AFRICAN RURAL EMPLOYMENT STUDY

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ECONOMIC ANALYSIS OF AGRICULTURAL PRODUCTION AND LABOUR UTILIZATION AMONG THE HAUSA IN THE NORTH OF NIGERIA

by

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THE AFRICAN RURAL EMPLOYMENT STUDY

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Table of Contents

I. INTRODUCTION

Much of the area farmed by the Hausa and settled Fulani in the northern part of Nigeria lies in the Sudan and Guinea ecological zones [Keay, 1959]. The case study presented here examines in some detail the farming practices and production of Moslem farmers in the Zaria area which is situated in the northern part of the Guinea zone. Through the empirical description and analysis of the present situation, an attempt is made to suggest factors that would need to be taken into account if change to a less traditionally orientated system of agriculture were to be successfully introduced.

The Zaria area[1/] is characterized by a predominately granite basement complex covered by loess. The land is generally a gently undulating plain at an altitude of 2,000 to 3,000 feet with some broad valleys and isolated hills. Leached ferruginous tropical soils are typical of the upland parts while in the valleys are found poorly drained hydromorphic soils of clayey textures. The mean annual rainfall of about 43 inches which falls during the period April to October, results in a severe water deficit during the dry season and surplus during the rainy season. Mean monthly temperatures fluctuate from 72°F in January to 84°F in April [Walters, 1967]. The natural vegetation is savanna woodland which,as a result of human activities, has been largely replaced by parkland.

Agriculture forms the principle means of livelihood for 75 percent of

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[1/] Most of the information in this paragraph has been kindly supplied by K. Klinkenberg, Head of Soil Survey Section, Institute for Agricultural Research, Ahmadu Bello University, Zaria.

the working population in the Zaria area. The predominantly illiterate rural population consists of two main segments: the nomadic pastoral Fulani who roam throughout the northern part of Nigeria with their herds of cattle and the settled, primarily crop farming population of both Hausa and Fulani origins. The settled rural population lives in two distinctive settlement patterns which can be differentiated on the basis of religion. Those of the Moslem faith tend to settle in villages or well-defined hamlets while non-Moslems are usually found in single residential units often in the more isolated areas.

II. ORGANISATION OF THE STUDY

Although much has been written about traditional agriculture there is a lack of micro-economic studies to guide policymakers and change agents. The central premise of this paper is that an understanding of present production processes and decision behaviour in traditional agriculture can be of paramount importance in determining the relevance, practicality and potential success of a change or innovation.

This case study, therefore, proposes to:

i. Describe present day traditional farming in the Zaria area both in terms of inputs and outputs.

ii. Interpret the empirical data and test various hypotheses regarding the present situation, i.e., the influence of external factors such as the goals underlying the farmers' actions, particularly profit maximisation and security.

iii. Derive from the descriptions and analyses some implications for introducing change.

The main criteria employed in the selection of the survey villages were that they should differ in ease of communication with Zaria[2/] and that they should be representative of other villages in the same general location.[3/]

The three Moslem villages selected were: 1) Hanwa, which borders on Zaria itself, 2) Doka, which is situated about 25 miles from Zaria on the main Kano to Zaria road, and 3) Dan Mahawayi, which is located about 20 miles from Zaria, the last seven miles of which are motorable only during the dry season.

In order to permit a more detailed presentation of the date, the fulfillment of the first objective is largely confined to a discussion of the results derived from 42 farming families in Dan Mahawayi. To do this the families are split into two land per resident strata: 19 farming families, i.e., small farmers, with less than 1.50 acres per resident and 23 farming families with 1.50 or more acres per resident, i.e., large farmers.[4/] Clayton [1964] has suggested that this is a convenient way of

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[2/] The underlying basis for the adoption of this criterion was the concentric ring theory of von Thunen [Newman, et. al., 1954] which has been 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 nearer urban areas than those situated further away owing to greater efficiency of the factor and product markets.

[3/] The problem of representativeness of villages always arises in studies in which only a small number are sampled. However, there was no indication in the results that the villages were in any way unique compared with other villages in the same relative location. Also the lack of capital in the study area where hand farming methods are practiced means that the potential variations in resource and enterprise combinations are very limited. This simplifies considerably the problem of selecting both representative villages and farmers [Clayton, 1964].

[4/] An alternative and more conventional way of defining large and small farms is in terms of size of farm. However, the correlation coefficients between farm land per resident and size of farm for Dan Mahawayi ($r = 0.51$) and the sample as a whole ($r = 0.81$) were significantly different from zero at the five percent level, indicating a high degree of correlation.

stratifying farms where capital investment is low. In order to fulfill objectives two and three, data from the 62 farming families in the other two villages were also included. The data presented in the paper pertain to the period April 1966 to March 1967.[5/]

III. TRADITIONAL FARMING IN DAN MAHAWAYI VILLAGE

Background

The village area of Dan Mahawayi has a total population of about 1300 inhabitants. The village itself is reputed to have been founded about 150 years ago by a pagan although it is now Moslem in faith. During the laying of the Gusau to Zaria railway in 1929 the Emir of Zaria compelled villagers to help in its construction. As a result many fled into nearby Katsina Province and never returned.

The village head, as in most villages in Hausaland, still wields a great deal of influence being responsible for collecting the taxes on behalf of the local authority, allocating vacant land, witnessing other land transactions and mediating in disputes. There is little evidence of the village undergoing significant change. The relative inaccessibility of the village has been partially responsible for this. Although the market, which meets on Thursdays and Sundays, is a focal point for the surrounding rural area there was during the survey year no extension worker

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[5/] The field work initially involved a detailed enumeration of a population of about 800 people in each village, providing a frame of farming families from which samples could be drawn. Two diameter enlargements of aerial photographs at a scale 1:10,000 were used in delineating field boundaries as a result of personal visits to each field farmed by individuals included in the population enumeration. The results presented in this paper were derived from a simple random sample of 106 farming families. Each family was interviewed twice weekly during the survey year, to obtain detailed day-to-day information on farm inputs, i.e., labour, land, seeds, fertiliser, tools, animals, etc., and output, and details on marketing, off-farm activities of family members, etc. Further details on methodology are discussed elsewhere [Norman, 1972].

or primary school operating in the village. Provision of inorganic fertiliser, seed dressing and purchasing of cash crops were undertaken in a seemingly haphazard fashion by unofficial middlemen who often sold fertiliser at prices higher than the official prices and purchased cash crops at lower prices than those officially set by the marketing board.

Resource Availability and Use

Land

Land Distribution: Land, in Dan Mahawayi as in all of Nigeria, is traditionally a communal asset. Consequently, individuals have only usufructuary rights over land. In spite of this and the low population density in the village area, there is a high degree of inequality in the distribution of farm land. Fifty percent of the farmers farmed only 22 percent of the land farmed,rather than the 50 percent they would farm under conditions of perfect equality. Further evidence of this inequality is given in Table I which shows the average sizes of farms for the two land-per-resident strata.

For the village as a whole the average size of farm was almost 12 acres in size. The range was from 0.6 to 53.6 acres in size. The farms tended to be fragmented and consisted of an average of almost 7 fields which varied in size from less than 0.1 to almost 19 acres. Fragmentation tends to be accentuated by the practice of dividing each field among the heirs on the death of the family head. Although the bulk of the land is inherited it appears that more modern or "mobile" types of tenure, e.g., loan, pledge, etc., become relatively more important in the case of the smaller farmers (Table I).

Composition of Farm Land: Two types of farm land can be differentiated: the upland fields which support, during the rainy season, crops of relatively

TABLE 1. Availability of Land and Labor

Variable Specification in Terms of an Average Farming Family[a]	Dan Mahawayi[b]		Average of the Three Villages[c]
	Small Farms	Large Farms	
Farm Land Per Resident (acres)	0.8	2.7	1.3
Land:			
Farm size[d] (acres)	5.5	17.2	9.1
Composition of farm (acres):			
Upland	5.0	15.8	8.1
Lowland	0.5	1.4	1.0
Percent of acres that were:			
Inherited or a gift	71.5	82.4	75.2
More "mobile" types of tenure[e]	28.5	17.6	24.8
Labor:			
Family size[f]	6.9	6.7	8.4
Age of family head (years)	44.6	41.5	43.7
Composition of families (percent):			
Iyali	63.2	52.2	57.1
Gandu	36.8	47.8	42.9

a) In cases where variables calculated were expressed as percentages or values per unit, ratios were calculated for each stratum by dividing the sum of the values for the numerator by the sum of the values for the denominator. Ideally, the ratio should be calculated for each farming family but this considerably increases the computational burden. Where significant biases were likely to result from using the former method, the latter approach was used. Where this has been done it has been noted in a footnote.

b) The 42 families in Dan Mahawayi were divided in two strata based on farm land per resident ratios: small farmers with less than 1.50 acres per resident (n = 19) and large farmers with 1.50 acres or more per resident (n = 23). The same applies to Tables 2,3,5 and 8.

c) Each village is weighted equally. The same applies to Tables 2,3, 5 and 8. The total number of families surveyed were 106: 42 in Dan Mahawayi, 44 in Doka and 18 in Hanwa. Cattle owners in Hanwa have been excluded from the data presented in this paper.

d) A field was defined as a contiguous piece of land farmed by one family. The sum of the acreages of fields left fallow or farmed by members of the family during the survey year constituted the farm.

e) For example, land that has been obtained through renting, pledging and purchasing. The latter is in the context considered mobile since there are no titles to the land and consequently land thought to be purchased is often pledged.

f) A family was defined as "those people eating from one pot."

low value per acre such as millet, sorghum, groundnuts and cotton, and lowland fields which support, throughout the year, more labour intensive, higher value per acre crops such as sugarcane.

The possibility of year-round cultivation of the limited amounts of lowland (Table 1) should logically induce a premium on such land. However, because of the unavailability of the high labour inputs required for cultivating lowland (Figure 1), alternative employment opportunities during the dry season and the relative inaccessibility of the village, a high proportion of such land is not cultivated (Table 2).

Labour

Family Size and Organisation: The size of family varied from two to 21 persons with the average size being about seven persons. It was possible to divide families into two types of units: a simple unit or iyali which consists of an individual married adult with his wives and dependent children, and a composite unit or gandu which is composed of two or more male adults, usually married, together with their wives and children.

In Dan Mahawayi simple units were found to be more common than composite units (Table 1). Both Goddard [1969] and Buntjer [1970] have observed that traditionally the gandu was the preferred type of family organisation. Why then is it no longer most popular? One of the basic reasons lies in the fact that the gandu head has considerable authority; he supervises the farming activities on most of the fields farmed by the family[6/] and he is able to direct the family members as to what and how much work should be

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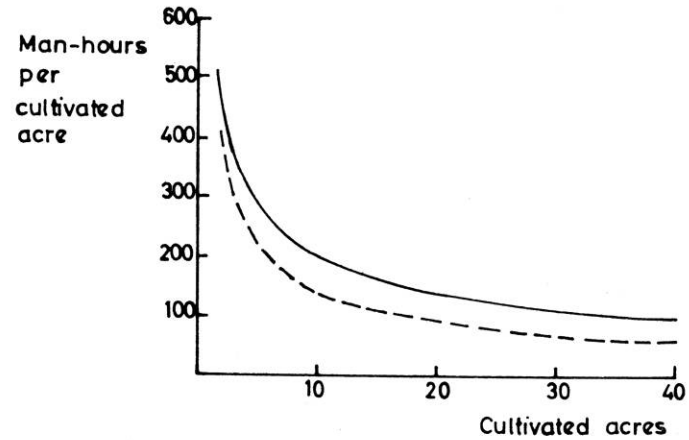
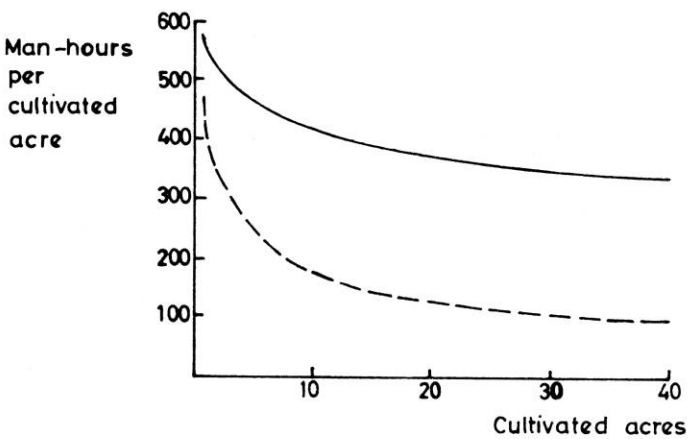
6/ Gayauna field or fields controlled by family members other than the family head accounted for less than 6 percent of the acreage of the average family farm.

Figure 1. Relationship between labour inputs and the number of cultivated acres per farm[a]





a Estimated from functions of form : log Y = a + b log X. The functions include the farmers surveyed in all three villages i.e; n = 106. Thirty four percent of the farms are less than ten acres in size.

TABLE 2. Use of Land

Variable Specification in Terms of an Average Farm	Dan Mahawayi		Average of the Three Villages
	Small Farmers	Large Farmers	
Fallow (percent)			
Total	13.0	23.4	19.8
Upland	10.3	21.6	19.7
Lowland	37.4	43.6	20.0
Adjusted[a] cultivated acres devoted to (percent):			
Cereals[b]	59.5	49.2	49.3
Grain Legumes[c]	23.4	23.8	24.7
Starchy Roots and Tubers[d]	4.7	6.5	8.2
Vegetables[e]	4.6	2.5	4.1
Surgarcane	2.7	4.1	6.9
Nonfood[f]	5.1	13.9	6.8
Cultivated acres devoted to (percent):			
Sole crops	25.8	23.1	23.3
Crop mixtures	74.2	76.9	76.7
Intercropping index[g]	2.5	2.4	2.5

a) In calculating adjusted acreage, acreage of each crop in the mixture is calculated by dividing the acreage of the crop mixture by the number of crops in the mixture. For example, a two-acre millet/sorghum mixture was recorded as one acre millet and one acre sorghum.

b) Millet, late millet, sorghum, maize, rice and iburo.

c) Groundnuts, bambara-nuts and cowpeas.

d) Cassava, Irish potatoes, sweet potatoes, yams and cocoyams.

e) Okra, onions, pumpkin, pepper, garden egg and tomatoes.

f) Henna, cotton, deccan hemp, tobacco.

g) The intercropping index is designed to measure the degree to which crops are grown in mixtures. Briefly the index is calculated for each farm by adding the acreages of each crop enterprise each of which is weighted by the number of crops in the enterprise (i.e., 1 for sole crops, 6 for six crop mixture), and dividing the sum by the total cultivated acreage. The value of the index can vary from 1 to 6 which was the maximum number of crops found in the mixture. [Norman, 1972]

done. At the same time he does have some obligations; he is responsible for providing food for the family and for paying any taxes due. However, although male adults other than the family heads have security as far as their food needs are concerned there has been, according to Buntjer [1970], an increasing tendency to resent the restrictions on freedom of action and behaviour. The gandu type of unit means that there are young married male adults who are not in a position to undertake a management role as far as farming activities are concerned. Consequently, the composite unit of family organisation seems to be in the process of being superceded by simple units although, of course, the rate and degree to which this occurs depends on a number of factors, such as availability of farm land, opportunities for off-farm employment, etc.

The increasing popularity of the simple units means that the average age of family heads is tending to decrease.[7/] According to the managerial effectiveness cycle formulated by Hedges [1963] this may, if the risk element attached to most innovations can be minimised, bring about a more favourable attitude towards improved farming methods. Under family farming conditions in traditional agriculture the bulk of the labour input and the managerial function or control of the production process is vested in one individual.

Work on the Family Farm: As would be anticipated in a society where a class of landless labourers does not exist in rural areas, most of the work undertaken on the average farm is provided from family sources although as expected, the contribution of hired labour did increase on large farms (Table 3).

[7/] The average age of a iyali head in Dan Mahawayi was 39 years old compared with an average age of 48 years old for a gandu head. Also, as would be expected, the average size of farm of an iyali was only 7.1 acres compared with 17.7 acres for a gandu.

TABLE 3. Utilization of Labor

Variable Specification in Terms of an Average Farming Family	Dan Mahawayi		Average of the Three Villages
	Small Farms	Large Farms	
Composition of Work:			
Total man-hours[a]	1036.9	1912.3	1753.3
Composition of farm work (percent of total man-hours):			
Family: Male Adults	77.4	56.4	74.6
Female Adults	0.1	0.1	0.4
Large Children	10.2	7.4	9.7
Nonfamily	12.3	36.1	15.3
Man-hours per cultivated acre:			
Total	216.0	144.9	240.2
Upland[b]	194.2	133.7	204.4
Lowland[b]	339.7	526.3	525.2
Work per family male adult[c] per annum:			
Hours per day worked[d]	4.7	5.0	5.0
Days worked:			
Family farm	146.2	136.3	141.1
Off-farm occupations	130.6	117.7	82.8
Total	276.8	254.0	223.9
Composition of work by male adults in off-farm occupations (percent):			
Traditional: Manufacturing[e]	22.6	20.3	19.1
Services[f]	41.4	39.0	31.3
Trading	35.6	34.7	22.3
Modern: Services[g]	0.4	6.0	27.3

a) The physical productivity of individuals varies according to age and sex. On the basis of this, one hour of work by different individuals was evaluated in terms of man-hours as follows: Small children 0-6 years old = 0.00, large children 7-14 years old = 0.50, male adults 15-64 = 1.00, female adults 15-64 = 0.75, and men and women 65 years old or more = 0.50. The figure does not include time spent travelling to and from the fields.

b) Does not include fields that are partly upland and partly lowland. The apparently inconsistent figures for lowland labor inputs on small and large farms is probably due to the very low amounts of lowland cultivated.

c) The number of male adults in the sample was: in Dan Mahawayi 26 in small farm stratum and 42 in large farm stratum, and 213 for all three villages.

d) Including travel time to and from fields.

e) Includes blacksmiths, tailors, carpenters, spinning, leather working and making pots, cigarettes, mats and sugar, etc. Average remuneration per day worked was 0.4 dollars.

f) Includes tending own house (fencing, building, thatching, cutting grass and firewood), barbers, butchers, hunting, begging, washermen, public officials, Koranic teachers, etc. Trading can also be classified as a traditional service. Average remuneration per day worked was 0.3 dollars.

g) Includes commission agents, messengers, laborers, nightwatchmen, bicycle repairers, buying agents, etc. Average remuneration per day worked was 0.6 dollars.

On an average farm in Dan Mahawayi about 71 percent of the labour on the farm was contributed from family sources. Of this, family male adults contributed by far the greatest proportion, i.e., 88 percent. The insignificant participation of women in farm work is related to the practice of the partial or complete seclusion of Moslem wives [Smith, 1955].

Hired labour can take three forms: work paid by the hour, contract work paid by the job and communal labour which is often contributed free of charge but may be rewarded with a meal or drink.[8/] Work paid by the hour and contract work are more productive and were by far the most common accounting for 55 and 44 percent of the hired labour, respectively.

Work Undertaken by Family Male Adults: The amount of work individuals will undertake is determined by many factors such as health, nutrition, climate, size of family and farm, subsistence needs, incentives, presence and accessibility of markets, attitude and educational level, availability of financial resources to pay for hired labour, off-farm employment opportunities, etc. In Dan Mahawayi an average male adult works about 263 days per year at an average of about five hours per day (Tables 3 and 4). These figures compare closely with those derived by other research workers in West Africa, e.g., Luning [1963,1964], Kohlhatkar [1965], Mann [1967], Galleti, et. al., [1956], Guillard [1958] and Haswell [1968].

Because of the seasonal nature of farming 47 percent of the average male adults' time in Dan Mahawayi was spent on off-farm occupations. The degree of emphasis on off-farm occupations appeared to be largely independent of the size of farm (Table 3). Off-farm occupations can be ascribed

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[8/] All three types of labour are often remunerated in kind rather than explicitly in terms of cash.

TABLE 4. Seasonality of Farming and Off-Farm Occupations in Dan Mahawayi

Variable Specification	Total	Percent of Total Man-Hours or Man-Days											
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Work on Average Family Farm (man-hours):													
Family	1080.8	3.9	8.1	11.3	10.6	9.7	7.1	5.5	5.3	3.3	2.2	1.8	2.5
Nonfamily	435.5	1.5	2.6	4.5	4.7	3.3	2.9	2.0	1.5	2.2	1.4	0.9	1.2
Work Per Male Adult (days):													
Farm	140.1	3.3	6.0	8.0	7.2	6.7	5.5	4.4	4.2	2.6	1.7	1.6	2.2
Off-Farm	122.6	5.0	3.8	3.4	3.5	2.5	2.7	2.4	2.8	4.0	5.4	6.1	5.0
Seasons of the year: Weather		← Rainy →							← Dry →				
Farming		← Planting →				← Harvesting →							
			← Weeding →										

to two main sectors, i.e., traditional and modern. Employment in the traditional sector consists of those jobs that are fairly independent of the developmental process or in other words are jobs that have been undertaken for many generations. In contrast jobs in the modern sector have arisen directly or indirectly as a result of improved communications and the development of large cities, commercial firms and governmental bodies. Because of the relative inaccessibility of Dan Mahawayi, off-farm occupations are largely confined to the traditional sector. This isolation has helped in establishing the importance of the Dan Mahawayi market in the locality and in preserving the traditional services and crafts. Because of the presence of the market, trading becomes an important off-farm occupation. There appeared to be no marked differences between the type of off-farm occupations undertaken by small and large farmers (Table 3).

Problems of Seasonal Employment: The seasonal nature of farming in the Zaria area due to the uneven rainfall distribution is emphasized by the results in Table 4. June and July are the busiest single months for farming activities. In Dan Mahawayi about 55 percent of the annual input of man-hours on family farms occurs during the May through August period. Conversely, the four month period from December to March accounted for less than 16 percent of the annual labour input.

The amount of labour a family can contribute or hire during the June-July period determines to a large extent the family's land requirements and level of agricultural activity during the rest of the year. The bulk of the farm work in this labour bottleneck period is devoted to cultivating and weeding. The empirical evidence indicates that the June-July labour bottleneck is an important constraint on an expansion of agricultural activity. There are at least three ways of ameliorating the effect of this labour constraint:

i. Increase the availability of family members for work on the family farm by reducing the time spent on off-farm activities. In Dan Mahawayi a significant inverse relationship was found to exist between the days spent per month by family male adults in family farm work and off-farm employment.[9/] Yet, even during the bottleneck period, about nine days per month or about 34 percent of an average adult male's working days were spent in off-farm occupations (Table 4). But it is possible that work on the family farm cannot be substituted for time devoted to off-farm employment to the extent that would be desirable for two reasons. Firstly, in order to be reasonably successful in the off-farm occupation during the dry season it is necessary to provide some continuity throughout the year. This would be particularly true in the case of occupations that involve patronisation by clientele, e.g., crafts and services such as trading. Secondly, the immediate need for money to buy food may compel family members to devote some time to off-farm occupations which yield an immediate monetary return. Cash and food resources tend to be low at the peak period in farming activities, since most crops are harvested between August and December and little additional income is obtained from farming activites until after the bottleneck period.

ii. Through the hiring of labour. One would expect that since labour is in such demand during the June-July period, it would also be the period when the bulk of nonfamily labour is hired. In fact, it can be deduced from Table 4 that 32 percent of the total man-hour input of nonfamily labour was employed during this period, corresponding to the 31 percent

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9/ The correlation coefficient between these two variables was -0.71, which is significantly different from zero at the five percent level. The nonparametric Kolmogorov-Smirnov test also indicated that the distributions were significantly different.

of total man-hour input by family members on the family farm. Results of a test for significant difference between the monthly man-hour input of family labour and nonfamily labour on the family farm when each monthly total was expressed as a percentage of each annual total supported the hypothesis of no difference.[10/] Hired labour is used throughout the year and is therefore apparently not reserved for the June-July period. Hiring of labour during the latter period may be limited for two reasons. Firstly, there is no class of landless labourers. Therefore the period hired labour is most in demand is the time when the individuals who could do it are busiest on their own farms. Secondly, the low level of cash resources during this period imposes a practical restriction on the amount of labour that can be hired.[11/]

iii. The introduction of improved technology, e.g., animal power and equipment, herbicides, etc. The potential success of such innovations in the future will depend on a number of factors, e.g., education of farmers on its use, profitability and dependability, and perhaps provision of credit.

Capital Goods

The two main inputs of traditional agriculture are labour and land. The amount of capital and the proportion of income invested are very low. Mellor [1967] has, however, emphasised that savings and investment are a

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[10/] The correlation coefficient between the two variables was 0.94 which is significantly different from zero at the five percent level. The results of the Kolmogorov-Smirnov test supported this conclusion in that no significant difference was found between the distributions.

[11/] It is perhaps interesting to note that contrary to expectations the wage rate for nonfamily labour remained almost the same throughout the year. Possible explanations for this are discussed elsewhere [Norman, 1972]. For example, during the dry season, the decrease in demand for nonfamily labour coupled with a decrease in labour supply could maintain wage rates at a level that exist during the rainy season. It can be postulated that the decrease in labour supply during the dry season could be attributed to the greater desire for leisure resulting from the increased cash reserves obtained from the just completed harvest.

function of two main factors: a) the attitudes toward saving, investment and consumption, i.e., the position of the supply schedule for saving and b) the marginal returns available to further investment. Consequently, capital formation in traditional agriculture tends to be low not necessarily because the capacity for saving is low but because the returns to investment tend to be low. Mellor gives two reasons for the low rates of return on investment. These are, first, that many forms of capital goods are directly formed from labour, e.g., simple tools, land improvements, etc., so that the returns are low because of the low returns to labour, and second, that the low level of technology greatly reduces the productivity of capital, e.g., investment in fertiliser, improved seeds, etc., compared with the returns in agriculture practiced at a higher level of technology.

It is not surprising therefore to find that investment in durable farm capital goods, i.e., livestock, buildings and equipment, was low (Table 5). The dependence on hand tools together with the absence of farm buildings, other than grain stores, resulted in an average inventory value of investment in these items of only 6.5 dollars per farm in Dan Mahawayi. The relatively larger investment in livestock, i.e., mainly chickens, sheep and goats, but also a few guinea fowl, donkeys and horses, arises in spite of the fact that livestock do not play an important role in the farming activities and incomes of most households. However, livestock do provide a form of investment that can readily be translated into cash.

The problems of the seasonality of farming have been emphasised in the preceding section. It was noted that during the peak period in farm activities, i.e., June-July, cash resources tend to be at their lowest level. The same problem, but perhaps somewhat less acutely, pertains to the two months immediately prior to this, i.e., April and May, when most of the

TABLE 5. Farm Capital Goods and Cash Expenses in Dollars[a]

Variable Specification in Terms of an Average Family Farm	Dan Mahawayi		Average of the Three Villages
	Small Farms	Large Farms	
Value of durable capital goods, April 1966:			
Livestock	7.8	22.6	21.9
Buildings, tools and equipment	6.1	6.8	6.2
Total	13.9	29.4	28.1
Inputed expenditure on capital goods, April 1966 - March 1967:			
Durable	2.9	8.9	5.8
Nondurable:			
Seed	8.3	31.3	19.6
Fertilizer	3.4	4.8	5.1
Total	14.6	45.0	30.5
Percent of total value of:			
Seed purchased	32.4	22.5	20.6
Organic fertilizer purchased	13.1	32.2	22.6
Cash expenses:			
Total	19.3	89.7	35.7
Composition of cash expenses (percent of total):			
Land	6.7	6.0	4.9
Hiring labor	49.3	68.5	57.9
Capital goods:			
Durable	27.2	12.9	20.6
Nondurable	16.3	11.7	14.6
Marketing costs	0.5	0.9	2.0

a) The exchange rate used in this table and Tables 6, 8, 9, 10, 11 and 12 was $2.80 per Nigerian pound.

main crops are being planted. This is also the time when the demand for nondurable capital is greatest, e.g., for fertiliser and seeds. Under such circumstances the input of fertiliser particularly suffers and,in fact, very little inorganic fertiliser was used although often organic manure was obtained free of charge (Table 5).[12/] Attempts are therefore still being made in Dan Mahawayi to maintain fertility through fallowing rather than the application of inorganic fertiliser. Seed, which apart from cotton was invariably unimproved, was often saved from the previous year's harvest (Table 5), or purchased, sometimes with borrowed money. Such money is often borrowed from local moneylenders, often traders, who charge high interest rates. Since land is a communal,asset farmers have little collateral and hence commercial institutions are not willing to consider moving into the field of rural credit. Government agencies in the past have suffered heavy losses in channelling loans through co-operatives and at the present time are doing little in the field of credit. There is no doubt, however, that something needs to be done to reduce the power of the local moneylender. Vigo [1965], in a study in the northern part of Nigeria, found that less than one third of the farmers were free of debt while almost 50 percent of the credit was borrowed from traders whose effective rates of interest ranged from 50 to 90 percent. Finally, a most sobering finding arising from Vigo's study was that over 80 percent of the credit was used for consumption purposes.

Cash Expenses

As far as farming activities are concerned, cash expenses or goods

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[12/] Most of the organic manure applied is produced as a result of the cattle owned by the nomadic Fulani being corralled on the field after harvesting has been completed. Often this arrangement is undertaken without monetary cost on either side; the crop residues provide food for the cattle which produce manure.

valued in terms of cash are used to obtain the services of inputs either on a temporary basis, e.g., renting, pledging or leasing land, hiring labour etc., or on a more permanent basis, e.g., purchasing the usufructuary rights to land, equipment, seeds, fertiliser, etc.

Farm cash expenses in Dan Mahawayi amounted to an average of 49.2 dollars per family (Table 5). As would be expected in an area where the dominant right to land is that which is inherited (Table 1), only six percent of the total cash expenses was spent on obtaining the rights of use to additional land. Not surprisingly, an average of 65 percent of the cash expenses, or reward in kind valued in money terms, was incurred in hiring nonfamily labour. The cost of the extra hired labour accounted for most of the difference in cash expenses of small and large farms. With respect to seed and fertiliser which accounted to an average of 12 percent of the cash expenses per family, the importance of sources of supply other than the market place have earlier been emphasised. Costs of marketing were relatively insignificant, i.e., one percent of total farm cash expenses, both because of the relatively low proportion of total production that is sold (Table 8) and because of the operation of middlemen or traders who purchase products directly from the farmers and arrange for their transport to the market.

Land and Labour Relationships

The magnitude of the labour input per cultivated acre was, as expected, found to be inversely related to both the land per resident ratio and to the number of cultivated acres on the farm (Table 3 and Figure 1). Although the use of nonfamily labour increased with an increase in the size of family

farm,[13] the results in Figure I also show the increase was not sufficient to offset the decline in the total man-hour input per acre. The results also indicate that the labour input per acre on upland was considerably lower than that on lowland.

The estimation of marginal value productivitiesof labour and land is important in relating these inputs to output. The results in Table 6 indicate that the marginal productivity of upland is less than lowland and that an increase in the cultivated acreage resulted in an increase in the marginal productivity of labour, due to the land being farmed less intensively.

Production and Incomes

Crop Production

The crops grown in any area are determined by three fundamental factors, i.e.,physical, social and economic considerations. Water, temperature and soil conditions are the main determinants of the physical ability of crops to grow. Nevertheless, although the physical determinants may be favourable as far as growth of a particular crop is concerned, social, e.g., personal tastes, tradition, etc., and economic factors, e.g., prices, ease of transport, etc., may bring about cropping patterns very different from what would be physically possible.[14]

A total of 21 crops grown by the farmers in Dan Mahawayi were more often grown in mixtures rather than in sole stands, a practice which is

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[13] The correlation coefficient between the two variables in Dan Mahawayi was 0.47 which was significantly different from zero at the five percent level.

[14] Political and institutional factors, e.g., marketing boards for cotton and groundnuts also have an influence on marketing channels and producer prices.

TABLE 6. Marginal Value Products in Dollars of Land and Labor on Small and Large Farms in Dan Mahawayi[a]

Variable Specification	Small Farms	Large Farms
Cultivated gona (acres)	16.81	8.42
Cultivated fadama (acres)	46.19	31.87
Family labor (man-hours)	0.07	0.10
Nonfamily labor (man-hours)	0.04	0.05

a) Small and large farms were the same as those defined in Table 1. The marginal value productivities were estimated from the following function:

$$Y = 37{,}3600\ X_1^{0.2724}\ X_2^{0.0665}\ X_3^{0.2667}\ X_4^{0.0585}\ X_5^{0.2179}\ X_6^{0.0803}$$

$$Sy_x = 0.1529$$

$$R = 0.8987$$

$$n = 106$$

Where:

Y = Gross income from crop production (sh.)
X_1 = Cultivated gona acres
X_2 = Cultivated fadama acres
X_3 = Man-hours of family labor devoted to work on the family farm
X_4 = Man-hours of nonfamily labor hired for work on the family farm
X_5 = Imputed expenditure on nondurable capital (sh.)
X_6 = Depreciation of durable capital (sh.)

The values of X_3, X_4, X_5 and X_6 were held at the means for the average farm in Dan Mahawayi.

termed intercropping (Table 7). These crops may be together for either a short time or a long time. In the northern part of Nigeria the crops tend to be planted in systematic spatial arrangements (Figure 2). On upland, crops are usually planted on ridges three feet apart while on lowland they are planted on the flat.

As Table 2 indicates, about half of the total adjusted cultivated acres were devoted to the growing of cereals which provide the basic diet of families. The larger farmers because of their greater production capacity supplement their grain crops with greater quantities of nonfood cash crops, i.e., primarily cotton.[15/] Grain legumes comprise the other main crop class that occupies a prominent place in the survey area in terms of acreage. In terms of individual crops, millet, sorghum and cowpeas were the most important food crops accounting for almost 60 percent of the total adjusted cultivated acreage in Dan Mahawayi while groundnuts, sugarcane and cotton constituted the main cash crops and accounted for a further 27 percent of the total adjusted cultivated acreage (Table 7).

Table 7 also indicates that only about 24 percent of the total cultivated acreage in Dan Mahawayi was devoted to sole crops. Intercropping two crops proved to be the most common method of cultivation although occasionally as many as six crops were found in a mixture. In Dan Mahawayi 77 different crop combinations were identified during the survey, but 60 percent of the acres devoted to mixtures were accounted for by only seven different crop mixtures.[16/] A millet/sorghum combination was by far the

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[15/] Also, although the return per acre from cotton is low, the demands on labour, the more limiting input on such farms, is also relatively low and is largely confined to months other than the bottleneck period.

[16/] These are specified by name in footnotes d, e, and f of Table 10.

TABLE 7. Acres, Yields and Location of Some Specific Crops, and Food and Cash Crops

	Dan Mahawayi Village		Total of the Three Villages						
	Adjusted Acres		Adjusted Acres		Yields per acre (lbs.)		Percent adjusted acreage of crop grown at different distances from compound		
	Total	Percent Acres Grown Sole	Total	Percent Acres Grown Sole	Sole	Mixed	Less than 600 yards	600-880 Yards	More than 880 yards
Crop:									
Millet	64.4	0.0	139.8	0.2	--	318	52.5	21.5	27.0
Sorghum	122.8	40.9	232.8	30.7	701	537	37.7	31.7	30.6
Cowpeas	47.5	3.0	98.8	2.3	--	105	33.4	31.1	35.5
Groundnuts	46.0	15.9	94.6	17.3	524	391	31.2	39.1	29.7
Sugarcane	14.8	98.8	57.6	97.7	12,316	-	24.1	41.9	34.0
Cotton	45.9	19.2	65.2	26.4	190	159	9.5	14.5	76.0
Food Crops[a]	270.4	20.1	568.7	17.8			40.7	30.8	28.5
Cash Crops[b]	123.9	22.5[c]	249.6	23.9[c]			26.9	38.7	34.4
Fallow Acres	106.1		225.2				17.1	36.9	46.0
Total Acres	500.4	23.7	1043.5	24.9			32.4	34.0	33.6

a) Food crops are defined as those food crops in which less than 50 percent of total production is usually sold, i.e., millet, late millet, sorghum, maize, iburo, bambara nuts, cowpeas, cassava, sweet potatoes, yams, cocoyams, okra, pumpkin and garden egg. The entry also includes two very minor nonfood crops, i.e., henna and Deccan hemp.

b) Cash crops are defined as crops in which more than 50 percent of total production is usually sold, i.e., rice, groundnuts, Irish potatoes, onions, peppers, tomatoes, sugarcane, cotton and tobacco.

c) Excluding sugarcane.

Figure 2. Spatial arrangement of two common crop mixtures

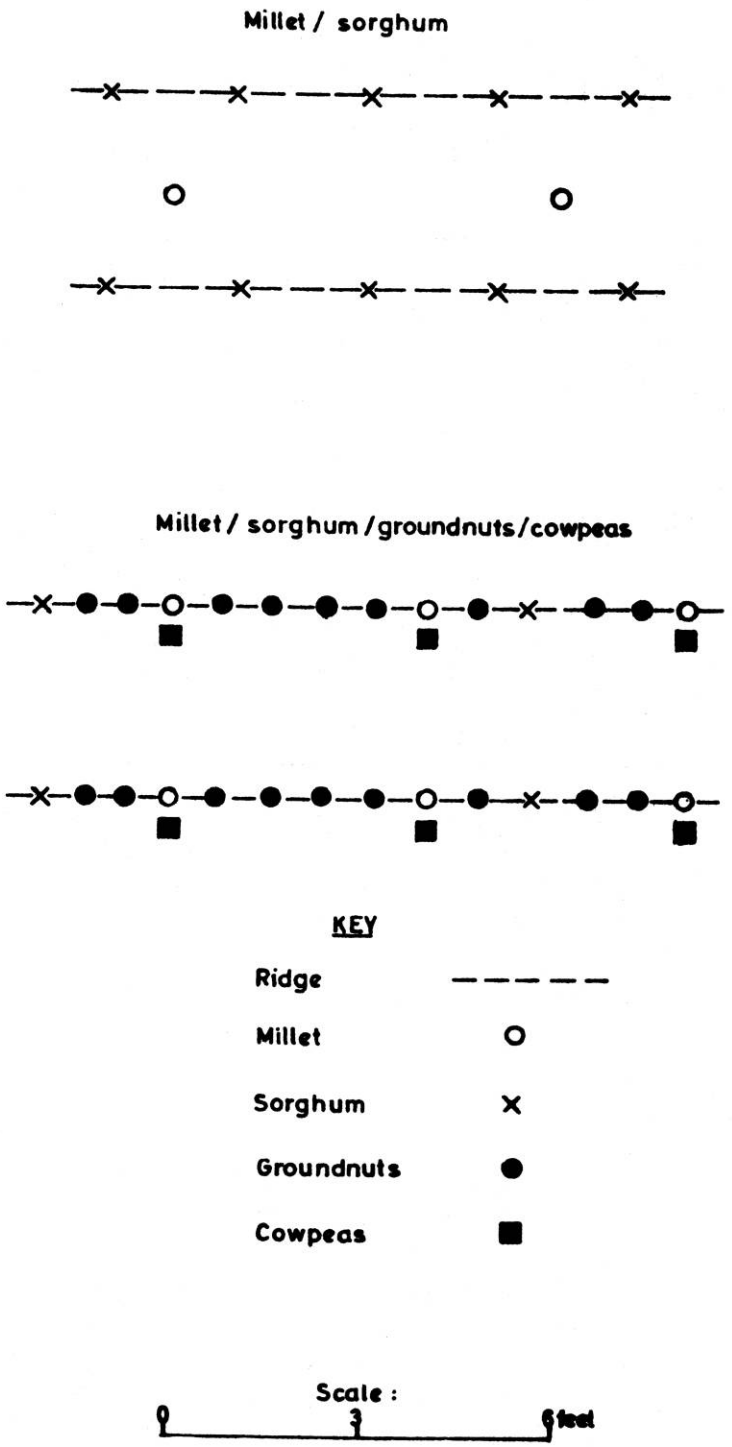

TABLE 8. Composition of Farm and Family Income

Variable Specification in Terms of an Average Farming Family	Dan Mahawayi		Average of the Three Villages
	Small Farms	Large Farms	
	Dollars		
Gross Farm Income:	141.1	392.0	267.4
Crops[a]	137.3	385.4	263.6
Livestock	3.8	6.6	3.8
Costs of Production[b]	21.8	91.2	45.9
Net Farm Income	119.3	300.9	221.5
Off-Farm Income	61.4	73.7	70.7
Total Income	180.7	374.5	292.2
Net Farm Income Per Acre	21.7	17.5	24.3
Total Income Per Resident	26.2	55.9	34.8

a/ The average percentage of crops sold for cash varies from 39.6 percent of small farms to 43.5 percent on large farms. The remainder is consumed or used as seed.

b/ Includes depreciation of tools, equipment and buildings, costs of acquiring usufructuary rights to land, value of seed planted, and costs of fertilizer, hired labor and marketing.

most important mixture accounting for about 27 percent of the area devoted to crop mixtures. For each crop mixture many different spatial arrangements of plants are possible. However, it was found that there were certain arrangements which were most popular for each crop mixture (Figure 2).

Grain legumes, starchy roots and tubers and vegetables are mostly grown in mixtures, while sugarcane is invariably planted as a sole crop. It is interesting to note that millet and cowpeas in contrast to sugarcane are seldom grown in pure stands. It is suggested that there must be logical reasons for these practices which have evolved over the years. For example, to make maximum use of the land and to enable the maximum return to be reaped from past labour, e.g., labour involved in preparing and ridging the land, it would appear reasonable in the case of millet and cowpeas to grow them in mixtures since millet is harvested in the middle of the growing season, (i.e., first half of August), while cowpeas are not planted until well after the beginning of the rainy season, (i.e., second half of July). On the other hand, it also seems reasonable for sugarcane, which produces tall plants with dense foliage, to be planted at high population densities in pure stands.

Under indigenous conditions yields of crops are low. This is not surprising since improved varieties are seldom used while the application of fertiliser is minimal. Growing crops in mixtures provides a good example of a practice which tends to be inconsistent with the generally accepted notion that improved biological technology should be introduced in the form of sole stands of crops. A detailed comparison of crops grown as sole stands and in mixtures under indigenous technological conditions is discussed later.

Incomes

The estimated average total income, i.e., net farm income plus off-farm income, in Dan Mahawayi, was about 287 dollars per family. Considerable difference between the two groups is illustrated in Table 8, with large farmers earning more than twice as much as small farmers.

The bulk of the income from farming was derived from crop production with only small contributions by livestock. However off-farm sources of income were significant, amounting to an average of 24 percent of total income. In the case of smaller farmers, the reliance on income from such sources was much higher, i.e., 34 percent.

For most families, incomes are low. Because of this, savings are very limited and their ability to overcome adverse circumstances is therefore severely curtailed. This is likely to result in a conservative attitude to change.

IV. COMPARISON OF THE THREE VILLAGES: ACCESSIBILITY AND POPULATION DENSITY

Location, which influences accessibility, and population density both affect life in traditional societies. The literature abounds with discussions as to how agriculture is influenced by location [Newman, et. al., 1954; Schultz, 1951] and population density [Boserup, 1965]. Such factors therefore hold implications for bringing about agricultural development and will of course also be of some significance in determining the necessity of seeking off-farm sources of income and availability of such income sources. The three villages reflect both differences in location or accessibility and in population density (Table 9). Since it is not always possible to differentiate between the effects of these factors they are considered together.

TABLE 9. Comparative Statistics in the Three Villages[a]

Variable Specification[b]	Dan Mahawayi	Doka	Hanwa
Ease of accessibility	Poor	Good	Very Good
Population density per square mile	81	396	709
Farm Land per resident (acres)	1.9	1.3	0.6
Average farm size (acres)	11.9	9.8	5.5
Coefficient of variation on size of farm[c]	88.4	78.9	70.2
Composition of farm (acres):			
Upland	10.9	8.6	4.8
Lowland	1.0	1.2	0.7
Fallow (percent): Total	21.2	26.8	2.6
Upland	19.2	28.5	2.8
Lowland	42.1	12.4	1.0
Percent of acres that was:			
Inherited or a gift	80.1	93.7	31.5
More "mobile" type of tenure	18.9	6.3	68.5
Inputs per cultivated acre:			
Labor (man-hours)	161.6	227.0	393.5
Organic fertilizer (tons)	0.4	0.5	1.5
Inorganic fertilizer (dollars)	0.1	0.1	0.1
Net farm income per acre	18.4	23.7	38.9
Composition of total income (percent):			
Farm	76.2	87.6	65.8
Off-farm	23.8	12.4	34.2
Days worked per family male adult per annum:			
Family farm	140.1	158.7	124.6
Off-farm	122.6	39.4	86.5
Total	262.7	198.1	211.1
Composition of off-farm work by male adults:			
Traditional: Manufacturing	21.3	29.3	11.3
Services	40.0	27.2	20.9
Trading	35.0	24.7	3.4
Modern: Services	3.7	18.8	64.4

a) Only characteristics directly alluded to in the text are included in the table. Definitions of variables contained in the table can be found in footnotes of other tables.

b) Where relevant the statistics are presented in terms of an average farm.

c) To enable direct comparisons to be made the same sample size was used for calculating this variable in each village (n = 20).

However as the ease of accessibility to Zaria increased, population density also increased. Thus the two variables are closely related to each other in this study.

Influence on Farming

As expected, the average size of farms decreased with an increase in population density (Table 9). Somewhat less obvious is the concomitant decrease in the relative variation in the size of farm. Population density is one of the possible factors that influences land distribution.[17] For example, it is likely that the high demand for land in the most densely populated village, Hanwa, has been of some influence in bringing about greater equity in land distribution. The opportunity cost of leaving land fallow in such an area is also relatively high and farmers are thereby encouraged to surrender their usufructuary rights. The result has been that since additional income can be obtained from renting, pledging, and leasing of land, land is infrequently left fallow (Table 9), and the more "mobile" types of tenure predominated in Hanwa compared with the less densely populated survey villages, i.e., Doka and Dan Mahawayi.

As a result of the decrease in the average size of farms with population density increases, the fixed quantity of land is farmed more intensively. The results in Table 9 show that as the amount of fallow land decreased,[18] fertiliser and labour inputs per cultivated acre increased which resulted

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[17] Since the three villages are located in the same ecological area it is believed that a comparison of population densities is valid. It is appreciated of course, that it is not the population density per se that is important but rather the population in relation to exploitable resources in the area.

[18] The figure for Doka, for reasons given later in the same section, does not fit into this trend.

in a greater return per acre. It is likely, however, that with further increases in population an upper limit will soon be reached in the return per acre under indigenous technological conditions. The only hope for substantially raising the ceiling is through the introduction of improved technology, such as greater use of inorganic fertiliser, improved seeds, seed dressing, irrigation, etc., or substantially changing the farming system, e.g., to market garden crops.

Accessibility can be of considerable influence in determining the types of products produced [Newman, et. al., 1954; Schultz, 1951]. It was noted earlier with respect to Dan Mahawayi (pages 5 and 6) that its relatively unfavourable position encourages farmers to leave the lowland fallow, although in more accessible areas it is in great demand. Sugarcane has a low value per unit weight thereby making transport costs very high. This partially accounts for the fact that only 12 percent of the lowland in Doka was left fallow compared with 42 percent in the more inaccessible, labour scarce village of Dan Mahawayi (Table 9). Such concentration in Doka on the highly remunerative but labour intensive sugarcane resulted in a correspondingly high percentage of upland being left fallow.

Influence on Off-Farm Activities

It could be hypothesised under ceteris paribus conditions that as population density increases, i.e., land becomes more limiting in relation to labour, greater reliance will need to be placed upon off-farm sources of income. There is, apart from the special case of Doka where sugarcane cultivation is a substitute for off-farm employment, some support for the hypothesis (Table 9). As the population density increases such employment

is more likely to be undertaken throughout the year, rather than being confined to the dry season.

The opportunities for income from off-farm sources depend to some extent on the location or accessibility of the village. The composition of off-farm employment as given in Table 9 can also be explained in terms of location. In the case of Hanwa, with its close proximity to Zaria men may prefer to obtain employment in the modern sector which is generally more remunerative than work in the traditional sector (see footnotes e, f, and g of Table 3). As has been noted earlier (page 12) the relative inaccessibility of Dan Mahawayi precludes employment opportunities in the modern sector. This together with the presence of a market, has encouraged activities in the traditional sector. In Doka, employment opportunities in the modern sector are also very limited. However, as was noted above, the accessibility to a main road has encouraged farmers to concentrate on growing the remunerative sugarcane rather than relying on the less certain sources of income provided from off-farm activities, particularly in the traditional sector.[19/]

V. EMPIRICAL ANALYSIS OF THE GOALS OF FARMERS IN A TRADITIONAL SETTING

The previous sections have considered in some detail the characteristics of farming in the survey area and the influence of accessibility and population density. It is now proposed to investigate briefly certain other influences, namely, the farmers' perception of their basic economic situation

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[19/] An alternative explanation is given elsewhere [Norman, 1972].

as exemplified in the goals adopted by them. For the purposes of this analysis we will draw on the results of 42 farming families in the Dan Mahawayi Village and the 62 farms in the other two villages.

The basic aims of families in their farming activity will be of considerable influence in determining the type of decisions and actions taken in the business, and the potential suitability and acceptability of innovations. Two goals are examined with respect to farmers in the Zaria area--the goals of profit maximisation and security. The concept of security is considered here to be the result of applying strategies of minimising risk. In more pragmatic terms, security is the desire to provide enough food for home consumption with any surplus resources being devoted to crops for sale on the market. In the context of the present study, induction rather than deduction has been used in examining the goal of security.[20/]

The most obviously unique characteristic of all the farmers, regardless of size of farm, location and population pressure factors, is their practice of intercropping or growing crops in mixtures. This practice is examined in some detail in this section and is tested for consistency with the two goals specified above. This is followed by a discussion on the consistency of the two goals for the farm business as a whole at this point in time.

The Rationalisation of Intercropping

The objective of this section is to examine the economic and social nature of the practice of intercropping. If any attempts are to be made

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[20/] Game theory is relevant in testing the validity of such a goal. However, this is beyond the scope of this paper.

to move these dryland Nigerian farmers from traditional hand cultivation based on intercropping methods towards more technologically advanced cultivation methods, it is necessary to understand both the economic relationships which face an individual farmer and his perception of these relationships.

Comparison of Sole and Mixed Crops

The results in Table 7 indicate that the physical yields per acre of individual crops were lower when grown in mixtures rather than as sole stands. Possible reasons for this include competition with other crops in the mixture for space, light and nutrients, and the lower population densities of individual crops when planted in mixtures compared with sole stands.

In order to compare different crop enterprises, yields were expressed in value terms per unit input. Very briefly the results can be summarised as follows:[21/]

i. Gross returns per acre. Although the yields of individual crops are lower when grown in mixtures (Table 7), the decrease is more than offset by the yields of other crops present in the mixture. Consequently, the average gross return per acre on upland for crop mixtures was almost 62 percent higher than from sole crops (Table 10). However, the average gross return per acre from sugarcane, the main crop grown on lowland, was much higher than anything grown on upland.

ii. Gross return per man-hour. The results in Table 10 indicate

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[21/] Some details on individual crop enterprises are given elsewhere [Norman, 1971, 1972].

TABLE 10. Labor Inputs, Gross and Net Returns of Sole and Mixed Crops in Dollars[a]

Type of Land	Number of Crops in Mixture	Man-hour Input Per Acre		Gross Return Per Unit Input			Net Return Per Acre		
				Acre	Man-hour[b]		Labor Not Costed	All Labor Costed	June/July Labor Costed
		Annual	June/July		Annual	June/July			
Upland	Average - Sole Crop[c]	146.6	49.5	21.5	0.1	0.4	20.8	10.4	18.7
	Two Crop Mixture[d]	235.6	60.7	33.7	0.1	0.6	33.0	16.2	28.7
	Three Crop Mixture[e]	225.3	61.1	32.2	0.1	0.5	30.8	14.7	26.5
	Four Crop Mixture[f]	271.1	90.3	47.7	0.2	0.5	45.2	25.8	38.8
	Average - mixed	237.3	63.9	34.8	0.1	0.5	33.7	16.8	29.1
	Average - overall	218.7	60.9	32.0	0.1	0.5	31.0	15.4	26.7
Lowland	Average - Sole[g]	525.6	66.8	120.7	0.2	0.8	91.0	53.4	73.0

a) Labor requirements and gross returns for a total of 11 crop enterprises were estimated. In order to calculate average figures for sole crops, two crop mixtures, etc. a system of weighting according to the total acres of each crop enterprise grown, was employed. The computation details and the limitations of the method are discussed elsewhere [Norman, 1972].

b) The figures in these columns were calculated through dividing the gross return per acre by the appropriate labor input.
c) Includes sorghum, groundnuts and cotton.
d) Includes millet/sorghum, sorghum/groundnuts and cotton/cowpeas.
e) Includes millet/sorghum/groundnuts, millet/sorghum/cowpeas and cotton/cowpeas/sweet potatoes.
f) Includes millet/sorghum/groundnuts/cowpeas.
g) Sugarcane.

that in terms of total man-hour input the average gross return for sole crops and crop mixtures is the same. However, it has been argued earlier that labour is only truly limiting during the June-July peak period and therefore a more valid ratio to compare is the average gross return per man-hour input during June and July. The return on upland using this ratio is higher for crop mixtures than for sole crops in spite of the fact that the labour inputs tended to be higher in the case of crop mixtures. The return on lowland, i.e., sugarcane, was however considerably higher.[22/]

iii. Net return per acre. In assessing the net return or profitability of enterprises in a traditional society numerous problems arise with respect to the costing of inputs.[23/] The results of three different measures are given and defined in Table 10. These indicate that in general the profitability of crop mixtures was about 60 percent higher than that from sole crops. Sugarcane grown on lowland was much more profitable than any crop enterprise produced on upland.

Reasons Given by Farmers

Initially an attempt was made to determine by survey of the family heads the main reason why they preferred intercropping to sole cropping. The answers to the question, which was made deliberately open-ended, had to be interpreted with caution. The reasons stated tended to fall into four broad categories; tradition, the need to maximise the return from the most limiting factor, the need for security and the beneficial effect of legumes on other crops.

[22/] Sugarcane which is grown on lowland has a very different scale of monthly labour requirements. The labour required during the June-July period is relatively low, therefore accounting for the higher return per June-July man-hour compared with crops grown on upland.

[23/] This arises because most of the inputs are provided by the family sources and are not purchased.

Reasons of tradition were, for example, consistent and overlapping with expressed need to maximise the return from the most limiting factor and the need for security, as will be shown in more detail below. Farmers' explanations of their reasoning that intercropping was a way of maximising their return to their most limiting factor showed that they considered land scarcity to be more limiting than labour shortage. It is interesting to note, however, the degree of intercropping actually practiced in the survey villages appeared to be largely independent of the land-labour relationship.[24/]

Security motivation and the beneficial effects of interplanted legumes have obvious rational bases which some farmers articulated in their responses. Intercropping leads to security through diversification in crop production; the strategy is an insurance policy. Intercropping of legumes with other crops provides an implicit, i.e., within each year, rather than an explicit, i.e., year to year, type of rotation.

Empirical Verification

Since farmers implied that both profit and security motives underlie their preference for intercropping,these were examined to determine whether or not they were supported empirically by the data collected in the survey.

The results given earlier indicated that under the technological conditions operating in the villages it was relatively more profitable to grow crops in mixtures rather than as sole stands. However, this does not necessarily mean that resources were being combined in a manner consistent

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[24/] Correlation coefficients between the intercropping index and size of holding, ($r = 0.01$)and the same index and the farm land per resident ratio, ($r = 0.17$) were not significantly different from zero at the five percent level.

the goal of profit maximisation. In order to test this, Cobb-Douglas production functions were estimated from which the marginal value productivities of each of the resources were estimated and compared with the price or opportunity cost of the relevant resource. In the majority of the functions estimated there were no significant differences between the marginal value productivity of the resource and the opportunity cost of that resource (Table 11). This confirms the notion implied in Table 10 that, under the conditions existing in the survey area, profits are maximised when crops are grown in mixtures rather than as sole stands.

A primitive test as to whether the practice of intercropping is consistent with the goal of security is to determine whether the absolute and relative variation in the gross return unit of input is higher or lower for crop mixtures than for sole crops. Lower figures for crop mixtures would imply that there is less risk or more certainty regarding the return that can be expected from growing crops in mixtures rather than as sole stands. The results in Table 12 support such a hypothesis.

In conclusion it would therefore appear that the practice of intercropping under indigenous technological, sociological and economic conditions is consistent with both the profit maximisation and security goals.

Results of Linear Programming Model

Empirical evidence has been presented that indicates the decision making pattern of farmers under indigenous conditions is consistent with the goals of security and profit maximisation. In this section linear programming is used in an attempt to determine whether or not farmers could under indigenous conditions improve their welfare in terms of the goals which they may have set for themselves. For this purpose a combined goal was assumed, i.e., the goal of profit maximisation subject to the security constraint of sufficient food production to meet the needs of the family.

TABLE II. Comparison of Marginal Value Products of Land and Labor on Sole and Mixed Crops[a]

Variable Specification	Marginal Value Products (dollars)			
	Labor		Land	
	Sole	Mixed	Sole	Mixed
All sole crops combined and crop mixtures combined	-0.01*	0.07	15.90	7.67
Individual Crop Enterprises:				
Average[b]	0.01	0.03	11.76	13.18
Range: Minimum	-0.07	-0.01	3.61	5.56
Maximum	0.06	0.08	26.37	20.57
Number of crop enterprises for which MVP significantly different from the opportunity cost.	1 out of 3	1 out of 7	0 out of 3	0 out of 7

a/ The marginal value productivities were calculated from Cobb-Douglas production functions. The dependent variable was expressed in gross return terms. The complete results and a discussion on their limitations are given elsewhere. [Norman, 1972]

b/ Average of the figures derived for each enterprise.

* Not significantly different from zero at the five percent level.

TABLE 12. Variation in Returns to Land and Labor in Sole and Mixed Cropping[a].

Variable Specification	Absolute and Relative Variation					
	Per Acre			Per Man-Hour		
	Average	Confidence Limits (95 Percent Level)	Coefficient of Variation	Average[b]	Confidence Limits (95 Percent Level)	Coefficient of Variation
Sample of:						
All Sole Crops	25.33	± 3.47	6.90	0.17	±0.11	16.30
All Crop Mixtures	35.00	± 4.45	6.40	0.14	±0.06	9.50
Individual Crop Enterprises:						
Average[c]: Sole	19.57	± 9.72	21.40	0.15	±0.10	28.2
Mixed	28.32	±10.85	17.20	0.14	±0.08	23.5

a/ In order to directly compare returns for sole and mixed crops it was necessary to have the same number of observations in each class. Since many more observations were available for mixed crops and some individual enterprises, simple random samples with the same number of observations were drawn to give equal sample sizes. Sample sizes were as follows: class per acre n = 70, class per man-hour n = 35, individual crop enterprises per acre n = 12, and individual crop enterprises per man-hour n = 6.

b/ The figures in these columns differ from those in Table 10 because sample sizes were often different (see footnote a) and no weighting system was used in the calculation.

c/ This is the average of the figures derived for each individual crop enterprise.

The details of the products actually produced and the income received from crop production by the average farmer are given in Column 1, Table 13. Model A was estimated using as restrictions the same amounts of upland and lowland and the same amounts of monthly labour devoted to crop production actually used in the average farm specified in Column 1. The results indicate that if family labour is not costed, the level of income from crop production could only be increased by about nine percent. When allowances are made for individual farm variations and the degree of uncertainty facing farmers in their actual farming operations the potential increase of income to be obtained from reallocating resources is not very high under existing technological, sociological and economic conditions. This confirms the conclusion arising earlier that families were in general allocating resources in a manner consistent with the goal of profit maximisation. The results for model A also indicate that the basic food needs of the family are satisfied.

In model B it was assumed that the same land restrictions applied as in the actual situation, but that the family labour available per month would be the same as that devoted to work on crop production during the peak labour month for family labour, i.e., June. The results indicate that with only a four percent increase in annual labour input, there is a substantial 28 percent increase in income, i.e., not costing family labour, relative to actual results. Also basic food needs are still satisfied. The bulk of the increase in income is derived from growing an extra half acre of sugarcane. This is feasible because much of the labour requirement for sugarcane occurs during the dry season. Where there is opportunity for off-farm employment during the dry season the family has to choose between the opportunity costs of leisure, growing sugarcane and off-farm activities.

TABLE 13. Comparison of Results of Two Linear Programs With the Actual Results of an Average Farm[a]

Variable Specification	Actual	Models	
		A	B
Cultivated Upland Acreage Devoted to:			
Sole Crops	1.2	0.9	1.8
Crop Mixtures	5.3	4.7	4.5
Adjusted Acres:			
Millet	1.3	1.5	1.8
Sorghum	2.0	2.5	3.6
Groundnuts	0.9	1.3	0.9
Cowpeas	0.9	0.3	-
Sweet potatoes	0.3	-	-
Cotton	0.5	-	-
Sugarcane	0.5	0.5	1.0
Others	0.9	-	-
Fallow: Upland	1.6	2.5	1.8
Lowland	0.2	0.5	-
Total	9.1	9.1	9.1
Labor Used (Man-hours):			
Family	1485.0	1274.8	1553.5
Nonfamily	268.3	268.3	268.3
Total	1753.3	1543.1	1821.8
Income from Crop Production (dollars):			
Costing seed and fertilizer only	238.9	259.9	305.4
In addition costing nonfamily labor	218.2	239.2	284.7
In addition costing family labor	103.9	141.0	165.1
Are Food Need Satisfied[b]	Yes	Yes	Yes

a/ The actual situation of an average farm in the Zaria area is given in Column 1. The plans specified in Columns 2 and 3 were derived from the 11 enterprises specified in footnotes c, d, e, f and g of Table 10. the same land restrictions were used throughout, 8.1 acres of upland and 1.0 acres of lowland. Monthly labor restrictions in Plan A were those actually devoted to crop production on the average farm, while in B the monthly labor restriction was taken as the actual nonfamily labor plus time each month equivalent to the time actually spent by family members during the peak labor month for the family labor, i.e., June.

b/ According to a consumption survey undertaken near the survey villages the daily per capita consumption of millet and sorghum was about 1.2 and 2.9 pounds [Federal Office of Statistics, 1966]. Annual figures per family were calculated using these statistics plus an allowance for some flexibility in consumption patterns and variations in yields. The figures used were 1400 lbs. of sorghum and 700 lbs. of millet per annum for family of eight persons.

Consequently incomes from crop production could be raised if families were willing to devote more time to farm work during the dry season. Presumably the fact that it is not the case at the present time is because of transport problems, the desire for increased leisure and the preference for pursuing other activities.

Possible reasons for the continued apparent consistency of the profit and security goals,as tested in the linear programming framework,are that these food crops are well adapted to the area and to the practice of hand cultivation while,because of the predominance of intercropping, the growing of cash crops, apart from sugarcane, usually also involves the simultaneous growth of food crops, e.g., millet/sorghum/cowpeas/groundnuts. Elsewhere [Norman, 1970] it is shown that within the same linear programming framework the dominance of crop mixtures is maintained even when improved technology, at present available, is introduced into certain sole crop enterprises,i.e., sorghum, groundnuts and cotton. Thus even under such conditions food needs are still met.

Further Evidence of Profit Maximisation and Security Goals

This section is devoted to providing some further empirical support that both the profit maximisation and security goals are important in the farm business.

With reference to profit maximisation under indigenous conditions, the results from production function analysis revealed that for the farm business as a whole, farmers were using inputs in a manner consistent with this goal [Norman, 1972]. In the context of this paper no explicit test of the goal of security is attempted. However some empirical evidence is given implying that the goal of security is important in the survey area. The evidence is as follows.

i. Crops grown. An average family grew eight crops which indicates diversification in production and therefore a strategy of risk minimisation. This is further supported by the fact that almost all farmers grew millet, sorghum and cowpeas which are primarily food crops. In fact about 70 percent of the total adjusted cultivated acreage in the three villages was devoted to the cultivation of food crops (Table 7).

ii. Distance from residential area. For obvious reasons a higher premium is attached to upland fields closer to the residential area. These tend to receive relatively more attention and are usually devoted to food crop mixtures such as millet/sorghum. At more intermediate distances legumes mixed with cereals, e.g., millet/sorghum/groundnuts/cowpeas, tend to dominate while in the most distant fields mixtures which are predominantly cash crops, e.g., cotton/cowpeas/sweet potatoes, are most common. Such a gradation reflects the priorities given to food crops (Table 7).

iii. Dependence on the market. It can be hypothesised that a completely subsistence orientated farmer will adopt a security type of strategy while a completely market orientated farmer will adopt a profit maximisation goal. In the survey area farmers consume some of the products in the home but also sell some on the market. Consequently they fall somewhere between the two extremes delineated above. The degree to which they sell on the market would perhaps give some idea as to how subsistence orientated they are and therefore how important the goal of security is. The results in Table 8 indicate that in fact only about 41 percent of the gross farm income from crop production was derived from crop sales.

VI. IMPLICATIONS FOR BRINGING ABOUT CHANGE IN A TRADITIONAL SETTING

Much literature has been devoted to the discussion of the profit maximisation [Hopper, 1965; Schultz, 1964] and security goals [Lipton, 1968] in traditional agriculture. It is not the intention here to discuss the relative merits of these arguments but they do indicate the complexity of the problem of ascertaining what the farmers' goals and motivations for acting the way they do, might be. The results for the survey area presented here have been examined under both hypotheses. That is, criteria for both profit maximisation and security achievement have been tested with the survey results. Both goals have been found to be consistent with the farmers' results and practices; the practice of growing crops in mixtures has been the outstanding example in meeting both profit-maximisation and security criteria.

However, there is no assurance that these goals would continue to be consistent with each other if a change in the existing indigenous conditions were to occur. For example, if improved technology resulted in the greatly increased profitability of crops grown as sole stands rather than in mixtures, the two goals could conceivably move into conflict. On the basis of the results of the survey it is not possible to predict definitively which goal would become dominant if such a situation arose. However, the relatively low incomes of farmers seriously hamper their ability to shoulder too much risk. This implies that the prospects of new technology being adopted will be much greater if, in addition to the proven increased profitability, the risk or standard deviation in returns from the improved

technology is the same or preferably less than under traditional indigenous practices.[25/]

The goals pursued by farmers are of fundamental importance in determining the attitudes to and perhaps ability to adopt innovations, the farming practices, the crops grown and the level of incomes resulting from the farm enterprise.

There are two potential ways that incomes can be increased when land and labour resources are limiting viz., by reallocating the resources currently commited to production or by increasing inputs particularly of an improved nature, e.g., fertiliser, seed, insecticides, etc. The results of the study have shown that under the current technological, sociological and economic conditions, i.e., the potential of the former approach is limited. Instead emphasis needs to be placed on increasing and improving inputs. It is essential, however, that the introduction of the new technology in the north of Nigeria conforms to the goals and motivations of the farmers. An educational programme, such as an extension service, can persuade the farmers of the profitability and, hopefully, the reduced risk of the change. Some kind of production credit or subsidy programme would enable the farmers who have been persuaded of the value of the change to adopt the frequently expensive new technology in their own operations. Finally, the development of the infrastructure, particularly roads, would be of great value in modifying farming patterns and in facilitating the movement of the improved inputs to the places of production.

[25/] Wharton [1968] has cogently discussed this in detail. He has emphasised in addition that even though the new innovation can objectively be proved to result in a higher profitability and lower standard deviation, the critical factor in ascertaining its possible adoption is the farmers' own subjective evaluation of these characteristics. The fact that these two evaluations can differ significantly highlights the critical role that extension workers play.

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