.71 consumer unit; and a younger child (less than 7 years old) equals 0.43 consumer unit.

[2]A few fields, e.g., less than 10 percent of the cultivated area in the Zaria area [Norman, 1967-72], known as gayauna fields, were farmed by individuals other than the household head.

Table 3.2 CHARACTERISTICS OF FARM FAMILIES IN THE THREE STUDY AREAS

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Family:				
Size[a]	5.6 (1.5)	8.6 (2.2)	6.0 (1.6)	6.7 (1.8)
20:80 percentile points[b]	4:7	5:11	3:8	4:9
Consumer units	4.1	6.2	4.4	4.9
Percent of families of *iyali* type	71.9	51.0	64.4	62.5
Land in hectares per:				
(a) Resident	0.7	0.5	0.7	0.6
20:80 percentile points[b]	0.4:1.1	0.2:0.8	0.3:1.0	0.3:0.9
(b) Consumer unit	1.1	0.7	0.9	0.9
20:80 percentile points[b]	0.6:1.4	0.4:1.0	0.4:1.3	0.4:1.3
Annual man-hours on the family farm	1566.3	1800.0	1316.5	1560.9
Source of farm work as a percent of total man-hours:				
Family: Male adults	72.4	72.2	75.2	73.3
Female adults	1.1	0.3	3.3	1.6
Older children	8.5	8.9	9.9	9.1
Hired[c]: *Kwadago*	7.7 (3.2)	8.6 (4.3)	3.1 (5.0)	6.4 (4.2)
Jinga	3.0 (7.2)	9.1 (6.3)	1.5 (7.7)	4.5 (7.1)
Gaya	7.3 (0.9)	0.9 (1.1)	7.0 (1.3)	5.1 (1.1)

[a]Figures in parentheses represent the average number of male adults per family.

[b]That is 20 percent of the families have valus less than the first-figure and 20 percent greater than the second.

[c]Figures in parentheses reflect the average wage rate per man-hour in Lobo.

are concerned. For these reasons, the composite family organization apparently is being superseded by the simple family type.[1] The rate at which this change is taking place depends on a number of complex interactions such as availability of land, opportunities for off-farm employment, and ownership of cattle [Buntjer, 1970; Goddard, 1969; Norman, Pryor, and Kroeker, 1976].

3.2.2 Types of Work on the Family Farm

Hand labor was the power source on farms in the study areas. This helps to explain the relatively low average size of farms--3.9 hectares. In terms of the land-labor ratio, the average was 0.6 hectares per resident (i.e., 0.85 hectares per consumer unit). The average annual labor input on the family farm was found to be 1,560 man-hours, excluding time farmers spent walking to and from the fields (Table 3.2).[2] Eighty-four percent of the total labor input on the family farm originated from family sources. However, less than 2 percent of this was contributed by women. Female work on farms was confined to specific operations, such as planting,

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[1]Implications of this are examined in Section 4.6.

[2]To permit direct comparisons between different types of labor, it is necessary to express days and hours in terms of a common denominator (i.e., man-days and man-hours, respectively). Much controversy exists in the literature over the relative weights to use [Collinson, 1972]. This problem is further complicated because relative work productivities vary depending on the type of task being performed [Hall, 1970; Cleave, 1974]. The approach used in this study can be criticized as being too simplistic, but it did cut down the computational burden. The weights used were as follows: young child (less than 7 years old) = 0.00 of a male adult equivalent; older child (ages 7 to 14) = 0.50 of a male adult equivalent; female adult (more than 14 years old) = 0.75 of a male adult equivalent; and male adult (more than 14 years) = 1.00 of a male adult equivalent. The concept used by Spencer and Byerlee [1977], who considered that wage rates of men and women reflected different degrees of productivity and who therefore used a weighting system based on this, was more precise than the one used in this paper.

separating groundnuts from the haulm, and picking cotton. The lack of participation by women in the work force is due to the Moslem practice of auren kulle or seclusion of women [Smith, 1955]. Hill [1972] has observed that the practice of seclusion of women in the Hausa area is more strict than in other parts of rural Moslem West Africa. Children contributed about 11 percent of the total family labor input on the family farm. Therefore male adults contributed the bulk of the labor from the family unit.

Hired labor contributed only 16 percent of the total labor input on the family farm (Table 3.2). A major reason for this is that there is no class of landless laborers in Hausaland. Also, since farming is only partially commercialized, there is often a cash constraint on hiring labor. Three types of hired labor are used: kwadago, which is hired labor paid by the hour; jinga, which is paid by the job; and gaya, which is communal labor. Remuneration for these types of labor can be in cash or kind. However, payment for gaya labor is minimal and where given is usually in kind. Although it appeared that all three types of hired labor were equally popular in the study areas gaya labor was more closely linked with traditional settings and with cattle ownership [Norman, Fine, Goddard, Pryor and Kroeker, 1976]. It is possible, therefore, to hypothesize that as development proceeds within the villages, gaya labor is likely to become less popular. Also the introduction of improved technology will invariably make farming more labor intensive if the power base does not change from hand labor to the use of oxen. If the increasing scarcity of hired labor persists, it is likely that jinga labor may become more popular than kwadago since the wage rate--when expressed in per man-hour terms--resulting from jinga work was, on the average, 69 percent higher than for kwadago work.

It is likely that the family will remain the main source of farm labor in Hausaland. Table 3.3 presents the results of a regression model showing the relationship of family labor devoted to work on the family farm to a number of other variables. As would be exprected, the amount of work input in the family farm was directly related to the size of the family (i.e., total residents), and number of hectares of fadama and gona cultivated.[1] Also, as would be exprected, there was a negative relationship between family labor and the amount of hired labor employed on the family farm. An additional variable reflecting time spent by family members on off-farm occupations was included in the initial analysis. A negative relationship existed between this variable and the dependent variable; however, it was not significant. This is not surprising since much of the off-farm work takes place during the dry season when work on the family farm is minimal, implying that time devoted to off-farm occupations does not compete with time devoted to work on the family farm.[2]

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[1]However, care should be taken in interpreting these results because of implying cause and effect relationships (e.g., hectares cultivated could be a function of labor inputs) and the mixture of supply and demand variables among the independent variables (e.g., size of family and number of cultivated hectares).

[2]Since family male adults contribute most of the family labor on the farm analogous results were obtained when work done by the farmer was used as the dependent variable (Table 3.2). In addition, a negative relationship was found between the number of male adults in the family and the time they work on the family farm.

Table 3.3. RELATIONSHIP BETWEEN TIME WORKED BY ALL FAMILY MEMBERS AND BY FAMILY MALE ADULTS ON THE FAMILY FARM, AND OTHER VARIABLES

Independent Variables		Relationship of: Family Man-hours Devoted to Work on the Family Farm[b]		Relationship of: Days Worked per Family Male Adult on the Family Farm	
Constant		52.6405		147.2285	
Size of family	X_1	90.6812*	(9.5869)		
Number of male adults in family	X_2			-28.9208*	(4.0447)
Hectares cultivated:					
Gona	X_3	157.5709*	(18.9643)	6.9533*	(2.0945)
Fadama	X_4	483.5380*	(23.6897)	56.5856*	(9.1995)
Hired labor: Man-hours	X_5	-0.6148*	(0.0749)		
Man-days	X_6			-0.2108*	(0.0465)
Dummy variables:[c]					
(a) Representing study area:					
S1 (Zaria = 1)	X_7	27.1919	(77.2779)	18.4388	(8.6849)
S2 (Sokoto = 1)	X_8	-30.4405	(82.8956)	-4.1466	(9.2588)
(b) Representing location of village relative to major city in study area:					
V1 (Near village = 1)	X_9	440.0466*	(82.3679)	39.6604*	(9.4580)
V2 (Intermediate village = 1)	X_{10}	205.2618	(90.0740)	34.9357*	(10.1170)
R		0.7444*		0.4842*	
Syx		571.5868		64.1518	

[a]Figures in parentheses are standard errors.

[b]Excludes time devoted walking to and from fields.

[c]The dummy variables are included to take account of differences in location (i.e., among study areas and in ease of access). Location differences can embody differences in climate, soil types, population densities, etc.

*Significantly different from zero at the 5 percent level. N = 340.

3.2.3 Work by Male Adults

On the average, a male adult in Hausaland was found to work about 1,270 hours per year, which included time required to walk to and from fields, and both farm and off-farm work. This labor was spread over a period of 244 days with an average length of 5.2 hours per working day. Table 3.4 gives an idea of the distribution of time worked by different male adults. These results were quite similar to those of other researchers in West Africa [Luning, 1963; Kohlhatkar, 1965; Mann, 1967; Galleti, Baldwin, and Dina, 1956; Guillard, 1958; Haswell, 1953].

The amount of work undertaken by male adults can be considered simplistically as a function of a number of factors including:

1. The ability to work, which is a function of health and nutritional levels

2. Incentive to undertake work, which is a function of subsistence needs and a desire for income over and above that required for subsistence

3. Opportunities for work, in which location will be important in determining whether farm and/or off-farm work is possible. Opportunities for farm work will be a function of a number of factors mentioned earlier in this paper, for example, the indigenous resource base possessed by the farming family, which will be influenced by physical factors (e.g., climate, including seasonality, and soil), biological, and exogenous factors (e.g., presence of markets).

An important problem in Hausaland is the seasonal nature of agriculture which largely restricts crop production to the rainy season and results in substantial underemployment in the long, dry season. As a result, considerable time is spent in off-farm employment which is undertaken both in and out of the village. On the average in the study areas, 41 percent of the total days worked by a male adult was spent in off-farm work (Table 3.4). This definition of off-farm work includes all time spent on activities other than crop production on the family farm. Therefore, time spent herding animals, working on other people's farm, etc., would be included under off-farm activities.

Off-farm occupations can be divided into two groups: traditional and modern. Traditional occupations are defined as the kind of work that has been undertaken for many generations. In contrast, jobs in the modern sector are defined as those which have come about directly or indirectly as a result of improved communications and the development of large cities, commercial firms, and governmental bodies. The significance and composition of off-farm employment will depend on a complex interaction of a number of factors. As the developmental process begins and communications improve, it is likely that the relative significance of activities in the modern sector will increase compared to traditional activities. During the survey years, however, traditional activities still accounted for 86 percent of the total time spent in off-farm occupations (Table 3.4).

3.2.4 Seasonality

The seasonal nature of rainfall together with the relatively low ratio of fadama land means that there is considerable seasonal variation in the level of agricultural activity.[1] The values of the coefficients

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[1] De Wilde [1967] was one of the first writers to document the problems and implications of seasonal bottlenecks.

Table 3.4. TIME WORKED BY FAMILY MALE ADULTS BY STUDY AREA AND OVERALL AVERAGE

	Study Area						Overall Average	
	Sokoto		Zaria		Bauchi			
Days worked by family male adults per year:								
Family farm	159.3		140.1		134.2		144.5	
Off-farm: In village	78.3		88.6		97.0		88.0	
Outside village	35.4		0.0		0.0		11.8	
Total	273.0		228.7		231.2		244.3	
Hours worked:								
Hours per day worked on:								
Farm[a]	5.8	(5.0)	5.1	(4.4)	5.6	(4.7)	5.5	(4.7)
Off-farm	4.8		5.1		4.2		4.7	
Total hours worked per year	1484.3[b]		1166.4		1158.9		1269.9	
Distribution of time worked per year in days:[c]								
20 percent worked less than	196	(670)[d]	154	(687)	159	(671)	170	(676)
20 percent worked more than	340	(1607)[d]	319	(1544)	334	(1468)	331	(1540)
Type of off-farm work (percent of days):								
Traditional: Primary	16.4		15.5		30.8		20.9	
Manufacturing	27.4		18.9		4.3		16.9	
Services	34.4		27.4		39.6		33.8	
Trading	7.7		20.4		16.9		15.0	
Modern: Services	14.1		17.8		8.4		13.4	

[a]The figures in parentheses exclude time farmers spent walking to and from fields.

[b]Inclues assumption that, in work outside village individuals, worked the same length of day as in off-farm occupations in the village. If estimates for work done outside the village are excluded, the average time worked is 1315.7 hours.

[c]The figures in parentheses are hours.

[d]Distribution of man-hours for Sokoto excludes time worked outside the village.

of variation calculated with respect to the number of man-hours spent per month on the family farm ranged from 42 percent to 78 percent (Table A.2). These values are high compared with those from other areas where there are opportunities for a more even distribution of agricultural activity throughout the year [Spencer and Byerlee, 1977]. The month in which agricultural activity was at the peak varied between May and August, although in most cases June and July were the peak months. An average of 241 man-hours per month was spent on the family farm during the peak month (Table 3.5). This was 85 percent more than the average annual monthly input of 130 man-hours. The slackest month occurred between January and March. The labor input on the family farm during the slackest month amounted to only 28 man-hours, which is 79 percent lower than the average annual monthly input. The disparity in the monthly distribution of labor on the family farm is emphasized even further by the fact that the four busiest months of the farming year (i.e., May to August or June to September) accounted for over 53 percent of the total annual labor input, while the four slackest months (i.e., December through March) accounted for only 13 percent of the total annual labor input on the family farm. The seasonal distribution of labor on the family farm for the Sokoto area is illustrated in Figure 3.2. This seasonal variation gives rise to two problems, which will be discussed in the following sections: the labor bottleneck period and provision of gainful employment for the family throughout the year.

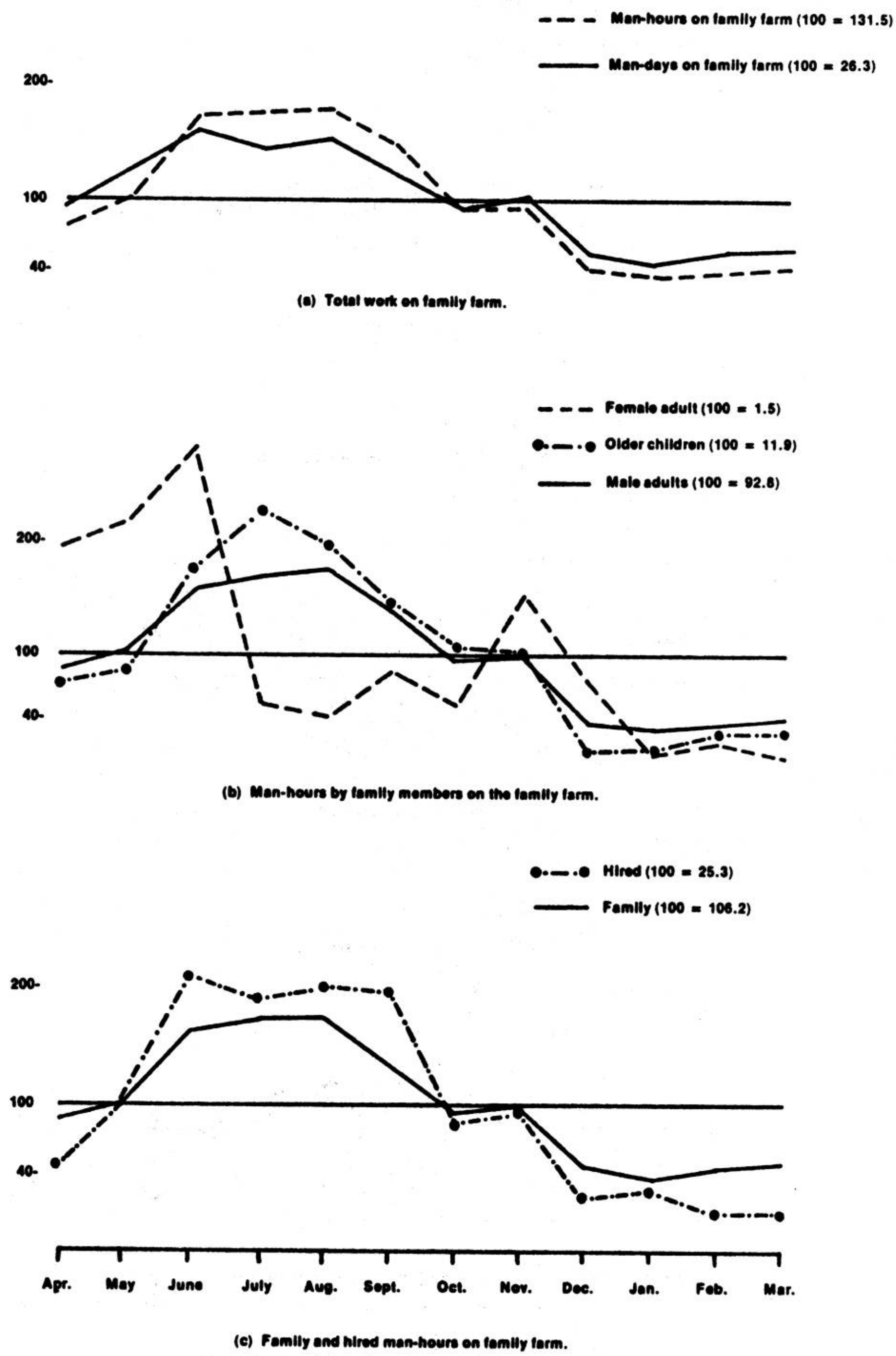
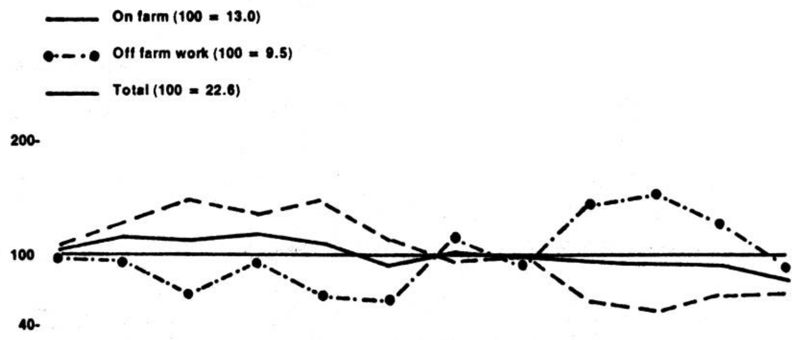
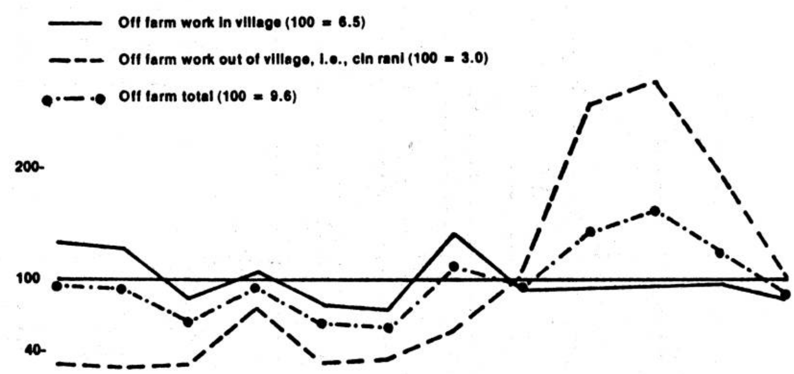


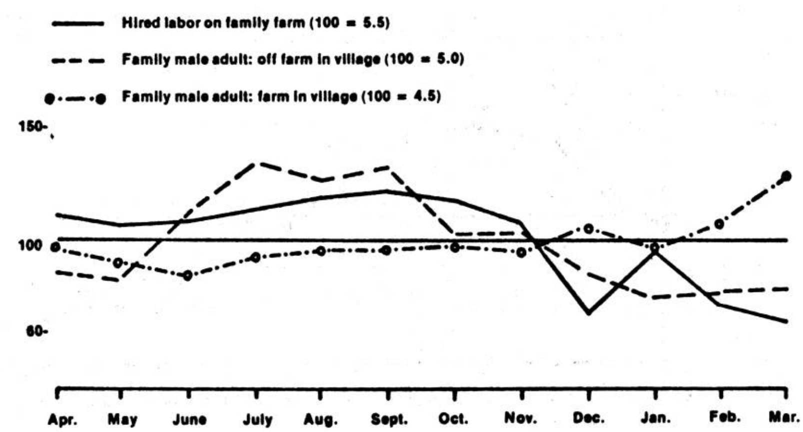
Figure 3.2 Seasonal Indices of Labor for the Sokoto Study Area



(d) Family male adult days.



(e) Family male adult days in off farm work.



(f) Average man-hours per day worked.

Figure 3.2 Seasonal Indices of Labor for the Sokoto Study Area (continued)

Table 3.5. INDICATORS OF SEASONALITY OF WORK BY STUDY AREA AND OVERALL AVERAGE[a]

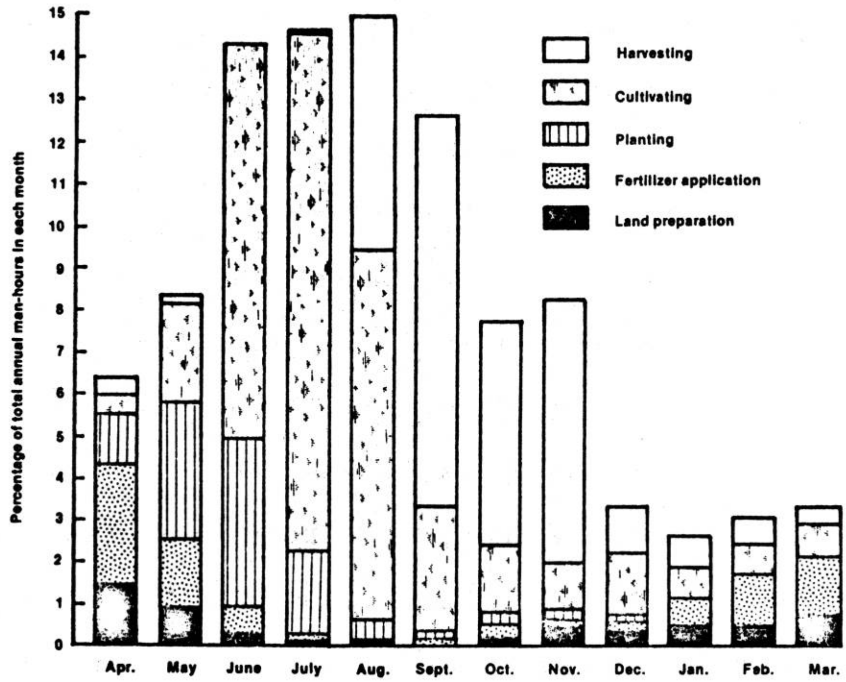
	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Busy period:				
Four busiest months:				
Months	June-Sept.	May-Aug.	June-Sept.	
Percent of total man-hours on family farm	56.6	50.4	53.2	53.4
Peak month:				
Month	July	June	July	
Total man-hours on family farm	257.7	255.5	210.0	241.1
Percent of total man-hours contributed by hired labor	21.0	18.6	12.1	17.2
Family male adults:				
Hours per day worked on farm	6.1	5.0	5.3	5.5
Days: Farm	19.9	16.8	19.2	18.6
Off-farm	7.0	7.6	6.5	7.0
Total	26.8	24.4	25.7	25.6
Slack period:				
Four slackest months:				
Month	Dec.-Mar.	Jan.-Apr.	Dec.-Mar.	
Percent of total man-hours of family farm	12.7	16.0	10.4	13.0
Slackest month:				
Month	Jan.	Mar.	Feb.	
Total man-hours on family farm	31.5	34.5	16.9	27.6
Percent of total man-hours contributed by hired labor	7.6	19.2	0	8.9
Family male adults:				
Hours per day worked on farm	3.5	2.7	4.2	3.5
Day: Farm	5.9	4.1	3.0	4.3
Off-farm	12.9	9.2	8.9	10.3
Total	18.8	13.3	11.9	14.6
Average month:				
Total man-hours on family farm	130.5	150.0	110.5	130.3
Hours per day worked by family male adults on family farm	5.0	4.4	4.7	4.7

[a]The months specified in the table do not apply to every village. Where differences arose, the majority month was listed, or if each month was mentioned equally, the mid-month was selected. Labor hours exclude time walking to and from fields.

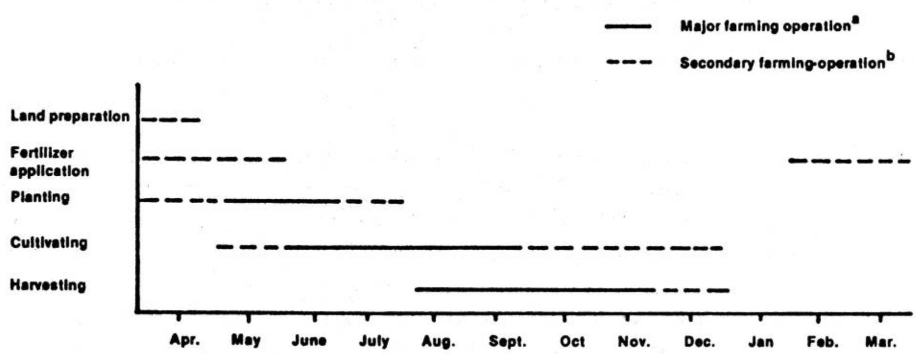
3.2.5 Labor Bottleneck

The amount of land that a family can work during the labor bottleneck period fundamentally determines the level of agricultural activity during the rest of the year. The labor bottleneck occurs during crop cultivation which includes thinning, weeding, and ridging activities as shown in the histogram constructed for the Sokoto area (Figure 3.3). The significance of the labor bottleneck period has been illustrated by linear programming models reported elsewhere [Ogunfowora, 1972; Norman, 1970] in which estimates of the marginal productivity of labor during this period were four times higher than the going wage rate. In summary our research has shown that seasonal labor bottlenecks are a major restriction on the level of agricultural activity during the rest of the year. There are at least three possible ways of modifying this restriction.

1. Increase family labor inputs in the family farm. Family members could contribute more time by giving up leisure time and reducing time spent in off-farm activities. Community norms, however, largely inhibit female adults from contributing much to work on the family farm. In addition, the labor inputs of older children at present represent only a small proportion of the total labor input on family farms. In addition, as education becomes more widespread (i.e., through the Universal Primary Education program recently introduced) it is likely that the labor input of older children will beccome smaller. Therefore, it is apparent that family male adults must continue to provide the major input on the farm. At the moment, they alleviate the bottleneck period in two major ways. First, male adults work



(a) Histogram



[a] A major farming operation was one in which monthly labor expended on that operation constituted 3 percent or more of the total annual labor used on all farming operations.

[b] A secondary farming operation was one in which monthly labor expended on that operation constituted between 1.00 and 2.99 percent of the total annual labor used on all farming operations.

(b) Bar chart.

Figure 3.3 Composition of work on the family farm by month and operation, Sokoto study area.

harder on the family farm during the bottleneck period. For example, the average time spent working on the farm during the peak month was 5.5 hours per day[1] compared with 3.5 hours per day during the slackest month (Table 3.5).[2] Second, by giving up leisure or reducing work in off-farm employment, male adults allocate more time to their farms. During the peak month, a male adult spent almost 26 days working, which is 26 percent more than the 20 days he spent in an average month during the year. Of that 26 days, almost 73 percent, or 19 days, was spent on work on the family farm. Even in the peak farming month, seven days were spent in off-farm work. Therefore, the potential for substitution between farm work and off-farm work is perhaps not so great as would be desirable. The major reason may be that to be moderately successful in the off-farm operation during the dry season, it is necessary to provide some continuity during the year. This is particularly true for occupations that involve regular clientele (e.g., crafts and services such as trading) and for cattle

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[1]At first glance, this figure does not seem to be high enough to constitute a bottleneck. However, it should be noted that this excludes time farmers spent walking to and from the field and also time devoted to off-farm occupations that are sometimes undertaken on the same days as work on the farm. Also, as has recently been well documented at a Conference on Seasonal Dimensions to Rural Poverty, held in July 1978 at IDS, University of Sussex, U.K., health and nutritional levels are often at their poorest level during the rainy season when agricultural activity is greatest.

[2]The variation in hours per day worked in off-farm employment was, in fact, lower than in the case of on-farm employment (i.e., 4.7 hours maximum compared with a minimum of 4.2 hours when viewed on a monthly basis). This means that the average value of the coefficient of variation in the hours per day worked on the family farm by male adults was higher than in off-farm employment (Table A.2). This conclusion is also illustrated in Figure 3.2 (f).

owners it involved a year round commitment.[1] The importance of off-farm work for many farmers is further emphasized by the fact that little income is obtained from farming activities until after the bottleneck period is over. Cash and food resources tend to be low at the peak period of farming activities since most crops are harvested between August and December. Therefore, those farmers facing severe depletion of cash and food resources would be compelled to work in off-farm employment even though the needs on their own farms might be high.

2. Increase the use of hired labor. One would expect that since labor is in such demand during the labor bottleneck period the bulk of hired or nonfamily labor would be utilized duirng this period. It is true that relatively more labor is hired in the peak period. In fact, 17 percent of the total man-hour input on the family farm during the peak month was contributed by hired labor and the greater amount of work undertaken by hired labor during the peak month involved longer hours and more days. However, in spite of the evidence that somewhat more hired labor is utilized during the peak period, it is not so great as expected. There are two possible reasons why more hired labor is not used in the peak or the bottleneck period. First, there is no class of landless laborers to fill this demand, thus the period in which hired labor is most in demand is the time when individuals are busiest on their own farms. Second, the low level of cash resources

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[1]Delgado [1978], in Upper Volta, through linear programming, found that the seasonal labor conflicts between crop production and keeping cattle were irreconcilable if farmers were to maintain their objective of growing enough millet for home consumption.

during this period imposes a restriction on the amount of labor that can be hired by farm families. Therefore, it appears that there is not a great deal of potential for increasing the amount of hired labor used by farming families.

3. The introduction of improved technology to modify the labor-bottleneck period. This will be discussed later in the paper. However, it is pertinent to mention that the possibility of developing improved technology either to overcome or to circumvent the labor-bottleneck period has not received the emphasis by researchers that is warranted in the light of the above discussion.

3.2.6 Underemployment of Family Labor

Farming is likely to remain the major occupation of the bulk of the rural population for many years to come. Also, it is likely that family male adult labor will continue to provide the major labor input in the family farm. However, the seasonal nature of agriculture produces special problems for employment of family labor. Family labor is occupied on the farm at certain times of the year, but at other periods there is little farm work. Therefore, on an annual basis it appears that labor is underemployed. In Hausaland, attempts have been made by farming families to overcome this problem by engaging in substantial off-farm occupations, particularly during the dry season. The results for the Sokoto area, given in Figure 3.2 (d), illustrate this. However, the main problem is the lack of sufficient off-farm employment opportunities.

3.3 Capital

The two main inputs of traditional agriculture are labor and land. The amount of capital and the proportion of income invested in traditional agriculture are usually low. Low capital formation in traditional agriculture may not be due only to a low capacity for saving but also, in part, to low return on investments. It is, therefore, not surprising that investment in durable capital was low. Dependency on hand tools, together with the absence of farm buildings other than grain stores and an occasional livestock hut, resulted in an average inventory value of investment in these items of only ₦8.29 (Table 3.6). This investment covered only the crop production component of the farming system.

Livestock, the other major source of investment, is largely independent of crop production. The investment in livestock (i.e., chicken, sheep, and goats, and a few guinea fowl, donkeys, and horses) was relatively significant in spite of the fact that such livestock did not play an important role in the farming activities and incomes of most families. However, livestock is a form of investment that can be easily translated into cash. The average level of investment in livestock amounted to ₦4.17. The largest investment in durable capital was made by those farmers who owned cattle. The overall average investment in cattle was ₦57, giving an average total investment in durable capital of ₦79.46. Those farmers who owned cattle derived substantial benefits from them. However, the level of investment required to possess cattle

Table 3.6. NUMBER OF LIVESTOCK BY TYPE AND VALUE OF FARM CAPITAL BY STUDY AREA AND OVERALL AVERAGE

	Study Area			Overall Average
	Sokoto	Zaria	Banchi	
Number of livestock:				
Cattle:	1.5 (38.2)	3.4 (15.8)	1.2 (12.7)	2.0 (22.2)
Other livestock:				
Sheep	0.1	2.2	1.1	1.1
Goats	4.6	2.1	2.5	3.1
Poultry	4.7	6.4	2.4	4.5
Guinea fowl	1.4	0.9	-	0.8
Ducks	-	-	0.1	0.1
Donkeys	1.0	0.2	0.1	0.4
Horses	0.2	0.1	0.1	0.1
Inventory value of durable capital				
Naira value[b]				
(a) Crop production (buildings, tools, and equipment)	14.25	4.51	6.12	8.29
(b) Livestock				
Cattle	49.74	95.11	26.14	57.00
Other	17.79	15.62	9.09	14.17
Total	81.78	115.24	41.35	79.46

[a]The figures in parentheses represent the average percentage of families owning cattle.

[b]1 Naira (₦) = 100 kobo = $1.50.

was relatively high.[1] As will be seen later in the paper, the ownership of cattle bestows special advantages on families; they have organic manure for field, substantial sources of supplementary income, etc.

On the average, the cost of capital used in crop production during the survey year was ₦23.39 per family (Table 3.7). However, much of this was an inputed cost and was not translated into cash.[2] Durable capital costs amounted to ₦2.91. The remaining capital costs were for seed and fertilizer. The seed component amounted to only ₦8.82 per year, with much of the seed used being saved from the previous cropping year. Inputed cost of fertilizer was ₦11.60. Of this, only 65 kobo could be attributed to the use of inorganic fertilizer.[3] Therefore, most of the fertilizer applied was in the form of organic manure, which was derived from livestock owned by the families or through contracts with nomadic Fulani cattle owners. Under these contracts, the manure produced on the field was usually considered sufficient payment for the right of the Fulani to graze their cattle on the residues of the harvested crop. The application of organic manure has become progressively more important in the attempt to maintain soil fertility in the face of an increase in population density, while the traditional means of fallowing has of necessity becomes less common.

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[1]The average number of chicken, sheep, goats, guinea fowl, donkeys, and horses owned by households is given in Table 3.6. Only an average of 22 percent of the farmers actually owned cattle. Farmers with cattle owned an average of 2.0.

[2]These figures must be treated with caution. This is particularly true with the input of organic fertilizer. It is difficult to measure the level of application of organic manure and problems of costing further compound it [Norman, 1967-72].

[3]These surveys were undertaken in 1966-68. It is more likely that the use of inorganic fertilizer has increased in more recent years.

Table 3.7. COST OF USING CAPITAL IN CROP PRODUCTION AND CASH COSTS PER FAMILY BY STUDY AREA AND OVERALL AVERAGE

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Estimated cost of using capital during survey year (₦)				
Durable	4.13	1.44	3.16	2.91
Nondurable:				
Seed	8.20	13.59	4.67	8.82
Fertilizer: Organic	25.48	5.40	3.89	11.60
Inorganic	0.03	0.17	-	0.06
Total (₦)	37.84	20.60	11.72	23.39
Cash costs:				
Total (₦)	15.86	25.04	8.33	16.41
Percent:				
Capital:				
Durable:				
Land	3.8	4.4	3.6	3.9
Other durable	25.4	13.1	34.8	24.5
Nondurable:[a]				
Seed	13.2 (16.4)	11.9 (20.4)	2.8 (6.7)	9.3 (14.5)
Fertilizer	4.9 (6.5)	3.3 (9.0)	- (-)	2.7 (5.2)
Hiring Labor	49.5	63.9	57.1	56.8
Marketing costs	3.2	8.4	1.7	2.8

[a]Figures in parentheses refer to average percent of the total value of seed or organic fertilizer used which was purchased.

3.4 Cash Production Costs

Cash costs are used to obtain the services of inputs either on a temporary basis (e.g., renting, pledging, or leasing land, hiring labor, and purchasing seeds and fertilizer) or on a more permanent basis (e.g., purchasing the usufructuary rights to land and equipment). Cash costs for crop production by families amounted to an average of only ₦16.41 (Table 3.7). This constituted about 11 percent of the total value of production derived from crops.

Land, as discussed earlier, is owned by the community; individuals possess only usufructuary rights to it. For this reason, it was not considered as a component of durable capital investment. Indeed, even in cash terms, the expenditure on land is low. Only 4 percent of the cash expenses was on the average devoted to obtaining usufructuary rights to the land. Another 24 percent was allocated to durable capital investment, while nondurable capital accounted for an average of only 12 percent of total cash expenses. In terms of the two components of nondurable capital, only 14 percent of the total amount of seed used in crop production was purchased. In the case of organic manure, the same figure was only 5 percent. Marketing costs accounted for 3 percent of the total cash expenses. The insignificance of this is related both to the low proportion of total production sold (see Section 3.7.3) and to the operation of middlemen or traders who often purchase products directly from the farmers and arranged for their transport to the market.

Hiring labor was by far the most important item of cash expenditure on crop production; it accounted for an average of 57 percent of the total cash expenses. The significance of this is apparent from the earlier analysis in which labor was shown to be limiting at certain times of the year. The significance of hired labor is further underlined by a study by King [1976] in Hausaland in which he found that an average of 74 percent of the credit borrowed under informal loans was used for hiring labor. It is to be expected that the introduction of yield-increasing improved technology, without a change in the power base, will involve an increase in absolute levels of expenditure on nondurable capital (e.g., improved seed, inorganic fertilizer) and a substantial increase in expenditure on hired labor. Institutional credit programs have often given credit for both durable and nondurable capital. In order to try to safeguard against misuse of such credit, these items have often been given in kind. Because of possible abuse of funds given in cash, and perhaps also because of a lack of recognition of the increased labor inputs that occur through the use of improved technology, such credit programs have often not included provision for hiring extra labor. This omission may well become an important constraint on the adoption of improved technology.

3.5 Land and Labor Relationships

Since hand labor was the only power source, the relationship between land and labor was important in determining the intensity of agriculture. The average labor input was 622 man-hours per cultivated hectare. It is reasonable to hypothesize that the amount of labor used per hectare will be inversely related to the number of cultivated hectares on the farm. The relationship is complicated by other factors such as the quality of land. Two possible indicators of quality of land are the proportion of cultivated land that is fadama and the amount of organic manure applied per hectare. It is hypothesized that the higher the quality of land, the greater will be the number of man-hours devoted to it on a per hectare basis. Regression models verifying the above relationships are given in Table A.4, while graphs constructed from them are shown in Figure 3.4. As can be seen from the functions estimated, the level of family input per cultivated hectare decreased more rapidly than total man-hours per cultivated hectare as the number of cultivated hectares increased. The difference can, of course, be attributed to the use of hired labor. The total number of man-hours of hired labor was shown to be significant, positively related to the number of cultivated hectares.[1] However, this significant relationship did not hold when hired hours were expressed per cultivated hectare.[2] This means that the use of hired labor could only partially offset the decrease in family labor inputs per cultivated hectare as the number of cultivated hectares increased.

3.6 Cropping Systems

3.6.1 Crops Grown

The cropping systems that have evolved in Hausaland reflect the end result of an interaction of the physical, biological, exogenous, and endogenous factors. A total of 29 crops, differing greatly in significance, was grown in the study areas. Cereal crops accounted for almost 60 percent

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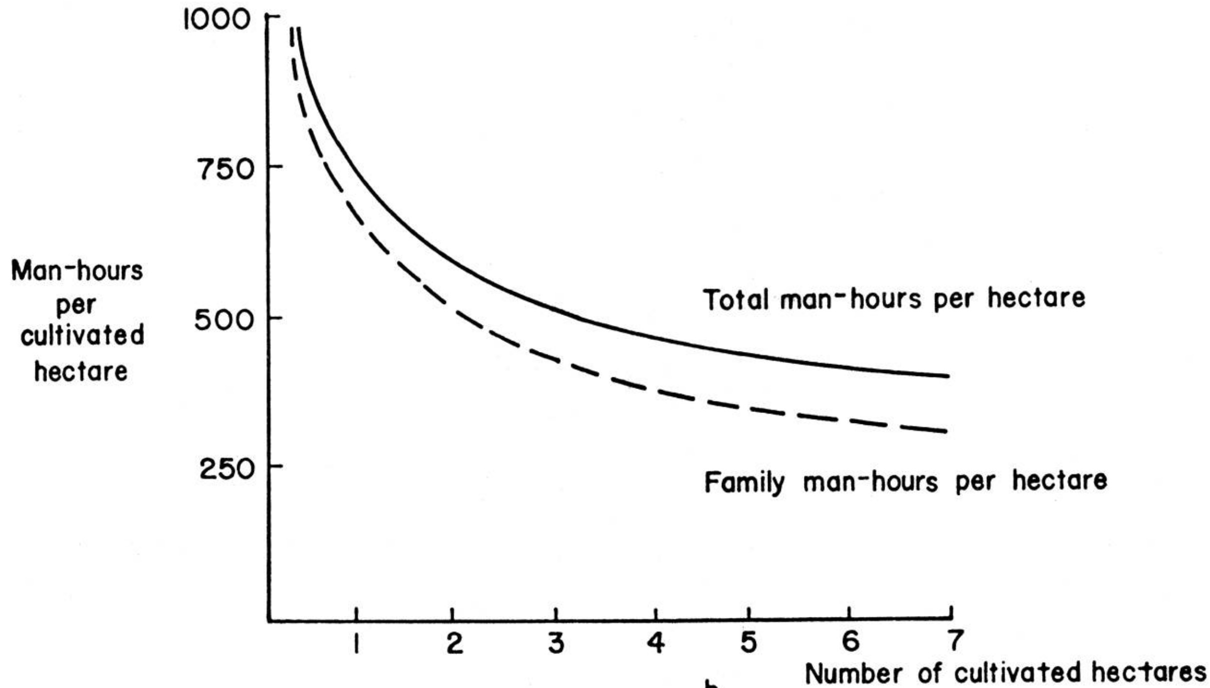
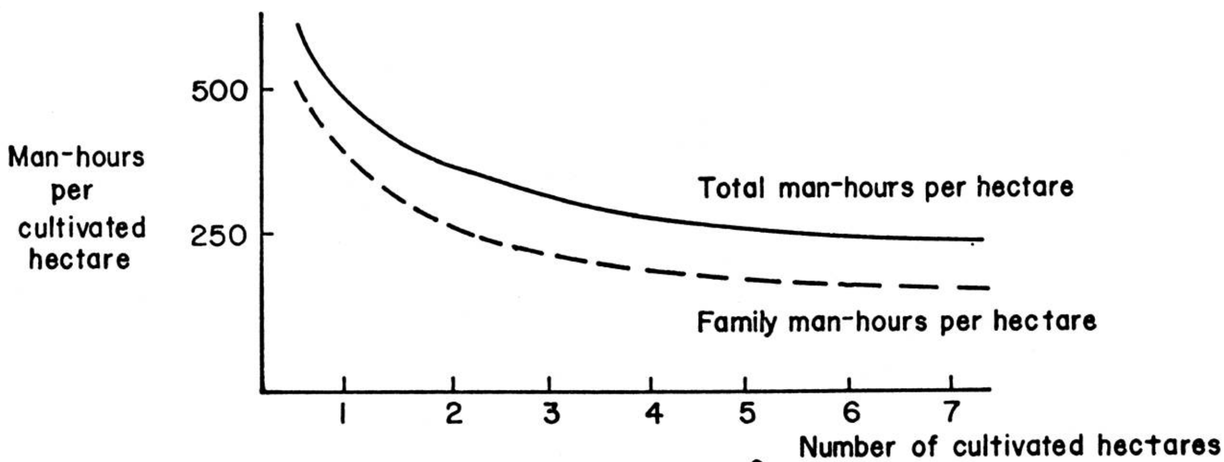
[1]The partial correlation coefficient between the logs of these variables, controlling for the two land quality variables, was 0.31, which was significantly different from zero at the 5 percent level.

[2]The partial correlation coefficient between the logs of this variable and cultivated land, controlling for the land quality variables, was 0.05, which was not significantly different from zero at the 5 percent level.



(a) Nasarawa[b]



(b) Gidan Karma[c]

[a] Constructed from functions estimated in Table A.4.

[b] X_2 and X_3 held at means, i.e., $X_2 = 0.1455$, $X_3 = 0.7610$

[c] X_2 and X_3 held at means, i.e., $X_2 = 0.0150$, $X_3 = 1.0660$

Figure 3.4 Relationship between labor input per cultivated hectare and number of cultivated hectares.

of the total adjusted acres[1] and grain legumes for another 24 percent. Starchy roots and tubers made up 6 percent, while vegetables, sugarcane, and nonfood crops accounted for the remainder.

The results given in Table 3.8 indicate that the major crops grown on gona land are millet (25 percent of the adjusted hectarage), sorghum (30 percent), cowpeas (16 percent), groundnuts (9 percent), and cotton (3 percent). Millet and sorghum constitute the major food crops grown by farmers in Hausaland [Simmons, 1976a]. The major crops grown on the fadama land are rice (4 percent) and sugarcane (2.5 percent). Cassava (4 percent) is grown on both gona and fadama land.

3.6.2 Mixed Cropping

On the average, only 26 percent of the cultivated land was sole cropped. The remaining land was primarily devoted to crop mixtures, i.e., two or more crops grown on a given piece of land at the same time.[2] Because of the shortness of the rainy season, double cropping was precluded on the gona or rainfed land.[3] Therefore, it has been suggested that in

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[1] A definition of adjusted hectares appears in Table 3.8. The use of adjusted hectares has been legitimately criticized [Matlon, 1979]. Although it is simple to calculate, the bias inherent in its calculation is likely to underestimate the significance of the dominant crops such as cereals.

[2] The different crops may be together for a short or a long time. Such a characteristic has made an acceptable definition of crop mixtures a contentious issue. For the purposes of this paper, any degree of overlapping in terms of time was considered to be mixed cropping.

[3] Double cropping, however, is possible on fadama land and was practiced to a minor extent. Six crop enterprises involving double cropping were identified, but these accounted for only 1.2 percent of the total cultivated land. There were, in addition, a few other minor crop enterprises which consisted of a combination of double and mixed cropping.

order to maximize the return per hectare per year, it is best to grow crops in mixtures [Dalrymple, 1970].

A total of 23 crops was grown in sole stands. In addition, a total of 230 different crop mixtures was identified. These mixtures did not take into account differences in planting patterns or plant population densities. Although the number of crop mixtures identified was very large, 53 percent of the total cultivated area in fact was accounted for by six crop enterprises as shown in Table 3.8. Of these mixtures, millet/sorghum and millet/sorghum/cowpeas were by far the most dominant.

The crop mixture index in Table 3.8 gives some idea of the relative number of crops grown in the mixtures. Although for each crop mixture many different spatial arrangements are possible, it was found that certain arrangements of crop constituents were most popular, particularly within a given village [Norman, 1967-72; Norman, 1974b; Norman, Fine Goddard, Pryor and Kroeker, 1976]. In general, systematic planting patterns are followed. On <u>gona</u> land, crops are usually planted in ridges one meter apart, while on low-lying <u>fadama</u> land crops tend to be planted on the flat.

Table 3.8 shows that some crops more than others are grown in sole stands. The major factor underlying the value of growing different species in mixtures depends on whether the relationship between them is competitive or complementary [Andrews, 1972]. When the relationship is complementary, it is likely that the different species will be grown together in a mixture. Complementarity will be enhanced when one or more of the following characteristics offset the competitive relationship

Table 3.8. TYPE AND ACREAGE OF CROPS AND CROP ENTERPRISES: BY STUDY AREA AND OVERALL AVERAGE[a]

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Adjusted hectares grown:[b]				
Millet and late millet	130.6 (4.5)	78.7 (2.0)	62.2 (25.4)	90.5 (10.6)
Sorghum	70.0 (3.0)	114.0 (26.6)	143.2 (57.0)	109.1 (28.9)
Rice	4.7 (31.6)	30.9 (73.4)	8.5 (100.0)	14.7 (68.3)
Groundnuts	8.5 (27.7)	42.5 (15.7)	36.8 (49.9)	29.2 (31.1)
Cowpeas	108.1 (0.0)	43.7 (2.1)	26.0 (4.3)	59.2 (2.1)
Cassava	20.7 (69.0)	9.3 (65.3)	7.6 (95.1)	12.5 (76.5)
Red sorrel	20.2 (0.0)	-	0.4 (0.0)	6.9 (0.0)
Sugarcane	2.4 (90.3)	23.4 (97.7)	3.0 (82.5)	9.6 (90.2)
Cotton	0.2 (81.8)	37.4 (31.3)	0.2 (100.0)	12.6 (71.0)
Total (all crops)	409.5	397.0	299.2	368.6
Percent of cultivated hectares				
Sole cropped	9.1	23.0	46.2	26.1
Value of mixed cropping index[c]	2.73	2.43	1.75	2.30
Major crop enterprises (hectares):[d]				
Sorghum	2.1	30.3	81.6	38.0
Sugarcane	2.2	22.8	2.5	9.1
Millet/sorghum	3.3	93.1	62.4	52.9
Millet/cowpeas	65.2	-	-	21.7
Millet/sorghum/cowpeas	142.3	14.0	19.2	58.5
Millet/sorghum/cowpeas/ red sorrel	48.5	-	-	16.2
Total number of crop enterprises	75	200	60	111.7

[a]The figures for hectares are aggregates for each area; those in parentheses represent the percent of the total adjusted hectarage each crop grown sole. For the overall average each area was rated equally.

[b]Only crops for which more than 20 adjusted hectares were grown in at least one study area were included in the table. The calculation of adjusted hectarage was necessary because of extensive use of mixed crops. The hectarage of each crop in the mixture was calculated by dividing the hectares the crop mixture by the number of crops in the mixture. For example, a 2-hectare millet/sorghum mixture was recorded as 1 hectare of millet and 1 hectare of sorghum.

[c]Details on the method of calculating the mixed cropping or intercropping index are given elsewhere [Norman, 1967-72]. A higher value indicated the preponderance of more crops in the mixture.

[d]Only crop enterprises for which more than 20 hectares were grown in at least one study area were included in the table.

between the species under consideration: different growth cycles, different water and soil nutrient demands, different rooting habits, symbiotic relationships between different species, differential labor demands and practices, etc.

As examples of the above, sugarcane and rice are usually grown as sole crops on fadama land. The potentially harmful shading effect of the tall dense stands of sugarcane limits the value of growing other crops in a mixture with it. Rice is often not planted in rows; therefore, weeding, cultivation, and harvesting would be complex if other crops were grown in a mixture with it. As shown in Table 3.8, millet and cowpeas are usually mixed on gona land. Millet is harvested in the middle of or before the end of the growing season, while cowpeas are not planted until well after the beginning of the rainy season. Also, millet is very commonly grown in mixtures in which another major constituent is sorghum. Millet matures early and thus complements the growth cycle of the long-season sorghum. It also has a rooting habit complementary to sorghum [Andrews, 1972, 1974]. Another justification for growing the nonsprayed cowpeas in mixtures is some evidence that insect damage is thereby reduced [Institute for Agricultural Research, 1972].

3.6.3 Justification of Mixed Cropping

When asked why they grew crops in mixtures, farmers gave a number of reasons. The major reason could be interpreted as 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 their main reason for growing crops in mixtures. However, in addition, a number of farmers mentioned the fact that it was

Table 3.9. COMPARISON OF SOLE AND MIXED CROPS ON GONA LAND BY STUDY AREA

	Sokoto		Zaria		Bauchi		Average Percent change from Sole to Crop Mixtures
	Sole Crops[b]	Crop Mixtures	Sole Crops	Crop Mixtures	Sole Crops	Crop Mixtures	
Labor (man-hours/hectare):[c]							
Annual	425.6	485.4	362.1	586.1	564.6	597.2	27.2
Labor peak period[d]	232.4	237.9	122.3	157.8	247.2	247.2	10.5
Yield (kg/ha):							
Millet	736	686	-	366	727	393	-26.4
Sorghum	652	122	786	644	839	729	-37.5
Groundnuts	429	188	587	412	392	217	-43.5
Cowpeas	-	56	-	132	-	52	-
Value of production (₦) per:							
Hectare	31.65	40.80	38.00	61.36	29.50	33.73	34.9
Annual man-hour	0.06	0.12	0.13	0.11	0.08	0.08	28.2
Man-hour during peak period	0.13	0.32	0.35	0.42	0.24	0.25	56.8
Net return (₦/ha), with labor:							
Not valued	30.74	38.94	36.79	59.48	30.74	33.76	34.9
Costing hired labor only	28.27	36.13	33.41	54.02	28.64	31.18	32.8
All costed	17.96	24.36	18.31	28.37	14.80	18.68	41.2

[a] The weighting system used in deriving the figures used for comparison in the table is discussed elsewhere [Norman 1974b].

[b] Cassava was one of the sole-crop enterprises. Since it is also a fadama crop, it does not appear as a constituent of any of the crop mixtures used in the analysis. It is a different type of crop from other rainfed crops, and has a different labor distribution.

[c] The labor figures exclude time travelling to and from fields and that also involved in threshing or shelling the crop.

[d] Peak periods were June to August in Sokoto; June and July in Zaria; and July to September in Bauchi.

Table 3.10. VALUE OF PRODUCTION FROM SOLE AND MIXED CROPS GROWN ON <u>GONA</u> LAND BY STUDY AREA[a]

Value of production (₦) per	Variable	Sokoto Sole crops	Sokoto Crop mixtures	Zaria Sole crops	Zaria Crop mixtures	Bauchi Sole crops	Bauchi 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	2.10-48.94
	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	0.07-0.20	0.09-0.29
	L or M	14	33	44	40	40	40

[a]Abalu [1976] has shown for the Zaria study area that crop mixtures contribute to income stability

[b]L = percentage of the crop mixture observations that were less than the median (50 percent observation) for sole crops. M = percentage of the sole crop observations that were more than the median (50 percent observation) for crop mixtures. The L value appears under sole crops and the M value under crop mixtures.

traditional to grow crops in mixtures. Probably the desire for security in fact accounted for the traditional popularity of mixed cropping.

The question addressed in this section is how much justification there is for the reasons given by farmers for growing crops in mixtures.[1] The following observations are derived from the results presented in Tables 3.9 and 3.10.

1. A major input in traditional agriculture is labor. On an average, the annual labor input per hectare from growing crops in mixtures was 27 percent higher than that from growing crops in sole stands. However, this differential was reduced to 10 percent when only labor during the peak farming period was considered.

2. For areas in which crops were grown in both sole and mixed stands the average decrease in yield of individual crops when grown in mixtures varied from 26 percent to 43 percent. Possible reasons for these lower yields include competition with other crops in the mixture for water, light, and nutrients and the lower population density of an individual crop when planted in mixtures.

3. When the yields of individual crops were expressed in terms of a common denominator such as money, the average value per hectare of crop mixtures was 35 percent higher than the value of sole crops. In addition, although the annual labor input from growing crops in mixtures

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[1]One deficiency in the analysis was lack of data ascertaining whether there were significant differences in the soil feriliity of land devoted to sole and mixed crops. Casual observation indicated that there was no significant difference, but this was not verified by direct measurement.

was higher than sole crops, the return from growing crops in mixtures per annual man-hour was 28 percent higher than from growing crops in sole stands. Moreover, when labor applied during the labor bottleneck period was considered separately the return per man-hour during the labor bottleneck period was 50 percent higher for crop mixtures. It appears, therefore, that mixed cropping helps alleviate labor bottlenecks. Linear programming results provide additional empirical support for mixed cropping [Ogunfowora and Norman, 1973].

4. The net return per hectare was 32 percent to 41 percent higher for mixed cropping depending on how labor was costed.

5. Finally, the results indicate that growing crops in mixtures gave a more dependable return. This is not surprising since crop species in a given mixture are likely to react differently to variations in weather and insect and disease attacks.

In summary, the reasons given by farmers for growing crops in mixtures were verified by the results presented above. The implications for introducing improved technology, in the light of the above findings, are important. Mixed cropping using indigenous technological methods proves to be rational and well adapted to both the technical and the human elements. Experimental evidence is accumulating which indicated that mixed cropping under improved technological conditions may also be more rational in terms of either a profit maximization or a security goal, provided that a change in the power source is not envisaged [American Society of Agronomy, 1976; Baker, 1974; Baker and Yusuf, 1976; Kassam, 1973; Kass, 1978].

Traditionally, improved technology has been developed specifically for sole cropping. The increasing research emphasis on mixed cropping at the IAR is justified by the results presented in this paper. Additional support for mixed cropping is provided by the findings of a recent study in the Kano area by Edache [1978]. He strongly supports the introduction of improved technologies incorporating mixed cropping into the National Accelerated Food Production Program (NAFPP) recently initiated in Nigeria [International Institute for Tropical Agriculture, 1977].

3.7 Income

3.7.1 Introduction

The average disposable income during the survey year was almost ₦200[1] per farm family (Table 3.11).[2] However, this should be regarded with caution since there are many problems in measuring and interpreting income figures.[3] Bearing in mind the problems of measuring income, it

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[1] This income figure refers to the 1966-68 period. The composite price index (1960 = 100) for low income families was 131 in 1966 and 348 in 1976.

[2] Although attempts were made to estimate incomes derived by women in independent economic activities, it is likely, because of the inability to monitor their activities adequately, that these were underestimated [Norman, Fine, Goddard, Pryor and Kroeker, 1976]. Simmons [1976b] in a later survey found women in the Zaria area villages earned about ₦4.15 per month in cash.

[3] Care needs to be taken in interpreting income figures particularly with respect to differences among areas. The reasons for this include the following:

a. The studies in different areas were undertaken in different years; therefore, the figures are not completely comparable.

b. The figures reflect income and do not indicate the cost of living. For example, it is likely that the cost of living is higher in the Sokoto area than in the Bauchi area, thereby accounting in part for the lower levels of income in the latter area.

c. Much of the information necessary for calculating incomes must be derived from variables that do not enter the market system (e.g., many

Table 3.11. INPUTS AND FARM INCOME BY STUDY AREA AND OVERALL AVERAGE

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Inputs per cultivated hectare:				
Man-hours[a]	572.8	716.6	582.2	623.7
Organic manure (tonnes)	3.71	2.71	0.53	2.31
Farm income (₦):				
Crops:				
Gross	160.68	199.11	87.88	149.23
Costs of production[b]	23.60	34.42	13.19	23.74
Net farm income from crops	137.08	164.69	74.69	125.49
Livestock:				
Other than cattle	3.28	3.08	1.35	2.57
Cattle	34.68	56.64	22.93	38.08
Net income from livestock	37.96	59.72	24.28	40.65
Total income (₦):				
Net income from crops and livestock	175.04	224.41	98.97	166.14
Other off-farm income[c]	44.47	39.61	35.46	39.84
Taxes	6.49	8.27	6.68	7.15
Disposable income[d]	213.02	255.75	127.75	198.83
Net farm income from crops (₦) per:				
Cultivated hectare	42.25	57.40	30.91	43.51
Man-hours of family labor[a]	0.17	0.12	0.07	0.12
Disposable income (excluding taxes) per consumer unit from (₦):				
Farm: Crops	34.15	27.74	17.87	26.59
Off-farm: Other than livestock	11.58	8.83	9.19	9.87
Livestock only	9.66	8.11	5.34	7.70
Return per man-day family labor (₦):				
Net farm income from crops	0.70	0.52	0.32	0.51
Off-farm income	0.44	0.37	0.34	0.38

[a]Excludes farmers' time travelling to and from fields.

[b]Includes only that manure explicitly paid for.

[c]That is, excluding livestock.

[d]This figure represents a return to the farmer and the family for their labor, management, and capital after taxes are paid.

Table 3.12. PRODUCTION FUNCTION FOR VALUE OF PRODUCTION DERIVED FROM CROP PRODUCTION IN ALL STUDY AREAS[a]

Independent Variables		Coefficient (standard error)	Mean Value Estimated at	MVP	Opportunity Costs[b]
Constant		1.4481			
Cultivated (hectares):					
Gona	Log X_1	0.3407 (0.0379)	7.18	79.29	11 to 75
Fadama	Log X_2	0.0797 (0.0266)	0.64	208.08	35 to 238
Man-hours of work[c] by:					
Family	Log X_3	0.2804 (0.0368)	1294.7	0.36	0.00 to 0.37
Hired Labor	Log X_4	0.0759 (0.0098)	266.2	0.48	0.37
Capital (S.R.):					
Fixed costs	Log X_5	0.0616 (0.0314)	42.70	2.40	1.05-1.70
Variable costs[c]	Log X_6	0.1833 (0.0312)	113.70	2.69*	1.05-1.70
Dummy variables:[d]					
S1	X_7	0.2046 (0.0257)			
S2	X_8	0.1231 (0.0234)			
V1	X_9	-0.0297 (0.0228)			
V2	X_{10}	0.0953 (0.0248)			
	R =	0.8937			
	S_{yx} =	0.1586			

[a]A Cobb-Douglas function was estimated. Where relevant the variables were estimated in shillings (i.e., the currency at the time). 10 sh. = ₦1. The marginal value productivities were estimated at the mean values derived for the overall sample. The value of the dependent variable estimated using these means was 1671 shillings (i.e. ₦167.00). N = 340.

[b]For the derivation of the opportunity costs, see Norman [1967-72] and Norman _et_. al. [1976c].

[c]Excludes time travelling to and from fields.

[d]The variable costs excluded funds expended for hired labor which were accounted for in variable X_4.

[e]For the definition of the dummy variables see Table 3.3, footnote b.

*Significantly different from the opportunity cost at the 5 percent level.

would appear from the results in Table 3.11 that on the average the income derived from crop production amounted to 63 percent of the total disposable income[1] while livestock contributed 20 percent. However, it is important to note that 94 percent of the livestock component was contributed by cattle. Off-farm income also was significant, amounting to 19 percent of the total disposable income.

3.7.2 Production Function Analysis and Net Farm Income

The results for the Cobb-Douglas production function estimation of the income derived from crop production (Table 3.12) show that farmers in general were allocating resources to crop production in a manner consistent with the goal of profit maximization.[2] The marginal value products of hired labor and fixed costs, although higher, were not significantly different from their opportunity costs. However, in the case of variable costs, the results appear to indicate that too little

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of the inputs are provided from farm or family sources, while much of the product produced is consumer in the house).

d. Special problems with respect to c include organic fertilizer and money from off-farm occupations. In the case of organic fertilizer, it was difficult to obtain accurate measurements of the quantities used; in addition, there is no established market price. It is obvious that the utilization of organic fertilizer becomes much more significant as population density increases and the potential for fallowing land decreases. Organic fertilizer other than that which was purchased with cash or payment in kind was therefore omitted from the income figures. This results in a distortion in income figures, particularly when different areas are compared. Money earned from off-farm occupations also proved to be difficult to measure. Therefore, the income figures in this paper should be treated with caution.

[1]Disposable income in this discussion refers to income before the subtraction of taxes (Table 3.11).

[2]The conventional approach has been used in estimating and analyzing the production function, although we recognize that its validity can be questioned (e.g., no farmer exists who has levels of resource utilization at the mean levels given in Table 3.12).

non-durable capital was in fact being utilized since the marginal value product was significantly higher than the opportunity cost. Unfortunately, in our research we did not record the cash flows of farming families in detail throughout the agricultural cycle. However, evidence from other studies undertaken in Hausaland has indicated that there is indeed a lack of adequate cash, particularly during the period between the onset of the rains and the harvest of the first crop (usually millet) [King, 1976; Matlon, 1979]. The results for the production function estimation indicate that the returns to scale were virtually constant (i.e., 1.02).

An attempt was made to ascertain the determinants of net farm income per cultivated hectare and per man-hour of work on the family farm. The results of the models are given in Table 3.13. When dummy variables reflecting location within an area and study area were incorporated, the major determinant of the dependent variables was the intensity with which land was being farmed. Results indicated that a higher level of man-hours per cultivated hectare resulted in a higher net farm income per cultivated hectare. However, in the case of net farm income per man-hour work on the family farm, there was a negative relationship to the number of man-hours per cultivated hectare. This is consistent with expectations, since one would expect progressively decreasing marginal productivity of labor on a given piece of land as the intensity of labor input increases.[1]

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[1]Alternative models with variables reflecting the quality of land (i.e., manure input and the proportion of the land that was <u>fadama</u>) and total cultivated hectares were also estimated. With these variables, inferior but consistent results were achieved. This is not surprising since the variables were earlier found to be strongly related to the man-hours spent per cultivated hectare on farm work (Table A.4).

Table 3.13. DETERMINANTS OF THE RETURN PER CULTIVATED ACRE AND PER MAN-HOUR FROM CROP PRODUCTION[a]

Independent Variables		Net farm income per cultivated hectare		Net farm income per man-hour of work on the family farm[b]	
		Dependent Variable			
Constant		114.6481		0.8823	
Total man-hours per cultivated hectare[b]	X_1	0.2798*	(0.0581)	-0.0010*	(0.0001)
Dummy variables:					
S1	X_2	224.3380	(23.5953)	0.3743*	(0.0531)
S2	X_3	114.3639*	(24.7253)	0.2981*	(0.0556)
V1	X_4	-15.0069	(24.8847)	-0.1437*	(0.0560)
V2	X_5	54.8731	(12.4039)	0.0272	(0.0279)
R		0.7087*		0.5319*	
S_{yx}		181.0422		0.4074	

[a]The income figure was expressed in shillings, in the currency at the time of the survey. ₦ = 10 shillings. For the definition of the dummy variables see Table 3.3. N = 340.

[b]Excludes time travelling to and from fields and in threshing.

3.7.3 Market Orientation

Conventional wisdom is that farmers in an area such as Hausaland will have as one of their major goals production of the food necessary for subsistence. Only when this goal is met are they likely to devote additional surplus resources to enterprises that result in products that can be sold on the market.[1] The results in Table 3.14, however, indicate that an average of only 63 percent of the farmers were self-sufficient in cereal production, which is the major consumption item [Simmons, 1976a]. If allowance is made for errors of estimation, it would appear that perhaps up to 50 percent of the farmers were not self-sufficient in cereal production. At the same time, however, there was considerable variation in terms of the relative degree of self-sufficiency, so that, on the average, a farming household would appear to produce 1,800 pounds of surplus grains.

It was estimated that on the average 24 percent of the total value production of products produced on the farm was in fact marketed. The degree to which each crop produced is marketed of course depends on whether it is a subsistence crop (e.g., millet, sorghum) or primarily a cash crop (e.g., cotton, sugarcane, calabash).[2] Because of variations in technical elements it is likely also that certain crops

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[1] Matlon [1979] has found that occasionally this goal has to be modified due to economic necessity.

[2] In the northern Nigerian context, the term "cash crop" has traditionally meant those crops that are marketed through marketing boards and usually are destined for the export market. Groundnuts and cotton are in this category. However, sugarcane and calabash, which are usually marketed, can, for the purpose of this paper, also be considered cash crops.

Table 3.14. ESTIMATES OF SELF-SUFFICIENCY AND PERCENTAGE OF CEREALS MARKETED BY STUDY AREA AND OVERALL AVERAGE

	Study Area			Overall Average
	Sokoto	Zaria	Bauchi	
Degree of self-sufficiency in cereals--percent of farmers:[a]				
Not self-sufficient	17.1	61.9	32.1	37.0
Producing:				
Less than 75% of needs	13.8	35.3	20.5	20.5
75-125% of needs	13.9	40.2	28.8	28.8
125-200% of needs	28.7	17.9	23.5	23.6
More than 200% of needs	43.6	6.6	27.2	27.2
Average quantity cereals produced above consumption needs (kg.)	1427	268	740	812
Estimated proportion of production marketed:[b]				
All products	10.1	38.8	NA	24.4
Cereals: millet	4.9	9.3	NA	7.1
sorghum	3.8	8.6	NA	6.2
Cereals as a percentage of total value of production	76.0	51.2	79.6	68.9

[a] It was assumed that the total domestic consumption of cereals was about 180 kg./capita. This is based on figures found by Simmons [1976a] plus an allowance for wastage and seed.

[b] Considerable problems were encountered in obtaining accurate estimates of production marketed [Norman, 1967-72; Norman et al., 1976a]. It is likely that the production marketed was underestimated. More accurate estimates of the proportion of cereal production marketed in the Zaria study area are given in a study by Hays [1975].

in some areas may be both a cash and a food crop (e.g., millet and sorghum in the Sokoto area). The revenue obtained from selling farm products on the market is available for the purchase of food and other items and for investment in the farming system. However, another important source of cash is income derived from off-farm activities.[1] One interesting point in Table 3.11 is that the return per man-day of family labor spent on the farm was greater than from that spent in off-farm activities. This is not surprising since, as was indicated earlier, much off-farm employment takes place at times of the year when the opportunity cost of labor is low, especially during the dry season.

3.7.4 Income Distribution

The Gini coefficients given in Table A.5 for net farm income, when compared with those derived for land distribution in Table A.1, indicate that the former is generally more unequally distributed than the latter. This implies that the land is being used at varying degrees of intensity, as confirmed by findings discussed in other parts of the paper (see Table A.4). The implication is that a relative shortage of land can be offset to some extent by increasing the proportion of other traditional inputs, particularly labor. This is possible even using the indigenous or traditional types of technology. The potential for this, of course, increases greatly with the introduction of land-intensive improved technology. However, in the case of villages where *fadama* land was more dominant, it

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[1] As mentioned earlier (Section 3.7.1), a major limitation of the studies reported in this paper is that it proved impossible to derive a complete record of earnings achieved by women. Since these earnings are primarily from off-farm activities, the figures on off-farm incomes are likely to be correspondingly underestimated.

appeared that land was more unequally distributed than net farm income. In results presented elsewhere [Norman, Fine, Goddard, Pryor and Kroeker, 1976c] it was shown that there is less variation in the manpower input per cultivated hectare of fadama land than for gona land. Also, there is likely to be less variation in the quality of such land than there would be for gona. It appears that these factors, plus the necessity of a much higher initial input of labor per cultivated hectare of fadama compared with gona, means that the potential for farming fadama land at differing degrees of intensity is more limited.

The results in Table A.5 also indicate that the distribution of disposable income including that derived from off-farm work, but excluding that from cattle, is more equal than that from crop production. This gives rise to the interesting implication that off-farm income earnings can and do compensate to some extent for low net farm incomes. This emphasizes even more the rationality of farmers in Hausaland who have recognized the complementarities of off-farm and farm work.

4. COMPARATIVE ANALYSIS OF TRADITIONAL FARMING IN THE SOKOTO, ZARIA, AND BAUCHI AREAS OF HAUSALAND

Since the nine villages in the three areas were not randomly selected, it was not possible to do any meaningful statistical analysis of the differences in farming in the three areas. Therefore, the observations in this section should be considered as preliminary and as possible trends rather than as statistically verified conclusions. In addition, it is difficult to measure the effects of the various factors, such as population, location, and climate on the productivity and profitability of farming. For example, the population density is lower in Bauchi than in Sokoto, while the climate, particularly as it affects the growing season, is harsher in Sokoto than in either Zaria or Bauchi. Therefore, the following analysis is advanced with a great deal of caution.

4.1 Effect of Population Density on Farming

Perhaps somewhat surprisingly we found that the farm size in the three study areas was very similar (Table 3.1). However, the proportion of fallow land differed greatly, decreasing as population density increased. Two factors may account for this phenomenon. It appeared in general that all farm land and cultivated land were more evenly distributed in the more densely populated areas (see Table A.1). This implies that the opportunity cost of leaving land fallow in such areas was relatively high, encouraging farmers who have surplus land to surrender the usufructuary rights to those who are short of land. The figures in Table 3.1 indicate that, although much of the land in all three areas was still inherited, more mobile types of tenure were apparently being used in the Sokoto and Zaria areas than in Bauchi, contributing to more even land distribution.

Although the land per resident and per consumer unit was on the average highest in Sokoto (Table 3.2), it appeared that the lower proportion of fallow land was apparently due to the poor fertility of the soil. Therefore, the period of fallowing is progressively shortened because of increasing pressure to produce food[1] and, because of the technical problem of fertility. Attempts were made to maintain the fertility of the land through more intensive applications of manure per cultivated hectare (Table 3.11). Unfortunately, it was not possible to ascertain whether the manure application completely offset the decrease in the length of the fallow period.[2]

4.2 Effect of Climate on Farming

In Sokoto where the growing season is much shorter, larger areas were cultivated per consumer unit compared to the other two areas. Thus, more days were spent on farm work and longer hours per day by male adults (Table 3.4). This work, when expressed in man-hours, was more concentrated

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[1] Lagemann [1977] obtained empirical evidence, in a study in eastern Nigeria, that yields and length of fallow were positively related.

[2] Figures indicating the net farm income per cultivated hectare in Table 3.11 are not good indicators of this relationship. The reasons are that there are complications due to differences in climate, crops grown, costs, prices and labor inputs. Also, there was a lack of reliable, field-specific knowledge on soil fertility and sometimes length of fallow period, when the field was last fallowed, etc.

seasonally than in the other areas (Tables 3.5 and A.2). As a result, off-farm employment was also more unevenly distributed, being concentrated primarily in the dry season. Off-farm employment in Sokoto was higher in part because an average of 45 percent of the days worked off-farm were spent in work undertaken outside the village during short-term migration (cin rani). As would be expected, this short-term migration took place primarily during the dry season (Figure 3.2 (e)).[1]

In comparing the cropping systems in the three areas, it is apparent that they are adapted to differences in the technical element. Millet, sorghum, cowpeas, and groundnuts were common in all three areas (Table 3.8). However, millet and cowpeas, which require a shorter growing season, were dominant in the harsher climate of Sokoto, while sorghum and groundnuts were relatively more important in the more favorable areas of Zaria and Bauchi. Farmers grow more millet and practice more mixed cropping in Sokoto in order to offset the risk of crop failure. In fact, millet was included in 66 percent of the crop enterprises identified in the Sokoto area compared to 30 percent of the crop enterprises in the Zaria area.

The two most common mixtures in all three areas were millet/sorghum, especially in the Bauchi and Zaria areas, which are similar climatically, and millet/sorghum/cowpeas, which was more dominant in the Sokoto area.

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[1]The relatively higher population density in the Sokoto and Zaria areas, together with the practice of cin rani in the former area [Norman, Fine, Goddard, Pryor and Kroeker, 1976], accounted for the higher proportion of modern services, which are better remunerated, in those areas than in Bauchi (Table 3.4).

Table 4.1. COMPARISONS BETWEEN TWO MIXED-CROPPING ENTERPRISES IN THE SOKOTO AND ZARIA AREAS

	Millet/sorghum		Millet/sorghum/cowpeas	
	Sokoto	Zaria	Sokoto	Zaria
Man-hours per hectare[a]	505.1	611.1	558.5	734.4
Number of stands/hectare	10,625	22,506	16,272	28,620
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
Cowpeas	-	-	0.02	0.02
Yield (kg/ha):				
Millet	892	370	772	400
Sorghum	186	768	124	714
Cowpeas	-	-	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

[a]Excludes time travelling to and from fields and for threshing.

A comparison of these two crop mixtures in the Sokoto and Zaria areas is in Table 4.1 which reveals the following:

1. In the drier area of Sokoto, the average number of plant stands[1] per hectare was much lower than the other two areas. This reduction shows how farmers in Sokoto adapt to low soil moisture and greater variability of rainfall at the beginning and the end of the growing season. It may also indicate a response to the lower fertility of soil compared with the Zaria area.[2]

2. Farmers in Sokoto grow a much higher proportion of millet in crop mixtures than in the other areas. This presumably is due to the comparative advantage that millet enjoys in the Sokoto area compared with Zaria, where other crops can be grown more satisfactorily.

3. The yield per stand of millet was much higher in the Sokoto area, while the yields per stand of other crops were correspondingly lower. However, although the grain yield of other crops in the mixture might be lower, these crops can still have considerable economic value to the farmer. This applies particularly to cowpeas, the haulm of which provides food for livestock.[3]

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[1]The number of stands was measured rather than the number of plants. The number of plants per stand varied according to species and location. Competition between plants in one stand is likely to be great, therefore reducing the yield per plant compared with the yield if there were only one plant per stand.

[2]Lagemann [1977] expressed a different point of view, concluding that in the much wetter area of Eastern Nigeria, farmers tend to plant more densely when the soil fertility declines. However, the potential for soil moisture stress is much higher in Hausaland than in eastern Nigeria.

[3]Since it was impossible to measure the quantity of forage produced, estimates of the value of this product were omitted from both the analysis of individual crop enterprises and from the income figures.

4. The higher number of stands per hectare combined with the greater yield per stand resulted in a higher yield of millet per hectare in Sokoto compared with Zaria.

5. The overall value of production per hectare was lower in the Sokoto area than in the Zaria area, although the return per man-hour was similar in the two areas, partly because the man-hour input per hectare was lower in Sokoto.

4.3 Self-Sufficiency and Incomes Among Areas

On a per family basis, the results indicated that families in the Zaria area derived the highest incomes from farming and had the highest disposable incomes, while families in Bauchi had the lowest incomes (Table 3.11).[1] There are two reasons that may contribute to the low incomes in the Bauchi area. First, market prices for crops were lower than in the other areas. For example, the average market price for millet and sorghum in the Bauchi area was 24 percent less than in the Sokoto area and 40 percent less than in the Zaria area. Therefore, it is not surprising that the gross income derived from crop production in the Bauchi area was much less than in the other two areas; this was also reflected in lower net farm incomes. The lower prices of millet and sorghum would also presumably reflect lower costs of living in this area compared with the other two areas. Second, there was a much lower proportion of cultivated land in Bauchi devoted to established cash-crop production than in the similar ecological zone of Zaria (Table 3.8).

[1] However, for reasons mentioned in Section 3.7.1, caution needs to be observed in interpreting comments in this section.

Farmers in the Sokoto area were in general the most self-sufficient in terms of cereal-crop production. In the Sokoto area, cereals are used as both a subsistence and a cash crop, while in the Zaria area other crops are produced for the market. It is apparent that Zaria farmers market more of their products, partly as a result of the established guaranteed prices for some of the cash crops (Table 3.14). Unfortunately, the data collected did not permit a detailed analysis of the relative significance of subsistence and profit maximization in the three areas. What is apparent is that both goals are relevant, although there may be some marginal differences in the weights attached to each within and among areas.

When incomes were expressed in return per consumer unit, farming families in the Zaria area appeared to be poorer economically than those in the Sokoto area (Table 3.11), because of the larger families in Zaria (Table 3.2). Livestock, when expressed in terms of income per consumer unit, was more prominent in the Sokoto area.[1] We suggest that with the increase in the use of manure as population density increases, livestock will likely become more important in the rural economy[2] with

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[1]The relative dominance of livestock was not maintained when income from livestock was expressed as a percentage of the total income per consumer unit.

[2]Caution must be used in interpreting comparative figures. For example, net farm income per consumer unit derived from crops when costing only manure that was paid for resulted in a ratio for Sokoto, Zaria, and Bauchi of 1:0.81:0.52 (Table 3.11). However, when all manure was costed, the ratio was 1:0.97:0.61, which represented a narrowing of the ratios. This is likely to continue as time goes on because of increasing population density. Indeed, more recent casual observation in the Sokoto area has indicated that manure is becoming an economic good, which is likely to have, in the absence of land-intensive improved technology, an increasingly adverse effect on incomes in the Sokoto area compared to other areas.

livestock supplying the manure for crops and an alternative source of income.[1]

Income derived from off-farm sources was highest in the Sokoto area no matter how off-farm income was expressed (i.e., as total off-farm income per consumer unit or as off-farm income per man-day of family labor). Although there is no question that climate plays an important part in encouraging more time to be spent in off-farm work in the Sokoto area (Table 3.4), it is likely that income derived from these sources will become more significant as population density increases. The practice of cin rani (i.e., seasonal migration) in the Sokoto area is no doubt partly a response to both the harsh climate and the increasing population pressure. This practice is not nearly so common in the other areas and may partially account for the high income per man-day derived from off-farm employment in Sokoto. This is significant, for with such a practice, the location of the village is no longer so important in determining the potential for highly remunerative off-farm employment (e.g., in the modern services sector).

4.4 Influence of Fadama Land[2]

The villages that were intermediate in terms of access to the urban areas had the highest proportion of fadama land. The fadama land permitted

[1] Lagemann [1977] reports that in Eastern Nigeria this relationship is a result of increasing population density and decreasing fertility of land. The major problems, of course, in developing the complementary relationships will be the availability of capital to invest in livestock and the provision of food for the livestock, especially during the dry season.

[2] The remaining parts of Section 4 consider analysis at levels below that of the study area. Because of space limitations only highlights of such analysis are presented. As a result, it was also not possible to present tables providing detailed empirical verification for some of the observations.

crop production to be more of a year-round activity. Family male adults, who provide most of the labor on the family farm, worked more days on the farm in these villages.

The higher quality of fadama land compared to gona land resulted in higher levels of labor input per cultivated hectare and also in higher net farm incomes both per cultivated hectare and per family man-hour spent on the farm. It is, therefore, not surprising to find that income derived from crop and livestock production accounted for a relatively higher proportion of total disposable income in the villages where fadama was dominant compared with villages where gona was more dominant. However, the former villages proved to be less self-sufficient in cereal production, for, apart from rice, the major crops grown on fadama land were cash crops such as sugarcane and calabash. This implies that, in order to surrender the goal of self-sufficiency in cereal production it was essential for farmers in fadama-dominated villages to have ready access to urban markets. Ease of access to the market was important because most crops produced on fadama land were of low value per unit weight and were therefore expensive to transport.

4.5 Influence of Cattle Ownership

Most of the cattle found in Hausaland are owned by nomadic Fulani [Van Raay, 1969]. However, as population density increases in the area, it is likely that nomadic pastoral life will decline and cattle will become further integrated into a crop/livestock farming system. In our studies we observed that sedentary farmers who owned cattle considered them as serving three functions: as a source of milk rather than as a source of meat production; as a form of savings and perhaps a status symbol; and as having a complementary relationship with crop production through the provision of manure. Cattle were not regarded as a power source.[1]

The *gandu* family structure (i.e., complex family units) was relatively more common in cattle-owning families, resulting in larger-sized family units. The larger size of family provided labor for time-consuming herding activities. Also, a larger proportion of such families were self-sufficient in cereal production. The income level of families owning cattle was also higher. The higher income levels were achieved not only directly through ownership of cattle but also indirectly through crop production in which the lower labor inputs per cultivated hectare were compensated for by more intensive use of manure per cultivated hectare. The result was similar net farm incomes per cultivated hectare but higher total net incomes from crop production on the larger farms of cattle owners.

4.6 Changing Family Structure

The tendency of the *gandu* family structure to give way to simple family units (*iyali*) has already been mentioned (Section 3.2.1).[2] This trend has a number of implications for agricultural development, two of which are discussed below.

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[1] The concept of cattle being a source of manure as well as a means of power was recognized in the 1930s through the introduction of a mixed farming scheme [Alkali, 1970]. This scheme encouraged crop farmers to purchase oxen and equipment through credit programs. The scheme has met with some success in parts of Hausaland, but, as in the Sahelian countries, successful performance has been linked to the presence of a profitable cash crop [Institut d'Economie Rurale, 1977; Lele, 1975].

[2] This same trend is occurring throughout the Sahelian countries.

1. Gandu families in general possessed higher levels of resources (i.e., land and labor) and they achieved higher levels of income. Thus, it is possible that different types of improved technology will be needed for gandu and iyali families. For example, Tiffen's [1973] research in another part of Hausaland found that where oxen and equipment had been introduced, they were mainly controlled by gandu families who owned cattle and had larger farms. On the other hand, it is possible that technology which promotes land intensification would be more relevant for iyali families.[1]

2. Managerial ability is obviously an important characteristic in determining the success of the farming enterprise. Since formal education was almost completely lacking in the villages in the three areas studied, the differences in observed managerial ability are likely to be primarily a function of the individual characteristics of the family head enhanced by experience that he had gained over time. However, the breakup of the traditional gandu family structure results in younger decision makers with a modest resource base and young children. As a result, these young decision makers will require new technology with a low risk factor. Fortunately, land-intensification technology is "divisible" (i.e., it can be added in small amounts) and it appears to be relevant for the younger heads of iyali households.

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[1]In the Sahelian countries, in contrast to northern Nigeria, the use of oxen for providing manure as well as for plowing is seen as a means not only of augmenting the productivity of labor but of land as well (i.e., a technology of land intensification).

4.7 Influence of Access to Urban Areas

In each area, three villages were selected which differed in their accessibility to the main city. Since degree of accessibility was found to be positively related to population density, it was not surprising to observe trends analogous to those discussed under Section 4.1. With easier access to urban areas the size of farms and proportion of fallow land decreased. As a result, land was farmed more intensively, requiring increased applications of manure to maintain soil fertility. The increased pressure on the land resource base to provide a source of income appeared to be compensated for by an increase in the significance of livestock enterprises and in incomes derived from off-farm sources. There was some evidence that such off-farm activities as trading increased in relative importance as the villages became more inaccessible [Norman, 1977a].

5. ANALYSIS OF IMPROVED TECHNOLOGY PACKAGES IN DAUDAWA VILLAGE IN THE ZARIA AREA

5.1 Introduction

In the preceding two sections, we analyzed the farming systems in different parts of Hausaland. What has emerged is a mosaic of the way the farmer has adapted his system to the realities of the technical and human elements. However, the increase in population density required researchers to develop and extend relevant technology to facilitate the adaptation process. The relevancy of the technology is defined in terms of its compatibility with both the technical and human elements.[1]

Based on our analysis, it is possible to define three particular problems in Hausaland:

1. In areas of low population density, the peak demand period for labor is likely to be the most constraining factor on expanded output.

2. In areas of transition to high population densities, it is possible that both a labor and a land constraint will emerge. The peak demand period for labor will be a constraining influence and land will emerge as a problem because soil fertility will decline under population pressure. The possible dual nature of these constraints will be exacerbated by the increasing necessity for farm families to spend more time in

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[1]Johnson [1972] and Swift [1978] have written convincingly about the value of indigenous knowledge, the experimentation undertaken by farmers and changes brought about through its application.

activities that require year-round commitment, including off-farm income-earning activities, as well as caring for cattle owned by the family.[1]

3. In areas of very high population density, land is likely to be the most constraining factor.

The above scenario of problems can be reduced to two basic constraints whose relative significance will depend to a large extent on the seasonality of agriculture and population pressure. These are improving the productivity of labor--particularly at bottleneck periods--and the productivity of land. Improved technology development needs to address these issues in order to increase the productivity of the existing farming systems.

1. Increasing seasonal labor productivity. Seasonal labor productivity could be increased directly by supplanting hand labor with some type of mechanization such as oxen plus equipment or by using chemical technology such as herbicides. Such types of technology increase the amounts of land that can be handled by the farming family. Indirectly, labor productivity could be increased through biological-chemical technologies such as improved seed, inorganic fertilizer, or insecticides which would avoid an increase in labor requirements during the bottleneck period. However, this technology is unlikely to be

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[1]As land becomes more of a constraint their value in contributing to maintaining soil fertility becomes greater. However, the problem of feeding them also becomes greater, usually involving a change to more labor intensive methods. In terms of allocative efficiency, results reported elsewhere indicate that the potential for increasing incomes and productivity through recombining resources and enterprises currently in use is limited [Norman, 1977a].

feasible in Hausaland for most crops due to the relatively short rainy season that allows for little flexibility in planting dates. Biological-chemical technologies are likely to result in increased weeding. Therefore, it is necessary to insure that the costs of increased labor input during the labor bottleneck period is more than offset by the increase in returns from its application. Further complications arise if improved technology for a cash crop rather than a food crop is being considered. Farmers would be reluctant to increase labor requirements for cash crops during the labor-bottleneck period since, all other things being equal, they would give priority to food crops during that period. It has been suggested elsewhere that farmers have a security orientation until food requirements are met, and then their goal is profit maximization [Norman, 1977a].[1]

2. Land intensification technology. Both mechanical and biological-chemical types of improved technology are relevant in areas where there is a relatively high land-labor ratio [Spencer and Byerlee, 1977]. However, as land becomes scarcer, mechanization in the form of oxen plus equipment is likely to become less economically viable unless owners undertake contract work for other farmers. In addition, as land becomes scarcer the attainment of greater output per unit of land will require the increased use of biological-chemical technology. However, if such technology is used, there must be assurance that soil fertility will be maintained.[2]

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[1]Although this has not been empirically verified, the various strategies that farmers employ appear to give indirect evidence of such a goal.

[2]Short-run private returns from the biological-chemical types of improved technology should not be achieved at the expense of long-run

5.2 Testing Improved Technological Packages

The improved technological packages considered in this section were basically biological-chemical in composition and they were introduced in Daudawa village in the Zaria area. They consisted of improved packages for sole-cropped sorghum, maize, and cotton, which were developed in order to increase land productivity.[1] These packages consisted of improved varieties, planting in sole stands, application of fertilizer, and, in the case of cotton, spraying.

The number of farmers involved in the testing of the packages over a four-year period (1971-75) are given in Table 2.2. Since the results presented in this section include oxen farmers, it is also possible to examine the interaction of biological-chemical and mechanical types of technology. Unlike the years during which the other studies mentioned in previous sections were undertaken, the period during which field testing of the improved technological packages was carried out at Daudawa was not typical. For example, only half of the usual amount of rain fell in 1973 and the growing season was considerably shortened (Table 5.1). This, however, provided a good test of the stability of the improved technological packages.

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societal costs of declining soil fertility. Because of the complexities of thinking in terms of both the short and long run, much agronomic work in savanna areas has tended to separate these two aspects into different research projects. This is regrettable.

[1]Many other improved technological packages have been developed at the IAR. However, they are beyond the scope of this paper. Abalu [1976] and Hays and Raheja [1977], for example, have field tested new technology for groundnuts and cowpeas, respectively. With reference to labor-augmentation types of technology, Ogunbile has done some work with herbicides while Tiffen [1976] and Asuquo have studied oxen. The results of much of this work remain to be published.

Table 5.1. WEATHER CONDITIONS IN DAUDAWA VILLAGE, 1973-74

	Long Term Average	1973	1974
Rainfall (mms)	1082	5914	1176
Months when rainfall was surplus	June-Sept.	Aug.-Sept.	July-Sept.
Growing season:[a]			
Length (days)	174	153	185
Start	May 11-20	May 21-30	May 1-10
End	Nov. 1-10	Oct. 21-30	Nov. 1-10

[a]The growing season is defined in Table 1.2.

Assessment of the relevancy of an improved technological package is a complex process, involving assessment of its compatibility not only with the technical element but also with the endogenous and exogenous factors. The results will be very briefly examined in the following sections.[1]

5.2.1 Compatibility with the Technical Element

The improved technological packages were tested on gona or rainfed land. As a result, one of the key questions is whether they were compatible with the rainfall distribution. The improved maize (S123 composite), with a growing season of 120 days, was found to be compatible with the growing season even during the unusually dry year of 1973 (Tables 5.1 and 5.2). The yields for the improved maize were very similar in each year. However, in the case of the improved sorghum (SK5912) variety, with a 160-day growing season, the results were not so promising.[2] The average yield of the improved sorghum was 32 percent higher in the more favorable year 1974 (Table 5.2). It is apparent that the sorghum variety is not so well adapted to the technical environment in the Daudawa area which has a shorter than normal growing season.[3]

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[1]Detailed analysis of the results of these tests are available elsewhere [Beeden, et al., 1976; Norman, et al., 1976a and 1976b].

[2]In fairness to IAR, the area in which this variety was tested was slightly north of the recommended zone.

[3]The results also indicated that the traditional variety suffered from a lack of rain in 1973. However, most of the sorghum in the test area is mixed cropped with millet. Therefore, the majority of farmers were able to derive a substantial yield in spite of the poor sorghum crop.

Table 5.2. VARIABILITY IN RETURNS FROM SOLE-CROP ENTERPRISES USING OXEN, DAUDAWA VILLAGE, 1973-74

	Days Between Planting and End of Growing Season	Yield (kg./ ha.)[a]	Net Return (₦)/hectare)[b]	Percent of Farmers Who		
					Net return more than average for	
				Covered costs[b]	Indigenous practice	Improved cotton
Sorghum:						
Indigenous:						
1973	128	436±172	37.95	83	42	67
1974	185	845±112	52.07	89	44	22
Improved:						
1973	141	1161±385	80.77	100	53	74
1974	179	1530±245	82.46	100	67	33
Cotton:						
Indigenous:						
1973	91	454±122	16.72	88	50	50
1974	131	364±128	38.84	100	42	17
Improved:						
1973	110	658±125	16.60	79	42	42
1974	143	784±127	80.18	100	74	39
Maize:						
Improved:						
1973	129	2867±516	193.96	100	-	100
1974	167	2927±589	186.75	100	-	100

[a]Includes 95 percent confidence limits.

[b]Includes value for family labor. Monetary costs and returns should not be compared with figures derived in previous chapters due to considerable inflation which occurred between 1966 and 1974.

Therefore, assuming ceteris paribus conditions, it is likely that farmers would prefer to grow the improved maize, because it has more dependable yields.

The introduction of improved cotton presents a number of technical problems, including the problem of water for spraying.[1] For many years, the IAR recommended that farmers spray cotton six times at weekly intervals using a hand machine that required 188 liters of water per hectare per spraying. The time-consuming nature of spraying plus the problem of finding a nearby water source, plus transportation problems, no doubt contributed to farmers not adopting this recommendation. The recent introduction of the ultra low volume (ULV) system of spraying has the potential of revolutionizing cotton growing in Hausaland. The elimination of the need for water, the considerable reduction in the time required for spraying, plus the relative cheapness of the ULV spraying machine and its ease of operation all make this technology much more feasible and profitable for the small farmer.

5.3 Compatibility with Endogenous Factors

Two facets need to be considered when assessing the compatibility of improved technological packages with the endogenous factors: compatibility with the goals of farmers and compatibility with the farming system that they adopt. Although no attempt has been made in this paper to verify the goals of farmers empirically, the goal of farmers in Hausaland is likely to be profit maximization subject to a food security constraint. As a result, the farmer is likely to adopt a conservative attitude with

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[1] Discussed in Beeden, Hayward, and Norman [1977].

respect to risk taking. This attitude to risk reflects the need to guarantee food supplies and to recover cash costs involved in adopting the approved technological packages [Zandstra, Swanson, and Zulberti, 1976]. Therefore, it is likely that both the level and dependability of profits that are produced by the technological packages will be important criteria for the farmers to consider in deciding whether or not to adopt the package.

5.3.1 Return Per Unit of Land

For farmers facing land limitation, the results indicated that on the average the profitability per hectare of the improved technologies for all crops was substantially higher than that for the same crops grown under indigenous conditions (Table 5.2).[1] The results indicated that on the average the improved sorghum technology under both hand and oxen cultivation was a good deal more profitable than that for improved cotton, while neither compared favorably with improved maize, which is not a traditional crop in the area (Table 5.3).

5.3.2 Return Per Unit of Labor

The impact of improved technology on the returns per unit of labor is mixed. The results are shown in Table 5.3. The first point to note is that the introduction of the improved technology required a substantial increase in labor inputs. The second point is that there is a marked

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[1] This does not apply to the profitability of cotton grown with improved technology in 1973. The reason for the big increase in 1974 was not only due to the improved yield but also to the substantially higher price set by the Marketing Board for seed cotton.

Table 5.3. AVERAGE COSTS AND RETURNS ON SOLE-CROP ENTERPRISES, DAUDAWA VILLAGE, 1973-74

	Oxen				
	Sorghum		Cotton[a]		Maize[b]
	Indigenous	Improved	Indigenous	Improved	Improved
Inputs (per hectare):					
Fertilizer (N:P:K)	0:0:0	95:46:0	1:0:0	27:22:0	189:49:49
Labor (man-hours)[c]	199.4	337.4	275.8	430.4	354.0
Input costs (₦/hectare):					
Non labor 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 (₦/acre)	45.01	81.62	19.68	40.73	190.36
Return/man-hour (₦)[d]					
June-July[e]	0.93	0.74	0.31 (1.05)	0.31 (1.05)	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

[a]Includes average for period 1971-74.

[b]Only improved maize is included.

[c]Excludes threshing and time spent travelling to and from the field.

[d]The method of calculating this involved dividing hours spent by family male adults into value of production minus value of family labor other than family male adults minus the opportunity cost of capital (assumed to be 12 percent) times the sum of the non labor and hired labor costs. The wage rate for hired labor approximated ₦0.10 per man-hour during 1973-74 in the Daudawa area.

[e]Figures in parentheses reflect the return per unit of labor put in during June. This is more reasonable in the case of cotton where under indigenous conditions planting is undertaken in July.

Table 5.3. AVERAGE COSTS AND RETURNS ON SOLE-CROP ENTERPRISES, DAUDAWA VILLAGE, 1971-74 (continued)

	Hand[f]				
	Sorghum		Cotton		Maize
	Indigenous	Improved	Indigenous	Improved	Improved
Inputs (per hectare):					
Fertilizer (N:P:K)	0:0:0	95:46:0	1:0:0	27:22:0	189:49:49
Labor (man-hours)[c]	240.9	400.5	384.2	516.9	526.3
Input costs (₦/hectare):					
Non labor costs	1.18	41.14	1.41	22.61	55.16
Labor (% hired)	24.83	41.21	32.61	43.32	54.00
Net return (₦/acre)	51.24	74.92	18.28	41.29	183.42
Return/man-hour (₦)[d]					
June-July[e]	0.81	0.53	0.17 (0.86)	0.25 (0.66)	1.05
Excluding harvesting	0.37	0.34	0.06	0.12	0.79
Total	0.21	0.17	0.04	0.07	0.33

[c]Excludes threshing and time spent travelling to and from the field.

[d]The method of calculating this involved dividing hours spent by family male adults into value of production minus value of family labor other than family male adults minus the opportunity cost of capital (assumed to be 12 percent) times the sum of the non labor and hired labor costs. The wage rate for hired labor approximated ₦0.10 per man-hour during 1973-74 in the Daudawa area.

[e]Figures in parentheses reflect the return per unit of labor put in during June. This is more reasonable in the case of cotton where under indigenous conditions planting is undertaken in July.

[f]Conversion ratios derived from other studies were used in converting tractor and oxen hours to hand-labor terms. For land preparation (i.e., ploughing) 1 man-hour using an oxen team was found from other studies to be equivalent to 3.60 man-hours using hand labor. Similarly, 1 man-hour using a tractor = 21.57 man-hours using hand labor. For ridging after sowing, 1 man-hour using an oxen team = 3.61 man-hours using hand labor. For evacuation of the harvested crop, it was assumed that a donkey could evacuate twice as much in the same time as a head load would require. For oxen, a ratio of 10:1 was used; and for a tractor, a ratio of 20:1 was assumed.

shift in the distribution of labor, with an average of 65 percent of the extra labor being devoted to harvesting the additional yield. The results in Figures A.2 and A.3 suggest that the adoption of the improved technological packages which increase yields have the potential of creating a harvesting bottleneck. However, we believe that the harvesting bottleneck will probably not be too serious for most crops in Hausaland because much of the harvesting occurs after the rains are over.[1] Greater problems are likely to occur when the improved technology increases labor required for weeding and spraying--especially during the peak period during June and July.

When the absolute increase in labor requirements and changes in the distribution of labor are considered, the improved technology for sorghum does not look very promising based on return per man-hour (Tables 5.3 and 5.4). For farmers facing both seasonal labor and land constraints, the relevancy of this technology can be questioned.

In the case of improved cotton, there are further complications because, until recently, the IAR recommendation for growing improved cotton stipulated planting in June instead of July. Although the improved cotton technology increases the returns to labor relative to indigenous cotton farmers are not likely to adopt the improved cotton for the following reasons: (1) food crops yield a much better return per man-hour during the June-July period and during the rest of the year

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[1]This observation should be viewed in terms of the potential seriousness of this bottleneck in relation to others earlier in the year. Timely harvesting is obviously desirable in order to reduce potential damage by birds, rodents and dust.

Table 5.4. CHANGE IN LABOR REQUIREMENTS AND NET RETURNS FROM ADOPTING THE IMPROVED TECHNOLOGICAL PACKAGES, DAUDAWA, 1973-74[a]

	Hand Power Only		Oxen Power	
	Sorghum	Cotton	Sorghum	Cotton
Increase in man-hours per acre (% 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)	94.2 (92.6)	92.4 (74.7)
Total	159.6 (66.3)	132.7 (34.5)	138.0 (69.2)	154.6 (56.1)
Increase in net return in ₦ per hectare (% increase):	23.68 (46.2)	32.01 (125.8)	36.61 (81.3)	21.05 (107.01)
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

[a]This table shows the absolute--and sometimes the relative--change in the variables specified in the table as a result of adopting the improved technological packages for sorghum and cotton without a change in the power source. For example, the total labor increase per acre for using the improved technology for sorghum with oxen as a power source was 337.4 - 199.4 = 138.0 man-hours/hectare. In this case the figures for the indigenous and improved practices are in Table 5.3. The percent increase is $\frac{337.4}{199.4}$ or 69.2 percent.

as well (Table 5.3); (2) cotton is a cash crop, and farmers are likely to allocate their labor first to food crops during the June/July labor bottleneck period; and (3) handweeding is still a major task when intrarow oxen cultivation (Figure A.1)[1] is practiced.

Changing the power base from hand labor to oxen increases the returns to labor. Oxen in Hausaland are used primarily for land preparation and for some interrow cultivation with ridging equipment. However, the problem of intrarow cultivation remains. Oxen are not often used for evacuating crops from the fields because many farmers who own oxen do not own carts. The introduction of oxen shifts the labor distribution during the farming year. Figure A.6 shows that the use of oxen tends to accentuate the harvesting bottleneck relative to the planting and weeding bottleneck in June and July. Tables 5.3, 5.4, and 5.5 show that the use of oxen results in a substantial increase in returns to labor compared to hand power and that the returns to labor are further augmented when oxen power is combined with the improved technological packages for sorghum, maize, and cotton.[2]

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[1]It has been noted that the deeper plowing possible with oxen allows better incorporation of residues and therefore indirectly aids in weed control. It also helps in the maintenance of soil fertility and improvement of yields [Monnier and Ramond, 1970; STRC/OAU-JP26, 1972a].

[2]In relation to this it is interesting to note that in West Africa the areas where the introduction of oxen has been most successful are where land intensive technologies--particularly for export cash crops--have been widely adopted (e.g., Mali Sud in Mali and Sine Saloum in Senegal.

Table 5.5. CHANGE IN LABOR REQUIREMENTS AND NET RETURNS FROM USING OXEN INSTEAD OF HAND POWER, DAUDAWA, 1973-74[a]

	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)	-	3.1 (3.8)	-	90.7 (29.7)
Total	41.5 (17.2)	108.4 (28.2)	63.1 (15.8)	86.5 (16.7)	172.7 (32.7)
Change in net return in ₦ per acre (% change):	6.23 (-12.2)	1.41 (7.7)	6.70 (8.9)	-0.56 (1.4)	6.94 (3.8)
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

[a]This talbe shows the absolute--and sometimes the relative--change in the variables specified in the table as a result of changing the power source for the various crops without a change in the technological package. For example cotton using improved practices required 516.9 man-hours/hectare using hand labor and 430.4 man-hours/acre using oxen. This represents an decrease of 86.5 man-hours/acre or % decrease of 16.7.

5.3.3 Dependability of Return

In addition to fluctuations in yields and returns as a function of weather, two factors are important in determining the dependability of returns produced by the improved technological packages. The first is the market price of the crop and the extent of local markets. For example, maize is not a popular food in the Savanna area.[1] As a result, there is a question whether there will be a dramatic reduction in the price if local output is rapidly expanded. The second question is the extent of the regional or national market for the product.

Sorghum is a major item in local diets and it is an established crop. For example, although sorghum yields fell dramatically during the drought year of 1973, improved sorghum was profitable in both 1973 and 1974. Since there is a dependable local market for sorghum it is understandable why many farmers will continue to plant sorghum even though they could reap higher profits from maize during many years.

Table 5.2 shows that all farmers growing improved sorghum and maize were able to cover their cash cost and most did in the case of improved cotton. Thus, nearly all the farmers were able to cover the cash costs involved in adopting the improved technological packages in 1973 and 1974 in Daudawa village.

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[1]The average consumption per capita in kilograms per week of millet, sorghum, and maize in the Zaria area was found to be 1.46, 1.93, and .08, respectively [Norman, et al., 1967a]. In the Ibadan area, the consumption of maize is 1.67 kilograms per capita per week. However, the maize being grown in the savanna area under the test program was a yellow variety which is not favored for human consumption. There is probably a market for such grain as animal food.

5.4. Compatibility with Exogenous Factors

The possible problem of markets for the products, which is an exogenous factor, has already been mentioned. In addition, the improved technology will require (1) an efficient fertilizer distribution system, (2) a credit program which will enable farmers to purchase the improved inputs and hire the extra labor required, and (3) a larger staff of extension workers. A larger extension staff is necessary because the improved technology involves a drastic change from mixed to sole cropping, is sensitive to timing of operations, and, in the case of spraying cotton, is relatively complex.[1] The extension worker can help train farmers in the use of the new technology.

To ensure that the improved technologies are adopted, it would appear that a relatively high infrastructural commitment is necessary on the part of governmental agencies. Unfortunately, during most of the period of the field testing, the government was unable to provide such a support system. Fertilizer was in short supply, there were no institutional credit programs available to the small farmers in the area, and there was a scarcity of extension workers. However, this situation has been recently corrected with the advent of the IBRD Integrated Agriculture Development Project at Funtua, which is in the general area of Daudawa village.

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[1] Yields and profitability were found to be closely correlated. Increased managerial skill is necessary in order to achieve high yields.

6. SUMMARY AND IMPLICATIONS

6.1 Summary

The purpose of this paper is to compare the performance of small-farm agriculture in three areas of Hausaland, to assess the relevance and profitability of three improved technological packages for small farmers in the Daudawa Village (near Zaria) and to discuss the results for research workers and policy makers in Hausaland and in the Sahelian countries of West Africa.[1]

6.1.1 Trends Over Time

The discussion has revealed that the rural economy of Hausaland is slowly changing and that these changes are significant not only for the farmers but also for research workers and policy makers.

The rural economy is becoming more monetized and, as a result, risk aversion is a straightforward and "rational" response to the increasing vulnerability of farmers participating in the market economy. Next, increasing population pressure is inducing land intensification. As a result, more research is needed on increasing yields per hectare and where feasible on small farmer irrigation with proper allowance for seasonal labor bottlenecks.

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[1]The results presented in this paper represent only part of the research program that has evolved since 1965 in the Rural Economy Research Unit and later in the Department of Agricultural Economics and Rural Sociology, Institute for Agricultural Research, Ahmadu Bello University.

The results of research on livestock, although fragmentary, point up the central importance of livestock as sources of manure for maintaining soil fertility under growing population pressure and as a source of income for sedentary farmers. Increasing population densities also have important implications concerning off-farm sources of income. The need for more research on crop/livestock interactions and off-farm employment is discussed in the next section.

Our research has shown that traditional farmers are extremely shrewd researchers. For example, in the Sokoto area farmers responded to low and unstable rainfall by reducing the number of plant stands per hectare, and increasing the percent of land in crop mixtures. As a result, the returns to the scarce resource, labor, were similar in Sokoto and in the Zaria areas even though the value of cereal production per hectare was lower in Sokoto than in the Zaria area. These data, reinforced by other findings, lead to the conclusion that research on the introduction of new technical packages for small farmers should start at the farm level in different micro environments and work backward to the research station.

Our research has also shown that the introduction of technical change is more than a technical problem. The development of a technical package for food crops which is (a) biologically stable over time, (b) adoptable by farmers, and (c) acceptable to consumers requires detailed knowledge of family structure, culture, climate and the environment.

6.1.2 Increasing the Relevancy of Technological Packages

We have argued that improved farming systems, to be acceptable and practical, must be based on an analysis of indigenous farming systems.

At the IAR and in government circles in Hausaland there has been increasing recognition of the limitations of some of the technical packages which have been developed for small farmers in recent years. As a result a number of modifications have been or are in the process of being introduced or investigated. The modifications in the cotton, sorghum, and maize technological packages which are being considered are as follows:

1. The technical element. There are a number of unresolved technical problems in developing a mixture of sorghum and millet. The value of such a crop mixture is being recognized in the National Accelerated Food Production Program which has been instituted in several parts of Hausaland. There is considerable research on long-season sorghum SK 5912 which can be grown in a mixture with millet but the yield of the former may suffer when the rainy season is shorter than average. Research is focusing on short-cycle sorghums which are better adapted to the existing rainfall distribution pattern. Unfortunately, the shorter cycle sorghums are affected by head mould, if heading takes place before the end of the rains [Kassam, Dagg, Kowal, and Khadr, 1976].

2. Endogenous factors.

(a) The reluctance of farmers to move up the traditional date of planting indigenous cotton--because of the conflict with the planting and weeding of food crops--has led to research on cotton varieties that can be planted later. Although this later planting results in lower productivity of the cotton plant, it is likely to fit in better with the indigenous farming system.

(b) There has been increasing research attention on the weeding-bottleneck period in June and July. For hand farmers, research has concentrated on using herbilizers--a mixture of fertilizer and herbicide--to kill the weeds. For oxen farmers, the use of herbilizer for intrarow weeding has been investigated. The use of herbicides could be a major breakthrough in solving the labor-bottleneck problem. However, many practical problems still exist. For example, farmers grow crops in mixtures, and most herbicides have a narrow spectrum of tolerance. Research has also been undertaken to develop more suitable cultivating equipment for oxen farmers.[1]

(c) The wider dissemination of ox carts would be very useful in overcoming the harvest bottleneck.

3. Exogenous factors.

(a) The need to provide a market for maize has been recognized in the IBRD Project at Funtua and the project management has arranged a guaranteed market for the product.

(b) There has been increasing recognition of the need to design institutions to insure equitable access to services and a substantial degree of local participation. A number of IAR studies in recent years have concentrated on precisely these problems.[2] It is

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[1] In other parts of savanna West Africa (e.g., certain parts of Senegal, where soils are light) it is possible to grow crops on the flat and use row tracing (i.e., cultivating in both directions by planting on the square). It has been found that this method reduces labor requirements for millet by more than two-thirds [Charreau, 1974; STRA/OAU-JP26, 1972b].

[2] For example, King [1976] has studied credit institutions and Krishnaswamy has been studying fertilizer distribution systems. Ejiga [1977] and Hays [1975; 1976] have studied the marketing of cowpeas and cereals, and researchers in the Guided Change Project have been studying a number of possible strategies for providing services at the village level.

assumed that government agencies will not be able to provide the degree of support desired by village people for improving rural institutions because of limited financial and manpower resources of state governments. Therefore, pleas have been made for the development of "intermediate" technological packages [Norman, 1976a] rather than the "advanced" technologies which were introduced in Daudawa village and discussed in Section 5. Relevant intermediate technologies would not involve a radical change in the indigenous farming system or an intensive extension program. They would be simple to adopt, would be flexible as to timing, would involve little risk, and would not involve a high investment in improved inputs. Faced with these constraints, it is unlikely that the research worker will be able to come up with technical improvements which will result in spectacular payoffs. However, a farmer is more likely to adopt a low profit technology if it involves little risk and a small investment.

6.1.3. Two Special Research Challenges

There are two areas--soil fertility and off-farm employment--which need more research in view of the results presented earlier in this paper.

1. The problem of soil fertility. Substantial research has been undertaken on this topic at IAR, but as yet there has been little practical application of the research. The complementary relationship between livestock and crop production has repeatedly been emphasized in this paper. The Mixed Farming Scheme in Hausaland [Alkali, 1970] and analgous programs in the Sahelian countries [Charreau, 1974;

Monnier and Ramond, 1970] have dealth with these inter-relationships.[1] Research is needed on how livestock can be economically integrated with crop production on farms smaller than ten acres. Research is also needed on whether domestically kept livestock can provide sufficient manure to maintain soil fertility; whether alternative feeding regimes to extensive grazing systems can be economically provided from crop production systems [Van Raay and de Leeuw, 1970]; whether markets can be satisfactorily established for livestock and livestock products (e.g., small farmers fattening livestock, markets for milk, etc.), and whether viable credit institutions can be established to provide the necessary capital.[2] Where livestock, particularly cattle, cannot be satisfactorily kept because of the tsetse fly, alternative systems for maintaining soil fertility need to be developed.

2. The problem of off-farm employment.[3] This paper has pointed up the significance of off-farm employment in Hausaland. Although farmers integrate crop, livestock, and off-farm enterprises, research and implementation institutions tend to work in isolation from each other on these problems. There is an urgent need for research that will increase farmers' incomes from off-farm employment.[4]

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[1] The maintenance of soil fertility has been a major motivation behind the strategy of introducing oxen in West Africa.

[2] Substantial research on parts of these problems has been undertaken both in IAR and in the newly created Animal Research Institute at Shika near Samaru. However, we believe that there is still a need for more integrative work and its application in the field.

[3] Pioneering research on off-farm employment has been undertaken in Sierra Leone [Liedholm and Chuta, 1976].

[4] An alternative strategy of expanding farm employment during the dry season is through irrigation schemes. Orewa has recently concluded

6.2 Implications for Policy Makers in Northern Nigeria and in Sahelian Countries[1]

This paper has emphasized the importance of understanding the micro environment as a precondition to designing and introducing technologies and strategies to improve the welfare of small farmers. The paper has examined the background of government policy making and research in a historical perspective.

The focus of this paper has been on Hausaland in northern Nigeria; however, there have been some references to research on farming systems in Sahelian countries. Although we have focused on micro research results it is obvious that the micro environment can only be understood through a knowledge of micro/macro linkages through factor and product markets and an understanding of how these linkages and policies influence incentives and performance at the farm level.

In the Sahelian countries, which, apart from the Gambia, are all francophone, single-commodity developmental agencies have played a major role in bringing about the adoption of improved technologies for cash crops such as groundnuts[2] and cotton.[3] In their implementation

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a study of the economics of tomato production under small-scale irrigation in three villages. An agricultural economist at the IAR, Palmer-Jones, is concluding a study of irrigation. To date, however, government attention has focused primarily on large-scale, capital-intensive irrigation schemes rather than on small-scale projects.

[1]An interpretive and comparative review of village studies undertaken in the semi-arid tropics of West Africa has recently been completed for ICRISAT [Ouedraogo, Newman and Norman, 1979; Norman, Ouedraogo and Newman, 1979].

[2]For example, Sine Saloum in Senegal.

[3]For example, Mali Sud in Mali.

programs, these agencies laid great emphasis on developing, controlling, and coordinating extension, input distribution and credit programs together with providing a market for the product. In northern Nigeria, in contrast, extension, input distribution, credit and, for cash crops, product-marketing programs remained in the hands of government. However, because of limited financial and human resources, there was limited participation by the government in these programs.

In looking at the current situation in the Sahelian countries and northern Nigeria, it is apparent that a degree of convergence is taking place in the implementation of development projects. In the francophone countries, the single commodity developmental agencies are being converted to regionally-based development projects incorporating all crops and sometimes livestock enterprises. The same approach is emerging in some of the IBRD projects in northern Nigeria. These changes in philosophy bring into sharp focus the significance of the total farming system and the need for a holistic approach in designing and introducing technologies and strategies for improving the welfare of farmers. This requires an interdisciplinary group undertaking studies at the farm level.[1]

We believe that, with some modification, the general methodological approach used in the socio-economic studies in Hausaland could be applied in the Sahelian countries. In order for such studies to be of maximum value, it is important that they be undertaken within

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[1]Such studies have been undertaken in the Sahelian countries often by anthropologists attached to organizations such as IDEP, IRSH, ORSTOM and IFAN. However, in general, these have been isolated case studies and they often have not been fed into the development of improved technologies.

institutions involved in developing new technology. This implies the presence of both technical and social scientists working together under one institution. In addition, cooperation between technical and social science researchers is necessary in testing the improved technologies at the farm level.[1] However, it should be noted that such cooperation at IAR is still relatively new and still needs to be refined.[2]

Considerable emphasis has been devoted in this paper to the importance of family labor and its allocation throughout the year. Since seasonal labor problems are more pronounced in some parts of the Sahelian countries, it is believed that detailed analysis of seasonal labor profiles by crop are of central importance in delineating the farm level constraints which must be addressed if developing improved technologies.[3]

In terms of the empirical results presented in this paper, emphasis has repeatedly been laid on location specificity. However, there are certain generalizations that can be drawn. Recurring themes in our paper are the need to understand the seasonality of agriculture and its uneven labor demands, the increasing population densities resulting in smaller farm sizes, length of fallowing, soil fertility, and the

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[1]The Experimental Unit approach in Senegal, at present, comes closest to embodying the concept of this approach.

[2]To date, interdisciplinary research between the technical and social scientists in the initial studies at the farm level, (i.e., positive and hypothesis-testing phases) has not taken place.

[3]In the Sahelian countries, studies collecting labor-flow data, apart from the case-study approach mentioned in an earlier footnote, have been rare. A recent notable exception has been work undertaken by the Evaluation Unit of IER in Mali [Institut d'Economie Rurale, 1978].

breakup of traditional family structures and the rationality of mixed cropping. One area of research however, that in general has been little emphasized in the francophone countries is mixed cropping. In the Sahel improved technologies for cash crops have emphasized sole cropping. Nevertheless, mixed cropping of cereals and legumes, particularly cowpeas, is widespread in the Sahel. Therefore, there appears to be justification for more research work on mixed crops in the Sahelian countries.[1]

Finally, in assessing the relevancy of the improved technologies for the Sahelian countries, a note of caution is required. The paper has emphasized location specificity, which implies that local testing is necessary before the potential transferability of a technology can be assessed. Casual observation would suggest that, for cotton, superior technologies are available in Sahelian countries. Also, the 160-day SK 5912 sorghum appears to have potential for the higher rainfall areas of some countries in the Sahel. Maize has considerable potential in the Sahel if the necessary input delivery systems and marketing problems can be solved.

6.3 Conclusions

Increasingly, in the savanna and Sahelian areas of West Africa, there is growing realization by policy makers that farmers adopt change on a voluntary basis. Consequently, it is of paramount importance that policy makers and research workers are sensitive to the expressed needs of farmers. We believe that a farming-systems approach [Institut d'Economie

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[1] ICRISAT, in particular, is now working on this in Mali and Upper Volta.

Rurale, 1976][1] to the development of new technology is sound and that it should be expanded. Such an approach, and indeed, the tenor of this paper point to the significance of the conviction expressed by a wise Islamic scholar, Alhaji Junaidu [1972]--sound development must build upon, rather than destroy, the farmers' traditional techniques.

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[1]A paper on farming systems methodology will be forthcoming as an MSU African Rural Economy Paper by Gilbert, Winch and Norman.

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APPENDIX

Table A.1. GINI COEFFICIENT ON DISTRIBUTION OF LAND BY VILLAGE[a]

	Total hectares			Cultivated hectares		
	N	I	R	N	I	R
H	0.1987	0.4319	0.2413	0.1990	0.4279	0.2518
I	0.3635	0.3997	0.3568	0.3410	0.3050	0.4850
L	0.3419	0.3316	0.5577	0.3459	0.3486	0.2876

[a]The letters in the table identify the village. For example, using the key on Table 2.1, village HN = Takatuku. The Gini coefficients were calculated on the basis of the families possessing the usufructuary rights during the survey year.

Table A.2. COEFFICIENTS OF VARIATION FOR LABOR INPUTS PER MONTH BY VILLAGE[a]

		Family Male Adults						Hired	
		Family Farm			Off-farm				
Village	Man-hours on Family Farm	Days	Hours	Hours/ day worked	Days	Hours/ day worked	Total days	Man-days	Man-hours
HN	61.9	34.6	57.6	30.2	31.8	7.7	10.5	123.9	135.3
HI	47.2	28.5	37.5	15.0	37.8	15.4	18.3	73.2	78.1
HR	71.4	52.2	66.4	21.2	39.5	18.0	10.9	85.2	90.6
IN	42.4	35.0	41.5	16.6	14.3	a	24.2	49.5	53.9
II	48.2	33.1	46.3	27.2	31.7	a	21.4	50.8	53.4
IR	54.9	50.3	58.7	10.7	46.0	a	19.0	40.3	52.6
LN	61.4	62.5	65.9	12.5	29.6	8.8	24.5	86.9	95.9
LI	44.0	24.5	39.3	17.6	20.5	12.2	19.8	95.4	100.4
LR	77.6	69.1	78.7	17.4	36.7	12.5	25.4	79.9	82.4

[a]Excludes time farmers spent traveling to and from fields.

Table A.3. CORRELATION COEFFICIENTS ON THE MONTHLY DISTRIBUTION OF WORK BY VILLAGE

	Between Days Spent by Family Male Adults on Farm and Off-farm Work			Between Man-hours of Family and Hired Labor on Family Farm		
	N	I	R	N	I	R
H	-0.9025*	-0.3956	-0.8902*	0.7594*	0.8946*	0.9491*
I	-0.7091*	-0.7001*	-0.2900	0.9387*	0.4219	0.8435*
L	-0.8448*	-0.3879	-0.8283*	0.2382	0.7762*	0.7462*

*Significantly different from zero at the 5 percent level.

Table A.4. RELATIONSHIP BETWEEN WORK PER CULTIVATED HECTARE AND NUMBER OF CULTIVATED HECTARES[a]

Independent Variables		Dependent Variable[b]			
		Total Man-hours per Cultivated Hectare		Family Man-hours per Cultivated Hectare	
Constant		2.7175		2.6831	
Cultivated hectares	Log X_1	-0.3222*	(0.332)	-0.3980	(0.0458)
Proportion of cultivated land that was <u>fadama</u>	X_2	0.3941*	(0.0812)	0.4296*	(0.1123)
Organic manure per hectare (metric tons)	X_3	0.0121*	(0.0031)	0.0099*	(0.0043)
Dummy variables:					
S1	X_4	0.0503*	(0.0248)	0.0281	(0.0343)
S2	X_5	-0.0804*	(0.0284)	-0.1275*	(0.0393)
V1	X_6	0.1304*	(0.0255)	0.1222*	(0.0353)
V2	X_7	0.0838	(0.0285)	0.0815*	(0.0394)
R		0.7023		0.6258*	
S_{yx}		0.1798		0.2486	

[a]Figures in brackets are standard errors. Details concerning the dummy variables are given in Table 3.3.

[b]Was logged. Variables excluded time traveling to and from fields.

*Significantly different from zero at the 5 percent level. N = 340.

Table A.5. GINI COEFFICIENTS ON INCOME MEASURES

Village	Net Farm Income[a]	Disposable Income I[b]	Disposable Income
Sokoto:			
Takatuku	0.2648	0.2237	0.2561
Kaura Kimba	0.4043	0.3777	0.4102
Gidan Karma	0.2990	0.2587	0.2631
Zaria:			
Hanwa	0.3588	0.3005	0.3108
Doka	0.2986	0.2770	-
Dan Mahawayi	0.5004	0.4728	-
Bauchi:			
Bishi	0.3728	0.3227	0.4795
Nasarawa	0.3612	0.3183	-
Nabayi	0.3873	0.3159	0.3262

[a] Net farm income from crops and livestock (excluding taxes).

[b] Disposable income excluding income derived from cattle.

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