SOCIO-ECONOMIC STUDY OF THREE VILLAGES IN BAUCHI STATE, NIGERIA [WITH EMPHASIS ON LABOR UTILIZATION]

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CHAPTER I

INTRODUCTION

Role of Agriculture in Nigeria's Economic and Social Development

Although agriculture no longer serves as the leading contributor to Nigeria's Gross National Product and leading foreign exchange earner, it still is the leading employment sector of the vast majority of Nigerian population. The decline in importance of the agricultural sector in terms of GNP has been partly due to the phenomenal growth in the Petroleum sector of the economy. Crude Petroleum production has grown from 395.8 million litres in 1970 to 765.7 million litres in 1977 whereas production in agricultural crops like Cocoa, Cotton and Groundnuts have shown a decline over the same period.[1] The extent of the decline in agriculture's decline can be observed in the Gross Domestic Product figures reported in Nigeria's Third National Development Plan which indicate agriculture's contribution to GDP at 36% and 23.4% for 1970-71 and 1974-75 respectively.[2] Other factors of relevance to this decline include a long period of adverse weather conditions, negative overall terms of trade in relation to other sectors of the economy as well as a very disturbing rate of farm urban migration [Matlon, 1979].

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[1]Figures given in Central Bank of Nigeria's Principal Economic and Financial Indicators 1970-1977.

[2]Third National Developjent Plan 1975-80, Vol. I., Federal Ministry of Economic Development, Lagos, p. 22.

Nothwithstanding this dilemma of the agricultural sector, the sector still has to perform at least most of the critical roles assigned traditionally to it [Johnston and Mellor, 1961]. Particularly the roles of leading Employer of labor and provider of food both within the sector and in the non-rural sectors are important. The agricultural sector is also the leading market for the more rapidly growing industrial sector. These important linkages enhance the agricultural sector problems in terms of achieving overall economic and social development. The issue is of such magnitude as to form one of the cornerstones of campaign attention for politicians vying for office on the impending hand over from military to a democratically elected civilian regime.[1] Agriculture is likely to serve as the major employment sector for a long time.

General Structure of Agricultural Production in the Northern States of Nigeria.

The problems described in the previous section apply with equal force to the Northern states of Nigeria, the area this study is concerned with.

Agricultural Production in the area is mainly in the hands of small farmers cultuvating an average of about four hectares (just less than 10 acres) per family made up mainly of upland farms or gona type. In areas with rivers that have suitable flood plains

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[1] New Nigerian, July 3, 1979.

fadama type farms supplement the gona farms.[1] Fadama lands have the advantage of enabling the farmer to grow crops the year round since the water table is close to the surface even during the dry season. Fadama lands also support more labor-intensive but highly remunerative crops like rice, onions, peppers and sugarcane. However, Fadama lands account for less than 10% of the farm land in the area.

Generally large holdings are absent in the area. Less than 4% of the total farm land is in blocks of 20 acres or larger [Federal Office of Statistics, 1966]. The tenure system to land is complex in the sense that it is neither completely individualistic nor completely communal. Rights to land ownership depend on membership in a community. Within the community individuals get usufructury rights to land. On the death of the 'owner' of the land it is often divided among his offsprings, particularly the male heirs according to Islamic Law. This leads to land fragmentation but relatively equal distribution of land holdings. The four hectares of land per family is on the average made up of four to six fields.

Farmers in the area widely practice mixed cropping, a system of cropping whereby more than one crop is grown on a piece of land at any given time. The number of crop mixtures enumerated varies from one area to another but is generally high, going up to over 200 (Norman, 1979). However, Norman noted that over 53% of the cultivated land is accounted for by about 6 crop enterprises. The rationale for

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[1] Gona land accounts for 92% of the average farm. [Norman et.al., 1979].

mixed cropping has attracted much attention and this will be examined in relation to the three Bauchi villages in this study.

The major crops grown in the northern states of Nigeria include sorghum (guinea corn), millet, and cowpeas as food crops. Groundnuts and cotton are the leading cash crops. Other crops are cassava, rice, sugarcane, maize, beniseed, tobacco and sweet potatoes.

Agricultural production is closely tied to the household. Most of the labor input is provided by the family members. Although there is some employment of hired labor, its extent does not seriously diminish the importance of family labor as the major input on the family farm.

The limited employment opportunity on the family farm coupled with population growth and seasonality of agricultural production in the area has led to a situation whereby in densely populated areas some of the family members embark on temporary dry season migration in search of employment away from their villages. This temporary migration is a well established practice in the areas of Sokoto and Katsina. (Luning, 1967).

The characteristics of the technology applied in agricultural production point to a very low level use of capital and improved inputs like fertilizer and herbicides.[1] The two major inputs are land and labor.

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[1]The use of fertilizer was estimated to be 1.28 kg (about 2.8 lbs.) per cropped hectare for Nigeria as a whole. (Third National Development Plan, 1975-80).

Before closing this section it is important to point out that the majority of the farmers are Hausas and Fulanis and are Moslems. Due to the practice of auren kulle[1] and a combination of cultural and social factors women do not participate to a significant degree in farmwork. Most of the farmwork is done by male adults. Most farmers despite increasing urbanization, live in small village communities.

Objectives and Plan of the Paper

The objectives of this paper stem from the realization that in order to solve the problems plaguing small-farmer agriculture, as in the study area, detailed microeconomic studies and analysis of operations are needed. Without detailed information about farm operations, it is unlikely that effective remedial measures could be devised to alleviate the problems.[2]

This paper mainly intends to contribute to the provision of data on small-farmer modes of operation with respect to the level of resources and the products produced using these resource inputs. Due to the wide scope of the subject, the paper will mainly concentrate on labor resource availability, use and productivity. Other factors will be covered only briefly. Labor's role in production in the area is of prime importance, and as such, I feel it deserves the central

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[1] Auren kulle is the practice of keeping married women and women of marriageable age in purdah.

[2] Stolper has given detailed accounts of the dangers of 'planning without facts'. See [Stolper, 1966].

role accorded to it in this paper.

The paper will test various hypotheses relating to labor utilization on the family farm. Monthly labor input data for a period of 12 months will be used for this purpose. The hypotheses concern the existence of labor bottleneck period when it pays the farmer to hire labor, the relationship between labor input on the family farm and the farm size, the rationality of leaving resources lie idle and the relation between various kinds of labor with hired labor. The hypotheses will be stated in explicit terms in the next chapter.

Chapter II reviews the available literature having relevance to this paper within the study area. The chapter also states the hypotheses to be tested later. Chapter III deals with the data, including source and collection methodology. Chapter IV tackles the analysis of the data and hypothesis testing, and presents and discusses results. The concluding chapter (Chapter V) will summarize and draw conclusions from the paper as well as discuss policy implications and avenues for further research.

CHAPTER II

LITERATURE REVIEW AND STATEMENT OF HYPOTHESES

Literature Review

The literature of traditional agriculture and agriculture in development theory is broad but well covered in various works (Mellor, 1966; Wharton, 1969; Johnston and Mellor, 1961; Schultz, 1964). Alot has also been written on the Nigerian economy and the role of agriculture in the economy (Eicher and Leidholm, 1969; FAO, 1966; Helleiner, 1966; Oluwasanmi, 1966; Wells, 1974). However, these writings are concerned with the aggregate national economy as a focal point. They provide little in the way of detailed quantitative accounts of the operations of farmers. I am concerned with farm management studies at the micro-level. Alot of the published material on this originated from the southern parts of the country.

Most of the studies prior to the early 1960s on farmers in Hausaland were done by social anthropologists.[1] These studies often gave detailed descriptive accounts of the farming communities, but mostly of a non-quantitative nature. Norman (1973) noted studies by Hill (1968) and Smith (1955) as leading examples. Quantification of village survey data mainly started with the establishment of the Rural Economy Research Unit (RERU) under the Institute for Agricultural Reserach, Ahmadu Bello University, Zaria in 1964.

RERU right from the start realized the importance of farm management studies together with the socio-economic factors in their role in the adoption or nonadoption of improved technologies by farmers.

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[1] See Norman, 1973.

The unit set out to fill the gap of needed data that is essential in the analysis of alternative strategies and policies for the improvement of farming technology in the northern states of Nigeria. Useful data should be available to the policymaker as well as to the extension agent if the hazards mentioned by Stolper (1966) in "planning without facts" are to be avoided.

RERU had a four-stage work plan for its research program; first it should determine what the farmers are doing; second, why they are doing it that way; third, what the farmers ought to do and finally stage four deals with policy issues concerning ways of bringing about desirable changes.[1]

There are two earlier studies in northern states of Nigeria prior to this one that have special bearing on this one. They are the Zaria village studies and the Sokoto village studies.[2] Their particular relevance stems from the fact that the same methodology was used for data collection and initial data handling as this one. In each of the studies a detailed input-output of the farming operation is given. The studies provide alot of useful data that provide basis for skepticism towards or even the rejection of certain approaches to research and technology development for the small farmer in the northern states of Nigeria. The research and technology development orientation has hitherto been directed in favor of sole cropping as against the

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[1]Further details of RERU operations and origin could be found in writings of Norman, particularly Norman (1973), pp. 2-3.

[2]These are reported as "An Economic Study of Three Villages in Zaria Province": Parts 1, 2 and 3 by Norman (1967-72) and "A Socio-Economic survey of three villages in the Sokoto close-settled zone" by Norman et.al. (1976).

traditional practice of mixed cropping. Evidence is accumulating, however, showing that it is rational to practice mixed cropping when compared to sole cropping (Norman, 1967-72, Norman et al, 1976; Norman, Pryor and Gibbs, 1979; Andrews, 1972, 1974; Abalu, 1976; Baker and Yusuf, 1976; Dalrymple, 1970).

Matlon (1977, 1979) studied the size distribution, structure, and determinants of personal income among farmers in three villages in Kano State, Nigeria. The emphasis on the identification of the rural poor, extent of income inequality among farmers and the possible sources of the inequality through comprehensive, quantified study is a primer. Matlon's study by stratifying households into income classes could permit the identification and design of relevant policies to meet the needs of even the poorest of the rural poor. The results from Matlon's work indicate that even though income distribution was relatively equal, the level of income was very low. There was also absolute impoverishment especially in the lower quintile of his study where calorie consumption was 20 percent below the minimum for subsistence estimated by FAO.

Many factors working together explain income inequality in the area. Among these are the demographic makeup of households, land use, levels of employment and factor productivity. Matlon concluded that no single factor explains major variations in income.

Luning (1967) reported the results of his survey of seven villages in Sokoto Province in northern Nigeria. In carrying out the Sokoto study he drew on his experience in similar work carried out

in various other parts of Northern Nigeria.[1] The study examined labor use and productivity. Luning used multiple regression analysis to show the relationship between output and the various inputs of land, labor and recurrent expenditures. His results showed that there was a diminishing return for each of the inputs and that overall there was constant return to scale in agriculture in the study area.

Ogunfowora (1972) analyzed data of 124 farm families in the Zaria area of Kaduna state to examine the economic organization of small farmers, the impact of improved technology on production and income and the pattern of farmers' response to different farm policy programs. The stability of sole cropping and mixed cropping was examined under varying resource levels and technologies. A combination of linear programming and regression analysis was used. Major results of interest to this paper include: (1) that farmers in the study area had been efficient and rational in their farm decisions (2) given the level of resources available to the small farmers there was little scope for improvement.[2] Ogunfowora's results support the practice of mixed cropping under traditional system of farming, but when resource restrictions are lifted and improved technology introduced, the crop mixtures compare less favorably with sole crops. He recommended that the design of further research should take note that his findings depended only on the supply side of the situation on the assumption that demand exceeded supply. Adjustments might have to be brought into

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[1] Luning has worked in Katsina, Kano, Shendam and Gusau areas as well.

[2] This testifies to Schultz's point of claiming very few inefficiencies exist in traditional agriculture. Schultz (1964).

the model if the assumption is not the case.

More recently, the economics and social organization of agricultural production in the Northern parts of Nigeria is receiving more attention.[1]

Statement of Hypotheses

The following hypotheses will be tested:

(1) That labor input per acre is inversely proportional to farm size,

(2) That hired labor is a substitute for family labor,

(3) That there is work-sharing among family male adults (the more the number of male adults in the family, the less each will work on the farm),

(4) That there is a labor bottleneck period when it pays to hire labor, and

(5) That the practice of mixed cropping is consistent with the goal of income maximization.

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[1]Research work by the Department of Agricultural Economics and Rural Sociology of Ahmadu Bello University should gradually reduce the paucity of information complained about earlier.

CHAPTER III

DATA COLLECTION AND PRESENTATION

Climate in the Study Area

The area has an average rainfall of 43 inches annually (Table 1) with a coefficient of variation (cv) in monthly rainfall of 127.

Table 1. Climate in the Study Area

Mean monthly temperature (°C)	
Minimum	12.8
Maximum	36.7
Total rainfall (ins.)	1102 mm
Coefficient of variation in monthly rainfall	127
Length of rainy period (days)	150
Length of growing season (days)	180
Starts	May 21-30
Ends	Nov. 1-10
Months with surplus water	June-September
Rain for some months in mm (cv)	
April	33 (157)
May	91 (90)
August	346 (46)
Sept.	185 (56)
Oct.	37 (164)

Source: Kowal and Knabe [1972]

The cv indicates that the amount of rainfall varies greatly from one month to another. Temperature does not limit the extent of agricultural production in the area. The major limiting climatic factor is rainfall both as to the total amount and its distribution and monthly variations. The growing season lasts for only 180 days per year.

The city of Bauchi (located 10° 17' N, 9° 49' E) lies within the northern Guinea ecological zone.[1]

Data Collection Methodology[2]

As far as possible, villages were selected to be representative, but due to certain limitations some purposive selection elements entered into the selection. Firstly, the villages had to vary in ease of access to Bauchi, the urban area. Secondly, for the purpose of enumerator supervision all villages had to be accessible at least by bicycle during the rainy season. To avoid correction for steep slopes on farm map aerial photographs only villages without steep slopes were chosen. Lastly, only villages whose village heads were sympathetic to the idea of the survey were included. Despite these purposive elements, the chosen villages do not seem to depart from other villages in the area in terms of factors like income, size and socio-cultural factors.

Two phases were used in selecting sample families. In the first phase, all families in each of the three villages were involved, followed by the second stage where only the families that entered

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[1] Kowal and Knabe (1972) give further details on the climate and vegetation of the area as related to agricultural production.

[2] Mainly based on Norman (1973).

the master sample were involved for detailed data collection. No rigid statistical sampling procedures were utilized in selecting the master sample, but the sampling percentage was deliberately made comparatively high so that the shortcomings would be overcome (Table 2). To insure this, the village size was limited to villages with a population of 1000 persons or less. Two enumerators were stationed in each village for the entire data collection period, and to guard against "uncooperative farmers" [Smith, 1955] a large sample of families was selected.

Table 2. Total number of farming families and the percentage included in the sample

Village	Farming families		Sampling percentage
	Total	Number in sample[a]	
Bishi	108	40	37.04
Nasarawa	95	37	38.95
Nabayi	79	39	49.37
Combined	282	116	41.13

[a]Not including families for which records were taken and then rejected due to data inconsistencies.

Data was collected in two ways depending on the information needed. In the first case, data was collected twice weekly by day and by field

on labor input [both family and nonfamily], seeds, cuttings and fertilizer, cattle coralling and output by field. The second case is for data collected infrequently involving farm inventory, retail prices, land tenure, purchases and sales of livestock, crop rotation pattern by field and similar information that does not have much of a recall problem.

Data Description and Presentation

Land

The average size for family farms in the area is about 9.71 acres, inclusive of fallow land. This figure is about equal to the average of 9.92 acres for the Sokoto area and 9.63 acres for the Zaria area. However, the effect of lower population density for the Bauchi area becomes apparent when the percentage of fallow land is examined. For the Sokoto and Zaria area, the percentage of land that was fallow was 3.3 and 16.8 percent, respectively, but for Bauchi area the percentage was 34.38.

For the Bauchi area as a whole, the average cultivated area was 6.37 acres, leaving 34.38% of the land fallow (Table 3). Gona land constituted about 96% of the farmland while fadama land makes up the remaining 4%. The two types of land differ in that fadama land is marshy lowland generally along river valleys that allows cultivation even during dry season. Gona land is cultivable only during the growing or rainy season.

Table 3. Characteristics of family farm size (acres).

Village	Mean[a]	Median	Range
Bishi	8.19 (5.51)	8.23	1.41:13.43
Nasarawa	7.37 (5.66)	7.03	2.26:17.06
Nabayi	13.47 (10.19)	8.94	3.29:19.03
Combined	9.71 (7.87)	8.07	1.41:19.03

[a]Figures in brackets are standard deviations.

The detailed composition of the average family farm in each of the three villages and for all the villages combined together is given in Table 4.

Table 4. Composition of the average family farm

	Whole MS[a]	Bishi	Nasarawa	Nabayi
Size of farm (acres)	9.71	8.19	7.37	13.47
Cultivated (acres)	6.37	6.76	5.30	6.98
fallow "	3.34	1.44	2.07	6.49
Gona "	9.32	8.18	6.17	13.47
Fadama "	0.39	0.01	1.20	0.00
Percentage of land that is fallow				
Total	34.38	17.57	28.01	48.18
Gona	34.21	17.52	26.02	48.18
Fadama	38.43	90.00	38.20	----

[a]MS refers to the total sample for all the three villages (Master Sample).

The high percentage of fadama left fallow in Bishi village resulted from the land not being cultivable or irrigable during the dry season and was overflooded during the wet season. This fadama land was also very small, just one-hundredths of an acre per family farm.

The tenure system in the area shows that over half the farmland, 53.04 percent, was obtained in the form of a gift, and 39.34 percent was inherited. It should be noted that only 1.27 percent of the land was purchased (Table 5). This probably points to the fact that land is fairly abundant in the area and so lacks a well defined market. It is not difficult to get farmland where there will be bush to clear. Even though inherited land makes up more than a third of the land, the percentage here is less than in other parts of northern Nigeria. For example, in the Sokoto area, the percentage of land inherited was found to be 62.50, and gifts constituted only 7.12 percent.

Table 5. Percentage of land obtained by different types of tenure

Village	Percent of Acres obtained by				
	Gift[a]	Inherited[b]	Purchase	Rented	Government
Bishi	74.61	17.58	2.34	3.91	1.56
Nasarawa	39.27	53.37	----	7.36	----
Nabayi	48.06	44.17	1.94	5.83	----
Total MS	53.04	39.34	1.27	5.84	0.51

[a]May be allocated by village head or by one farmer to another and could be either uncleared bush or existing farms.

[b]Share of land received at death of a relative (usually father to sons) based on Islamic Law.

Due to the scarcity of land in the densely populated Sokoto area, land has acquired value and this is partly reflected in the fact that 20.69 percent of the land was purchased [Norman, et al. 1976].

The higher percentage of inherited land in the Sokoto area also reflects the tenacity with which families try to keep family land within the family despite population pressure and the increase in monetization.

The land tenure system is mainly based on communal ownership with individuals having usufructory rights. The system does not freely allow alienation of land. The village head, by authority vested in him by the Emir, deals with all affairs related to land at the village level. The cultivator can enjoy the rights of use for an indefinite period of time provided he uses the land for his own benefit and that of his community. Some can claim that lack of title to land may act as a disincentive to efforts at investments in land improvement; however, observation shows that rights to inherited land are rarely contested. Another observation indicates that the system of tenure is gradually changing and selling of land is becoming common.

The figures in Table 5 indicate that gifts are the most frequent form of land tenure transaction, accounting for about 75 percent of acres in Bishi and 48 percent in Nabayi. In Nasarawa gifts accounted for only 39 percent of the acres. This observation could be explained in that Bishi and Nabayi had more extensive crop production and large areas of bush were being brought under cultivation, a form of gift allocation. The two villages were also observed to have high incidence of gift transaction between farmers. The higher incidence of inherited land in Nasarawa partly reflects the desirability of Fadama land.

Land close to the compound is also considered more desirable and is well preferred over gonar daji or land further away in the forest.

Labor

Among the factors influencing labor availability for farm work are the following:

(1) Number of household members who can work on the family farm.

(2) Length of time each family member is willing to spend working on the family farm.

(3) The availability of financial resources to hire labor from outside.

Each of the factors above is determined by other sets of variables. For example, the length of time each family member is prepared to work on the farm may be influenced by such factors as the amount of work necessary to provide subsistence needs, availability of off-farm employment, incentive system as to the rewards to work, nutritional and health status of the individual family member, et cetera.

Definition of Person-Equivalents

In the measurement of labor input the unit of measurement is very important if inter-study comparison is to be achieved. The scale used in this study is shown in Table 6.

Table 6. Person-equivalents used in this study[a].

Labor Class	Age (years)	Male Adult Equivalents
Small Child (SC)	Less than 7	0.00
Large child (LC)	7 - 14	0.50
Female adult	15 - 64	0.75
Male adult	15 - 64	1.00
Person	Over 64	0.50

[a]Adapted from Norman et al. (1976)/

The scale is constructed based on the idea that labor productivity at the early years of life increases, then decreases. A second point taken into account is that the physical productivity of female labor is less than that of a male.

The choice of this scale does not make it the best and I realize it is open to bias, but the literature is full of controversies on this aspect [Collinson, 1972]. In this study most of the farm work was performed by male adults, as such not much bias is introduced by the scale.[1] Spencer and Byerlee (1977) have used a weighting system based on difference in wage rates between males and females. For comparison with other studies in the area this scale is maintained in this study.

Size and Composition of Households

In an economy where most of the farm labor supply is from members of the family, a closer look at the structure, composition and age-

[1]Relatively few women participate in farmwork in Moslem areas of northern Nigeria. Auren kulle or purdah is often blamed for this but there are likely to be some socio-cultural factors as well.

distribution of the family is in order.

The average size of family for the three villages together was 6.03. Nasarawa had the largest family size average at 6.59 while Bishi had 5.72 and Nabayi 5.79 (Table 7). This means that the smaller farms at Nasarawa were being farmed by a larger number of people compared to situations in the other two villages.

Table 7. Average Size of Family

Village	Family Size	Standard deviation
Bishi	5.72	3.10
Nasarawa	6.59	4.02
Nabayi	5.79	2.61
Whole MS	6.03	3.27

In terms of the composition of the average household for the Bauchi area there were 1.54 male adults, 1.78 female adults, 1.48 large children and 1.23 small children (Table 8). The 1.54 male adults in an average household were responsible for most of the work done on the farm and consequently the income earned. The difference in composition of households between villages is not marked.

Table 8. Composition of an average sized family[a]

Village	Number of persons by class				
	Total	MA	FA	LC	SC
Bishi	5.72 (3.10)	1.55 (0.88)	1.77 (1.00)	1.35 (1.59)	1.05 (1.06)
Nasarawa	6.59 (4.02)	1.70 (1.00)	2.16 (1.21)	1.54 (1.54)	1.19 (1.51)
Nabayi	5.79 (2.61)	1.38 (0.75)	1.44 (0.68)	1.54 (1.35)	1.44 (1.19)
Whole MS	6.03 (3.27)	1.54 (0.88)	1.78 (1.02)	1.48 (1.49)	1.23 (1.26)

[a]MA=male adults, FA=female adults, LC = large children, SC = small children. The figures in brackets are the standard deviations. MA and FA include persons over 64 years.

Composition of Work on the Family Farm

The average labor input per family farm per year for the whole master sample is just over 1318 man hours of which about 87 percent was contributed by family labor, the rest being hired. If we remove the contribution of gayya[1] to hired labor we find that the importance of hired labor has been further reduced to only less than 5 percent of the labor input manhours.

In an area where auren kulle, the seculsion of women of marriage-able age is practiced it is not surprising that the female adult contribution to total labor on family farm was less than 4 percent.

[1]Some could argue that gayya is not strictly hired labor in the ordinary sense of the term: it entails social obligations and no going wage rate. It is communal labor based on reciprocity.

On the other hand over 73 percent of the farm work was done by male adults, with large children contributing just under 10 percent (Tables 9 and 10).

Table 9. Contributions (man-hours) by different labor types to total labor on family farm. a

Village	Total	Average man-hours per family farm per year					
		Family			Hired[b]		
		Male adults	Female adults	Large children	Kwadago	Jinga	Gayya
Bishi	1617.84 (475.14)	1007.66 (677.83)	122.60 (243.42)	170.52 (320.04)	27.84 (39.44)	49.37 (71.04)	239.85 (232.86)
Nasarawa	1341.81 (522.46)	1104.21 (782.29)	31.21 (125.68)	84.82 (179.67)	45.68 (100.71)	7.09 (26.26)	68.80 (211.18)
Nabayi	989.77 (341.17)	800.41 (361.80)	0.00 (0.00)	128.87 (249.79)	40.95 (102.78)	8.92 (21.76)	10.62 (20.98)
Whole MS	1318.64 (453.13)	968.78 (637.72)	152.23 (166.82)	129.18 (258.24)	37.94 (85.15)	22.29 (49.74)	108.22 (205.55)

[a] Figures do not include time walking to and from fields. Figures in brackets are standard deviations.

[b] Kwadago refers to the hiring of labor by the time worked.

Jinga is contract labor. The hiree and the hired work out the payment based on size of field and level of expected difficulty of work.

Gayya is communal labor based on reciprocity; no explicit wage rate. Meals and drinks are often served to the participants.

Table 10. Percentage contribution to total labor by labor type.

Village	Percent of total labor					
	Family			Hired		
	Male adults	Female adults	Large children	Kwadago	Jinga	Gayya
Bishi	62.28	7.58	10.54	1.72	3.05	14.83
Nasarawa	82.29	2.33	6.32	3.40	0.53	5.13
Nabayi	80.87	0.00	13.02	4.14	0.90	1.07
Whole MS	73.47	3.96	9.79	2.88	1.69	8.21

Contributions by male adults among villages were similar except for Nabayi village in terms of man-hours. This could be due to the shorter rainy season in Nabayi compared to the other two villages, since the Nabayi male adult contribution on a percentage basis was more than the average of the three villages. Female adults did not contribute to total labor on family farms at all in Nabayi, but for Nasarawa and Bishi the contribution was 2.33% and 7.58% of total man-hours respectively.

The Bauchi area showed less hiring of labor at 12.78 percent of total labor, while Sokoto had about 19.23 percent (Norman, et al., 1976). All members of the family contributed a higher percentage to total labor in Bauchi than in Sokoto. In particular, female adults contributed three times (percentage wise) as much in Bauchi as in Sokoto although the absolute values of the contributions still were low for both areas. This differential labor contribution may be explained if one observes that Auren kulle may not be as entrenched in the Bauchi area as in the Sokoto case.

Effect of Season on Labor Input

The distribution of rainfall, where most of it falls between the second half of April and October, coupled with the predominance of upland rain fed soils has given farming a pronounced seasonal pattern. Almost 40 percent of the annual labor input in man-hours were used during the months of June to August. If September is added, this peak farming activity period of four months took 52 percent of the annual labor input. In contrast, the dry season period of December to March accounted for less than 11 percent of annual labor input (Table 11). This seasonal nature of farming is not peculiar to the Bauchi area alone but exists in most of the northern parts of Nigeria.

The effect of seasonality among villages can also be observed in that about 50 percent of all labor input was used during the months of June to August in Nabayi. The corresponding percentages for Bishi and Nasarawa were 36.58 and 35.97 percent, respectively. The greater concentration of activity in Nabayi during the peak period of June to August was due to the shorter growing season for the village, being the northern-most of the three villages.

The importance of farming operations differed greatly. The following table (Table 12) gives a greakdown of work done by operation on the family farm. Cultivating was the most important operation in terms of the manhours put into it, followed by harvesting, land preparation, planting and fertilizer application in that order. For the master sample as a whole, 55 percent of total labor input was used on cultivating, just under 22 percent on harvesting and about 14 percent on land preparation. The figure for land preparation was double that

Table 11. Percentage labor contribution on the family farm by month and by type of labor
(Man-hours)

Type of labor	Class of labor	Total		Monthly percentage worked											
		Man-hours	Percent	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Family	Male adults	968.78	73,47	6.11	8.55	9.30	11.82	9.17	8.71	5.23	6.97	2.29	1.70	1.21	2.91
	Female adults	52.23	3.96	0.21	0.40	0.44	0.71	0.57	0.41	0.35	0.65	0.06	0.05	0.03	0.05
	Large children	129.18	9.80	0.90	1.18	1.35	1.48	1.36	1.29	0.67	1.09	0.20	0.13	0.01	0.14
	Total Family	1150.19	87.23	7.22	10.13	11.09	14.01	11.10	10.41	6.28	8.71	2.55	1.88	1.25	2.60
Hired	Kwadago	37.94	2.88	0.07	0.33	0.25	0.66	0.35	0.25	0.44	0.49	0.03	0.01	0.00	0.00
	Jinga	22.29	1.69	0.05	0.13	0.44	0.28	0.39	0.15	0.11	0.01	0.00	0.00	0.00	0.00
	Gayya	108.22	8.20	0.08	0.11	0.09	0.84	0.43	1.42	0.57	2.36	1.26	1.03	0.00	0.01
	Total hired	168.45	12.77	0.20	0.57	0.47	1.94	1.06	2.06	1.16	2.96	1.30	1.04	0.00	0.01
Total		1318.64	100.00	7.42	10.70	11.56	15.95	12.16	12.47	7.44	11.67	3.85	2.92	1.25	2.61

reported by Norman for the Sokoto area. This is probably due to the existence of large fallow lands and uncleared bush that take more time to prepare for planting compared to the continuously cropped lands of the Sokoto area.

Table 12. Work done by operation on the family farm by village

Village	Percent of Man-hours					Average total man-hours
	Land preparation	Fertilizer application	Planting	Cultivating[a]	Harvesting	
Bishi	13.36	0.47	7.46	48.67	30.04	1617.84
Nasarawa	6.25	1.71	7.48	70.28	14.28	1341.80
Nabayi	24.16	0.16	11.63	46.60	17.45	989.77
Whole MS	13.78	0.79	8.52	55.16	21.75	1318.63

[a]Includes thinning, weeding and ridging operations after planting.

Less than 1 percent of the labor input was spent on fertilizer application due to the low rates of fertilizer use in the area. For example, the Bauchi area used only about one-sixth of the amount used in the Sokoto area.

Labor Inputs of Family Male Adults

It is recognized that since most of the labor input on the family farm is supplied by male adult members of the family, we should look at this component in more detail.

From Table 13 it can be seen that, for the three villages as a whole the average hours per male adult was about 1160 hours per year, spread over a period of 230 days.

Table 13. Estimate of average time worked per male adult by village.

Variable Specification	Bishi	Nasarawa	Nabayi	Whole MS
Work on the family farm				
Hours per day				
Travel time included[a]	6.08	5.39	5.36	5.61
Travel time excluded	5.18	4.44	4.41	4.68
Hours				
Travel time included	762.69	787.00	702.58	750.76
Travel time excluded	650.10	648.50	578.07	625.56
Days	125.50	145.98	131.17	134.22
Off-farm work				
Hours per day	4.81	4.40	3.44	4.22
Hours	485.85	348.08	380.87	404.93
Day	101.06	79.17	110.61	96.95
Total Work				
Hours	1248.54	1135.08	1083.45	1155.69
Days	226.56	225.15	241.78	231.16

[a]Calculated on the basis of the number of field visits, the distance from the compound for 50 percent of the acreage of the village and an assumed walking rate of 1.5 mph.

Male adult monthly labor distribution

Due to the seasonality of farming, the male adult labor input showed great monthly variation. Of particular importance and interest would be the comparison between input during June to August and the dry season period of December to March. Male adults worked an average of about 17 days per month during the peak period of June to August but only an average of 4 1/2 days a month during December to March (Table 14). They also worked 5.1 hours a day for the peak period compared to 3.6 hours per day during December to March. The percentage of total work done on the family farm was highest at 74.5 during the month of July and lowest at 25.8 during the month of

Table 14. Monthly labor distribution per male adult for farm and off-farm occupations

Variable Specification	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Days worked:													
On family farm	134.42	12.31	15.02	16.10	19.00	15.68	14.93	10.15	13.07	5.76	3.71	3.14	5.55
Off-farm Occupations	96.24	8.22	5.68	5.89	6.50	6.66	7.38	9.53	8.72	10.07	10.68	8.79	8.12
Total on and off farm	230.66	20.53	20.70	21.99	25.50	22.34	22.31	19.68	21.79	15.83	14.39	11.93	13.67
Percentage of work on family farm	58.28	59.93	72.55	73.22	74.50	70.19	66.93	51.60	59.97	36.38	25.79	26.36	40.58
Hours worked on family farm[a]	4.67	4.24	4.87	4.94	5.31	5.00	4.98	4.40	4.56	3.40	3.92	3.28	3.72
Off-farm occupations	4.22	4.10	4.38	4.42	4.52	4.12	3.76	4.28	4.20	3.91	4.25	4.31	4.52

[a]This excludes time spent walking to and from the field at the beginning and end of the day.

January, further highlighting the seasonlity effect. For the master sample as a whole there is a negative (significant at the five percent level) correlation coefficient of -0.7996 between days worked per month by male adults on the family farm and on off-farm occupations. When disaggregated by village, however, this correlation was found to be positive for the village of Nasarawa at 0.3879 but not significant. The possible explanation could be due to Nasarawa's comparatively large amount of fadama land and its remoteness in terms of accessability, thus, limiting available off-farm occupations.

Composition of off-farm employment

Since, as we have seen above, a substantial part of work-time is carried out in off-farm employment, this deserves a closer look. This is done here by categorization into two major sectors: traditional and modern. The former refers to "jobs that are fairly independent of the development process, i.e. jobs that have been existing for generations" (Norman et al, 1976) in contrast to jobs in the modern sector which opened up due to improved communications and the sprouting up of large cities, commercial enterprises and government. For the master sample as a whole, only 8.7 percent of the number of days worked was devoted to the modern sector. These percentages for the three villages were 10.7, 5.3 and 9.3 for Bishi, Nasarawa and Nabayi respectively. The value for Nasarawa was so low because of its relative lack of access and isolation. The low proportion of days worked in the modern sector further emphasizes the role of traditional approaches in most aspects of living in the area.

Within the traditional sector most of the days spent by male adults were devoted to traditional services like building houses, rumbuna (storage bins) digging and repairing wells and acting as butchers, musicians, Koranic teachers, bankers (moneylenders) etc. In Bishi this accounted for 53.6 percent of total number of days on off-farm work. In Nasarawa and Nabayi the figures were 45.47 and 19.47 percent, respectively. The relatively low figure for Nabayi could be accounted for partly by ownership of cattle which was highest in Nabayi and so being a very demanding job occupied a large proportion of time devoted to off-farm employment leaving less for the services.[1]

The degree of emphasis by village on off-farm employment showed the male adults in Nabayi spent on the average 31 days more and in Bishi 21 days more than in Nasarawa where fadama land allows dry season cultivation (Table 15).

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[1]Cattle herding in this study is considered as an off-farm operation.

Non-family labor

From Table 10 it is observed that non-family or hired labor contributed only about 12 percent of total labor on the farm. This is small compared to figures elsewhere (the U.S. for example) as well as other areas of northern Nigeria. However, non-family labor almost equaled the combined female adult and large culdren's contribution to total labor (Table 11). An examination of the amount of hired labor in relation to farm size shows that there is apositive correlation coefficient that is significantly different from zero for Bishi and Nasarawa. This relationship is not significant for Nabayi village (Table 17).

Table 16. Correlation coefficients between farm size and man-hours of hired labor.

Village	Correlation coefficient between man-hours of hired labor and farm size	
	Total acres	Cultivated acres
Bishi	0.57*	0.61*
Nasarawa	0.50*	0.38*
Nabayi	0.05	0.17
Whole MS	0.18*	0.39*

* Significantly different from zero at the five percent level.

That the relationship was not significant in the case of Nabayi Village could be partly explained by the shorter growing season in Nabayi and thus a shorter and more intense labor peak demand period

making most people work on their farms. Without a class of landless laborers there could only be very little differential in hiring labor between small and large farms.

Types of Non-Family Labor

The three types of non-family labor used in the study area are Kwadago, Jinga and Gayya. These terms are defined in Table 9 footnote. Strictly speaking, only the first two could be considered as hired labor in the normal sense of the term. The third one, Gayya has social connotations that go beyond normal market transactions.

In terms of man-hours employed Gayya came first with 108.22 hours per year followed distantly by Kwadago and Jinga with 37.94 and 22.29 man-hours respectively (Table 9). Likewise, 61 percent of non-family labor used by an average family in the area was made up of Gayya labor (Table 17).

Table 17. Different types of non-family labor used by an average family.

Type of Labor	Man-Days	Percent of total days non-family labor used	Man-hours per day[a]	Wages (Sh)[b] per	
				Man-day	Man-hour
Kwadago	7.64	24.78	4.97	2.47	0.50
Jinga	4.33	14.05	5.15	3.96	0.77
Gayya	18.86	61.17	5.74	0.72	0.13
Whole MS	30.83	100.00	5.46	1.61	0.29

[a]Excludes time travelling to and from field at the beginning and end of day.

[b]Sh stands for Nigerian shilling which would be about 16 cents.

Comparing the working day for jinga and Kwadago reveals that jinga workers put in a slightly longer working day than those employed under Kwadago. This is probably due to the pay by the job system used in jinga (Table 17). It is interesting also to note that Gayya labor showed the longest working day at 5.74 man-hours per day. This is contrary to findings in other areas of Northern Nigeria like Sokoto where Norman et al (1976) found that the length of the work day was shortest for Gayya, the communal labor.

The overall dominance of gayya is clear as a major source of non-family labor. The other two forms of non-family labor although lagging behind gayya, have been observed to be increasing in relative importance due to the population pressure and the modernization process.

The significance of Kwadago and jinga in Nabayi probably reflect the environmental urgency to do a lot of work concentrated in a short period of time. This means monetary remuneration had to be offered.

The difference in wage rates for all non-family labor in the villages could be taken to indicate the relative importance of the different types of non-family labor and the condition of the supply and demand for non-family labor in each village. In Bishi the predominance of gayya type, with its lower remuneration had led to an overall low wage rate (Tables 18, 19).

Table 18. Amount and type of non-family labor used and remuneration paid by an average household by village.

Village	Total Man-days	Percent of total days			Man-hours per day	Wage (sh[a]) per	
		Kwadago	Jinga	Gayya		Man-day	Man-hour
Bishi	55.80	8.89	16.34	74.77	5.68	1.36	0.24
Nasarawa	20.59	41.40	6.30	52.30	5.90	1.77	0.30
Nabayi	14.94	63.95	15.28	20.77	4.05	2.35	0.58

[a]See footnote b, Table 17.

Most of the hired labor was undertaken by male adults. It has similar fluctuation to that shown for family male adults, i.e. with peak during the rainy season and decline during the dry season. The work day for hired labor is also longer during the rainy season than during the dry season (Table 19).

Due to the fluctuations in labor utilization and the lack of a class of landless laborers, one would expect wage rates to fluctuate seasonally. A look at Table 19 shows there was little fluctuation in wage rate throughout the year leading to the conclusion that wage rates were probably institutionally determined.

Capital Goods

In the survey villages, as in most areas with nearly traditional agriculture, land and labor form the major inputs. Investments in agriculture are generally low and even then are mainly labor-derived ones like hand-made granaries, wells, and simple tools. Mellor (1963 and 1966) explained the situation by pointing out that low incomes derived from farming lead to low abilities to save and that the low

Table 19. Details of non-family labor used by an average household by month.

Variable specification	Type of labor	MS Average	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Man-days	Kwadago	7.64	0.18	0.89	0.62	1.67	0.96	0.72	1.23	1.23	0.12	0.02	0.00	0.00
	Jinga	4.33	0.13	0.34	0.39	1.08	0.78	0.82	0.40	0.28	0.10	0.00	0.00	0.01
	Gayya	18.86	0.31	0.28	0.30	1.86	1.17	3.02	1.27	5.12	3.01	2.47	0.00	0.05
	Combined	30.83	0.62	1.51	1.31	4.61	2.91	4.56	2.90	6.63	3.23	2.49	0.00	0.06
Hours worked per day	Combined	5.46	4.08	5.01	4.72	5.52	4.83	5.97	5.27	5.90	5.32	5.47	0.00	3.50
Man-days	Kwadago + Jinga	11.97	0.31	1.23	1.01	2.75	1.74	1.54	1.63	1.51	0.22	0.02	0.00	0.01
Average wage (Sh). per Man-hour	Kwadago + Jinga	0.60	0.57	0.53	0.64	0.66	0.79	0.69	0.53	0.29	0.27	0.63	0.00	1.00

incomes are due to low productivity which in turn is due to low capital investment. Thus, the low productivity trap is completed. To break this cycle, farmers have to borrow from local moneylenders with all the problems and costs associated with such borrowing. Other alternatives include institutionalized credit unions for farmers, most of which are still on the drawing board.

Capital goods can be defined as those material economic goods other than land which are used for the production of wealth. Durable capital in this study refers to capital which lasts two or more years and necessitates the computation of depreciation as well as gives flow type services, e.g., tools that last more than two years. Non-durable capital, on the other hand contribute to production once: for example, seeds and fertilizer (ignoring soil retention and buildup).[1]

Table 20 indicates that for the master sample as a whole the average total value of durable capital goods including cattle amounted to only 419.38 shillings (about 63 dollars). If cattle is excluded the average falls to 151.10 shillings (about 22.5 dollars).

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[1]It is understood that this definition is not adequate for all purposes, but it is adequate for this paper and is necessarily simplistic.

Table 20. Average value (shillings) of farm capital goods owned per household[a].

Village	Cattle	Livestock[b]	Tools, buildings and equipment	Total durable capital goods excluding cattle	Total durable capital goods including cattle
Bishi	589.46	89.12	59.50	148.62	738.08
Nasarawa	--	136.65	74.74	211.39	211.39
Nabayi	194.87	46.97	49.47	96.44	291.31
MS Average	268.78	90.11	60.99	151.10	419.88

[a]Land has not been valued as a capital good since it is a communal asset to which only usufructory rights are obtained.

[b]Excluding cattle.

Bishi had the highest value for average durable capital goods at 738 shillings followed by Nabayi with 291 shillings and Nasarawa with 211 shillings. The value for Nasarawa is low because there was no cattle ownership in the village whereas for the other two villages the cattle contributed a lot to their higher investment figures. Even though households do not own cattle, Nasarawa had the highest average non-cattle capital.

For the study area as a whole, average expenditure on both durable and non-durable capital goods was low. It was found to average 117 shillings (about 17.5 dollars). Most of the capital expenditure was on non-durable capital, specifically manure and seeds which accounted for almost 73 percent of the expenditure on capital goods (Table 21).

Table 21. Average imputed expenditure (shillings/household) on capital goods[a].

Village	Durable capital	Non-durable capital			Total
		Manure	Seeds	Total	
Bishi	29.80	41.56	36.23	77.79	107.59
Nasarawa	34.83	52.16	76.49	128.65	163.49
Nabayi	30.04	22.94	27.06	50.00	80.04
Total MS	31.56	38.89	46.59	85.48	117.04

[a]Durable capital is composed of purchases and repairs of tools, equipment and buildings and a decrease in inventory during the survey year. The values do not include livestock.

CHAPTER IV

DATA ANALYSIS

Analytical Tools Used

To test the hypotheses stated earlier the analytical tools used are regression analysis (simple and multiple) and basic linear programming. We will first discuss the basic theory of regression analysis and then present results obtained using it. Secondly, we will discuss linear programming and similarly present the results obtained.

Regression Analysis

Regression analysis is a statistical tool which utilizes the relation between two or more quantitative variables so that one variable can be predicted from the other or others [Neter and Wasserman, p. 21]. When a single predictor or independent variable is involved, then the regression procedure is termed simple regression. When more than one independent variable is included, the procedure is called multiple regression.

Regression analysis gives only the tendency for one variable (the dependent) to vary in systematic manner with one or more other variables. Since the relation is statistical as opposed to mathematical, there is no complete determination of the relationship. But it is possible to estimate the probabilities of the coefficients falling within certain ranges. The estimates of the coefficients are tested against null hypotheses. The standard error of the regression coefficients with the associated t-values are examined for

significant difference from zero at chosen percent levels.[1]

Relationship between labor input per cultivated acre and farm size.

The relationship between labor input per acre and the size of the farm is of great interest in an economy where the two inputs, land and labor, are the main factors of production. The direction of the relationship, whether negative or positive, is likely to have an impact on adoption of new technologies, especiably those that depend on expanding the size of the farm. If labor input per acre is negatively related to farm size then this could either point towards the existence of "economies to scale" or else the inability to get the required amount of labor to use per acre for optimal production. The latter investigation will be necessarily left to a later study. Here, the hypothesis to be tested is that labor input per acre is negatively related to the size of the farm.

The regression function found most satisfactory to estimate the relationship between intensity of labor use and measures of farm size was:[2]

$$Y = a + b \log X$$

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[1]The choice of significance level to test the hypotheses in this paper took into account the subjective prior probabilities of the hypotheses and the alternatives. For a discussion of choice of significance levels see Mandercheid (1965).

[2]However, before deciding on the above specification for the function, others were tried and found less satisfactory. Among those tried were:

$$Y = a + bX$$
$$\log Y = a + b \log X$$
$$\log Y = a + b X^2$$
$$\log Y = a + b \log X + c \log X$$

where Y = measure of labor input specified as

(a) total man - hours per cultivated acre

(b) Family man-hours per cultivated acre

(c) Non-family man-hours per cultivated acre

(d) Man-hours per acre on cultivated gona

(e) Man-hours per acre on cultivated fadama

and X = Number of acres cultivated by the household.

From the functional form one can deduce that it is asymptotic on both the X and the Y axes. The function, to be appropriate, requires all values of X to be greater than or equal to zero. The data meets this requirement since the range of farm size is 1.41 - 19.03 acres. Thus besides giving most satisfactory fit, it is also theoretically consistent with the data. The results obtained using the function are shown in Table 22.

The results indicate that there is a significant negative relationship between the total man-hours used per cultivated acre and the size of the farm in acres. The larger the size of the farm the smaller will be the labor input per acre. This implies that larger farms are farmed less intensively than smaller ones. The same result was obtained when family man-hours per acre were used as the dependent variable instead of total man-hours per acre.

Of greater interest, however, is the fact that the above also held true when hours of hired (non-family) labor per acre were used. This implies that owners of large farms who hire labor were unable or chose not to obtain the necessary hired labor, for one reason or the

Table 22. The relationship between labor input per acre and farm size[a]

Variable		Sample Size	Estimating Equation					
Y	X		Constant	Coefficient	Standard Error	t-value	R	S_{yx}
Total man-hours/ cultivated acre	Nos. of cult. acres	116	400.9116	-230.7241	39.0775	-5.9043*	0.4839	121.2202
Family man-hours/ cultivated acre	Nos. of cult. acres	116	329.2814	-174.1194	31.8117	-5.4734*	0.4562	98.6813
Non-family man-hours per cultivated acre	Nos. of cult. acres	95	91.6948	- 73.3388	24.7115	-2.9678*	0.2941	70.6346
Man-hours/acre on cultivated gona	Nos. of cult. acres	116	356.6530	-191.9895	35.9909	-5.3344*	0.4469	111.6454
Man-hours/acre on cultivated fadama	Nos. of cult. acres	23	2833.737	-2215.715	1850.3999	-1.1974	0.2528	2819.9881

*Significantly different from zero at the five percent level

[a]Households with no figures for the Y or X were excluded from the estimation

other to maintain the level of intensification.[1] The results could also be indicative that larger farms are more efficient in using labor. However, it is not the intention here to give a definitive explanation of the differential in intensity of labor use between small and large farms. Further work is needed first.

Man-hours per acre on cultivated fadama does not show a significant difference from zero for this relationship. This could be explained by looking at the nature of types of crops grown on the fadama land. Most of them are labor intensive crops deserving a lot of attention and care throughout their growth cycle, e.g. rice, sugarcane and onions. This could explain why a reduction of intensification was not possible if reasonable crop yields were to be ensured. Furthermore, the sample size is comparatively small (n=23).

The next regression function run was to identify the determinants of labor input by family members on the family farm. In particular, this run tests the hypothesis that hired labor is a substitute for family labor. If the hypothesis is maintained one expects the value of the coefficient relating the two types of labor to be negative. The results are shown in Table 23.

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[1] One explanation for this could be the absence of a class of landless laborers to work on farms coupled with the fact that demand for hired labor is highest during the peak labor demand period of June-July-August when most people who hire themselves out (part-time) also have to work on their farms.

Table 23. Determinants of Labor Input by Family Members on the Family Farm

Variable					Variable				
Dependent	Independent	Partial Regression Coefficient	Standard Error	t-value	Dependent	Independent	Partial Regression Coefficient	Standard	t-value
Y					Y				
	Constant	13.8337	513.1274			Constant	-12.4818	579.9426	
	X_1	0.1670	0.2074	0.8052		X_1	0.5097	0.2248	2.2674*
	X_2	80.0006	18.6550	4.2884*		X_2	152.5713	17.6002	8.6687*
	X_3	98.3079	16.1940	6.0706*		X_4	89.9949	42.2840	2.1283*
	$R = 0.7656^*$	$R^2 = .5861$				$R = 0.6865^*$	$R^2 = .4715$		

*Significantly different from zero at the 5 percent level, Sample size = 116.

Key to variables:

Y = Number of man-hours worked by family members on the family farm

X_1 = Number of man-hours non-family (hired) labor worked on the family farm

X_2 = Size of family

X_3 = Number of acres cultivated by the family

X_4 = Land per resident

The results indicate 58 percent of the variation in the number of man-hours worked by the family members on the family farm was explained by the number of man-hours hired labor worked on the family farm, the size of the family and the number of acres cultivated by the family.

The coefficient of hired labor is 0.1670 with a standard error of 0.2074. It is not significantly different from zero. This sign is unexpected since it is expect from theoretical foreknowledge that the relation between family labor input on the family farm and the amount of hired labor for the family farm to be negatively related. The result indicates hired labor complements family labor.

The other two variables, family size and number of cultivated acres in the first regression equation have the expected signs and are both significantly different from zero at the five percent level. The larger the size of the family the larger the potential labor input by the family, everything being equal. Also the larger the size of the family farm the more the time expected to be devoted to farm work. This is reflected by the positive relationship observed (Table 23).

Another equation was run to identify the factors that determine the amount of work undertaken by non-family labor on the family farm. The results (Table 24) indicate that the number of man-days worked by family members at other occupations and the number of acres cultivated by the family are significant factors. The size of family turned out to be not a significant factor. However R^2 turned out to be small ($R^2 = .22$) indicating that the factors explain only about 22 percent of the observed variation. This is not entirely surprising since

hiring of labor in the study area appears to be a complex process influenced not only by the factors above but others that seem unrelated to them, like sickness, widowship, the wealth position of the family and individuals. This aspect needs further investigation, especially the gayya system.

Table 24. Determinants of Work by Non-family Labor on the Family Farm.

Variable		Partial Regression Coefficient	Standard Error	t-value
Dependent	Independent			
Y	Constant	-58.5922		
	X_1	0.5117	0.1820	2.8122*
	X_2	-0.1410	8.4318	0.0167
	X_3	21.5068	6.8393	3.1446*
	R^2 = .22 Syx = 225.9316			

* Significantly different from zero at the five percent level.

Key to variables:

Y = Number of man-hours non-family labor worked on family farm.

X_1 = Number of man-days worked by family members at other occupations.

X_2 = Size of family.

X_3 = Number of acres cultivated by the family.

The last regression problem looked at was that of the determinants of the amount of work undertaken by male adults (most important source of work) on the family farm. Results indicate again the overall importance of the farm-size in acres and, of course, here the number of male adults in the family as major determinants of male adult labor input on family farm. The results also show that there is a negative relationship between the amount of male adult labor and that of the hired or non-family labor on the family farm. This stated in other words means that the two forms of labor substitute for one another. However, the relationship was not significant at 5 percent level (Table 25).

Table 25. Determinants of the amount of work done by male adults on the family farm.

Variable Dependent	Independent	Partial regression coefficient	Standard error	t-value
Y	Constant	152.1066	61.28	
	X_1	-37.6310	7.7123	-4.8794*
	X_2	- 0.0305	0.0248	-1.2341
	X_3	8.5927	1.8485	4.6485*

*Significantly different from zero at the five percent level.

Key to variables:

Y = Number of days worked per male adult on the family farm.

X_1 = Number of male adults in the family.

X_2 = Number of man-hours non-family labor worked on the family farm.

X_3 = Number of acres cultivated by the family.

It is also to be noted that there is a negative relation between the labor input per male adult and the number of male adults in the family. The more the male adults for a given family the less the labor input per male adult. The latter implies some form of work sharing, or else indicates an attitude of "let my brother do it."

The implications of these results will be discussed later.

Linear Programming

This section on linear programming was mainly included to demonstrate its application in determining critical constraints that face the small farmer given the resource level at his disposal during a given production period. Thus, the analysis used here is mainly static analysis (modifications, however, could be included to account for time horizon). I am interested in the determination of the months during which the farmer is faced with a labor constraint. This is of particular importance in the development economics literature where various hypotheses have been put forward as to the nature of agricultural labor supply and its marginal productivity on the farm. Some researchers [Lewis, 1954] have hypothesized that labor in agriculture has a zero marginal product and could be withdrawn from the sector without affecting the level of output. Other researchers have argued that the marginal product of labor in traditional agriculture is positive but very small. In fact, there are all shades of values asserted to the value of labor's marginal product.

The basic linear programming model can be stated as

$$\text{Maximize} \qquad G = \sum_{i=1}^{n} c_j x_j$$

$$\text{Subject to} \qquad a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \leq b_2$$

$$\vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \ldots \quad a_{mn}x_n \leq b_m$$

$$\text{and,} \qquad x_1 \geq 0, \quad x_2 \geq 0, \quad \ldots, \quad x_n \geq 0$$

The c_j's, the a_{ij}'s and the b_i's are constants. The formulation indicates that the problem is that of maximizing a linear function, called the objective function, under given linear constraints, often in production application referred to as resource constraints.

The x_j's represent levels of the decision variables. Although the c_j's, a_{ij}'s and b_i's are all constants which can be positive, negative or zero and have specific interpretations. The b_i's represent the amount of the ith resource available for allocation to alternative decision uses. The aij's represent the amount of the i'th resource required for the production of a unit of the jth activity. G represents the overall desirability or effectiveness of different activity combinations while the cj's represent increases in G that would result from unit increases in the associated x_j's.

The general approach in similar studies is to use profit maximization as the objective function. This approach is relevant in these cases where farmers are mainly commercial and have profit maximization

as their sole aim. In the area studied in this paper there are other objectives besides getting the highest net returns. For example, it has been established that the farmers are interested in particular consumption habits, producing particular crops and livestock rather than others; as a starting point, they endeavor to produce enough food for the family. Other factors that should be taken into account include the prevalence of mixed cropping in the study area--over 50 percent of the cropped acres were under mised crops, i.e. two or more crops growing on the same piece of land at a given time.

We found that we could not ignore these factors but could not take into account all of them either. We used maximization of gross income as the objective function but, in the allocation of activities and constraints took into account the production of the commonest crop mixtures in the area. To be more realistic we also subjectively restrained the growing of cassava which, although having high returns per acre, has peculiar production problems, e.g. being perennial and requiring the fencing of land to ward off animals from the crop all year round. This does not seriously impair the analysis since it is only grown on about 2 percent of the cropped acres.

Other Restrictions

We have used two types of land, the gona type with a maximum of 9.32 acres and the fadama type with a maximum of .39 acres. We did not incorporate the hiring in or out of land because earlier runs indicated land was not a limiting factor. This also simplified the model.

The capital restrictions are derived from the imputed cost of seeds and fertilizer (mainly animal manure). The coefficients for each crop enterprise labor requirement are attached in the appendix. The maximum amount of labor available is restricted to the maximum average hours worked during the peak labor demand month of July at 161.03 man-hours per month.

Figures are not available in this study for differential management ability, so it is not explicitly considered.

Activities

The production activities are comprised of nine crop mixtures and four sole crops most commonly grown in the area. Table 26 shows the enterprises considered and the percentage of total common crop acres devoted to sole and crop mixtures. The crop mixtures in the list are denoted by naming the crops in the mixture. We have considered only up to three-crop mixtures in LP run.

Table 26. Percentage of total crop acres devoted to sole and mixed crops (Survey results)

Number of Crops	Percentage of cultivated total crop acres
1	46.18
2	37.10
3	13.36
4	2.95
5	0.41

List of Crop Enterprises

Millet

Sorghum (guinea corn)

Ground nuts

Millet/sorghum

Millet/groundnuts

Sorghum/groundnuts

Sorghum/cowpeas

Groundnuts/cowpeas

Millet/sorghum/groundnuts

Millet/sorghum/cowpeas

Sorghum/groundnuts/cowpeas

Rice

Sugar

The results in Table 27 and Table 28 indicate that all the crops that entered the solution were in the form of mixture with two-crop mixtures taking up 8/9 and a three crop mixture taking up the other one.ninth. The gross revenue was low at 769.89 shillings and an average return per cultivated acre of 148.06 shillings. This is an indication of the low returns obtained in agriculture within the study area. Indeed, returns per acre of up to 279 shillings have been reported elsewhere (Ogungowors, 1972).

Table 27. Optimum farm plan and shadow prices

Activity	Acres
Millet	---
Sorghum	---
Groundnuts	---
Millet/Sorghum	2.71
Millet/groundnuts	---
Sorghum/groundnuts	---
Sorghum/cowpeas	1.89
Groundnuts/cowpeas	---
Millet/sorghum/groundnuts	---
Millet/sorghum/cowpeas	0.61
Sorghum/groundnuts/cowpeas	---
Rice	---
Sugar	---
Labor shadow Prices (shillings)	
May labor	1.10
June labor	0.60
July labor	3.08

Table 28. Summary of resources used and returns to the inputs

Variable Specifications	Shillings (or acres)
Gross revenue	769.89
Total acres cultivated	5.21
Total fallow (acres)	4.11
Gross return/man-hour	0.29
Gross return/acre	148.06
Capital used	8.29
Average shadow price of labor May-July	1.59

The results of the LP optimal plan show that the existence of 46 percent of crop acreage under sole cropping deviates from income maximization since no sole crop entered the final LP solution. But, since it has been pointed out that security of food production is important in the area this is not entirely surprising. The 46 percent of acreage was planted with millet, the most drought-resistant grain crop in the area.

In the LP solution, there is a high percentage of land left fallow (44 percent). This is a fairly good approximation to the 34 percent fallow land found actually in the area during the survey for this study. It also indicates that farmers may be cultivating more land than would be necessary for optimum allocation.

The return to man-hour of labor at 0.29 shillings is surprisingly the same as the average wage rate per man-hour found in the survey indicating that farmers were rational in the payment offered to labor.

The existence of shadow prices for labor during the May-June-July period despite slacks in other months indicates the shortage of this input during the peak demand period of sowing and early weeding and cultivation. Furthermore, these shadow prices were very high, indicating that the farmer could increase gross income by putting in more labor during the period. This conclusion is supported by evidence that during the period a sort of general mobilization of labor is in force for farm work. Even women and children participate in some farm activity at the time. However, there is still room for employment of labor at a benefit to the farmer if he could afford it. Unfortunately, it is during this period that cash on hand for the farmers is at its lowest. The latter together with the problem of getting laborers during this time enhances the bottleneck. Thus, we are faced with the irony of excess labor during a greater part of the year (often reduced by some level of off-farm employment and cin rani)[1] and shortage of labor during most of the short growing season.

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[1] cin rani, temporary dry-season migration is not common in Bauchi, unlike in Sokoto and Katsina areas, further north.

CHAPTER V

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

Summary and Conclusions

The paper has looked at small farmer agriculture in three villages of northern Nigeria. We realize the importance of the small farmers in Nigeria's agricultural sector and hence in the overall economic and social development. Agricultural revenues although lower are not as transient as the oil revenues.

Details of small farmer operations as to the utilization of labor, particularly the predominant family labor has been investigated as well as the use of land and capital. A wide variety of data that could be used as a basis for further research as well as guidance in implementing agricultural extension programs has been presented. The latter is justified because much-needed data on small-farmer operations is lacking.

Hypotheses concerning labor utilization have been tested particularly as to the limitation in labor available during some months of the year and the determinants of the amount of work on the family farm. The method of analysis used was a combination of regression analysis and static linear programming. The hypothesis that labor input per acre is inversely related to farm size was maintained. This indicates that intensity of labor use is reduced as farm size increases. This result applies to gona farms only since when fadama acreage was used the hypothesis was rejected (Table 22).

The hypothesis that hired labor is a substitute for family labor was rejected. It was found that hired labor complements family labor,

but the relationship was not significant at the 5 percent level.

The occurrence of work-sharing among family male adults, so that the larger the number of male adults in the family the less each one works on the farm is also maintained.

The results of the LP runs support the hypothesis that there is a labor bottleneck period when it pays the farmer to employ labor at a higher wage rate than the average ongoing wage rate at the time. The LP results also support the hypothesis that leaving some resources idle (particularly land), even under optimum allocation, given the resource constraints is not irrational.

The hypothesis that mixed cropping is consistent with the goals of income maximization is supported by the LP results. In fact all the crop enterprises that entered the final LP solution were mixed crops.

Policy Implications

It is realized that there is a problem in prescribing policy palliatives from an analysis like this one. In the first place, there are problems with the data collection methodology, especially as to the village selection, as well as the simplification and aggregation of the data for the purpose of analysis. There is also the question of meeting the assumptions of the models used, for example, the assumption of perfect complementarity and linearity in the LP formulation. Also 10 years have passed since the data was collected. Nevertheless the results are sufficiently indicative of the direction policy measures should proceed.

The results indicate that very little hope exists for improving the incomes of the small farmers to a large extent through mere reallocation of existing resources under the local technology. There is also the irony of having excess of labor over the greater part of the year and its shortage during the labor bottleneck period of May-July. As I see it, the key to improving the income of farmers in the area lies in developing new technologies that take into account the realities of agricultural production in the area.

The presence of the peak labor demand period with labor commanding high shadow prices indicate that a form of credit scheme should be established to raise the level of cash on hand available to farmers during that period.[1] Since we have noted that a class of landless workers is not apparent, the credit scheme alone may not alleviate the shortage of on-farm labor, without coupling it to some form of tractor-hiring scheme.[2]

Since the limitation of the indigenous technology in improving incomes is immense, thre is need to increase efforts at making available to the farmer an improved package that fits into the farmers socio-economic environment. One possibility is for crops with different labor requirement distribution so as to offset a heavy demand for labor during a short period.

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[1]The possibility of workers migrating from other parts of the country with a different timing of the rainy season is worth investigating.

[2]Care has to be taken as to the ramifications of mechanization without detailed analysis of its effects on employment and income distribution.

The emphasis on sole cropping in research institutes needs to be reoriented towards mixed cropping, sole cropping being very limited in the area. This, if carried out, will be more relevant to most of the area of northern Nigeria. Various studies (Abalu, 1976; Andrews, 1972, 1974; Baker and Yusuf, 1976; Dalrymple, 1970; Institute for Agricultural Research, 1972; Norman, 1967-72; Norman et al., 1976) have pointed out the advantages of mixed cropping, particularly risk reduction,more efficient use of labor, pest control and maintenance of soil fertility.

Finally there is an urgent need for policy makers to look into ways of creating employment opportunities for labor during the long dry season.

Small farms and the small farmers are likely to be around in the area for a long time. There is an increasing demand on them to produce more both for subsistence needs as well as to produce surplus for the urban working class which is growing larger year by year. Research into the detailed economic and social environment of these farmers should continue so that effective measures could be devised to improve the lot of the areas' majority of the population.

Concluding Remarks

The model used in this study has many limitations some of which have already been discussed earlier. The t-tests used in the regression analysis assume that errors are normally distributed, but this assumption is not entirely met and hence the tests are only approximate.

Furthermore, it probably would have been more accurate to use simultaneous equation model to test those hypotheses relating to labor use instead of the separate models used in this study.

Further research is still needed on mixed cropping and on the role and details of non-family labor, particularly the social and economic aspects of gayya.

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APPENDIX I
Tableaux of Coefficients Used in LP Problem*

	RHS	MILLET	SOR	G/NUTS	CASSA	MIL/SOR	MIL/GN	SOR/GN	SOR/PEAS	GN/PEAS	M/S/GN	M/S/CP	S/GN/CP	RICE	SUGAR
OBJFUNC		105.25	129.06	99.97		168.16	55.96	139.99	119.88	54.43	161.26	143.36	123.74	219.98	85.50
GONA	9.32	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
FADAMA	0.39													1.0	1.0
CAPITAL	64.48	0.8	1.92			1.79	9.82	10.33	--	--	9.81	5.61	--	--	--
LAB-JAN	161.03	0.0	3.14	--		2.08	9.57	2.35	2.09	--	0.87	13.21	--	--	86.55
LAB-FEB	161.03	0.0	0.43	--		0.36	39.36	--	0.84	--	0.15	0.7	--	--	99.25
LAB-MAR	161.03	1.23	4.2	.82		4.3	16.26	--	2.71	--	2.43	3.96	--	6.6	87.93
LAB-APR	161.03	14.68	20.72	14.3		21.68	28.57	16.92	22.9	1.0	32.45	21.29	12.21	6.78	15.28
LAB-MAY	161.03	14.04	28.82	7.27		33.32	55.03	23.42	20.99	93.29	43.38	50.74	32.39	10.98	4.35
LAB-JUN	161.03	23.15	28.12	32.54		28.95	45.48	14.29	37.47	7.1	47.96	19.30	25.7	18.79	--
LAB-JUL	161.03	30.44	41.81	61.01		37.05	37.90	47.72	24.11	150.29	32.16	24.66	32.14	98.8	82.61
LAB-AUG	161.03	20.08	25.74	58.48		31.60	24.39	19.51	22.77	33.39	35.27	35.09	28.16	66.89	178.14
LAB-SEP	161.03	22.30	34.10	24.17		30.38	45.74	8.18	19.98	30.93	32.39	41.19	31.94	34.94	60.38
LAB-OCT	161.03	2.75	11.92	44.57		11.52	2.39	25.29	10.34	72.15	24.65	11.52	14.06	8.73	82.61
LAB-NOV	161.03	4.77	33.31	56.1		32.89	1.06	32.86	12.89	54.48	39.32	48.62	31.76	22.03	8.33
LAB-DEC	161.03	2.17	9.29	--		2.52	--	6.41	14.51	17.68	8.65	13.17	26.13	1.56	8.33

* The figures for cassava were removed due to the peculiarities associated with cassava as described in the text (page 45).

RHS = level of resources available

OBJFUNC = Objective function = gross margin

APPENDIX II

Location of study villages in Bauchi Province