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Traditional African Farming Systems in Eastern Nigeria

An Analysis of Reaction to Increasing Population Pressure

Von

JOHANNES LAGEMANN

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EDITORS' NOTE ON THE AFRICAN RESEARCH PROGRAMME

Owing to the generous financial support of the Fritz Thyssen Foundation, Cologne, the Department for Development Studies/ African Studies Centre of the IFO-Institute for Economic Research in Munich was able to embark upon a comprehensive research programme dealing with theoretical and practical aspects of economic development in general with particular reference to tropical Africa. The programme has been conducted partly by the Department itself, partly in conjunction with other institutes and researchers.

The research activities cover investigations into the primary sector (agriculture, forestry, mining) as well as into the secondary and tertiary sectors (industry, handicrafts, trade, banking, energy supply and transport). Besides macro-economic investigations and sociological studies (mostly industrial sociology), also social change and its implications as well as political, legal and administrative aspects of the development process are investigated.

The entire research programme being conducted up to Spring 1977 covers the titles listed in chronological, i.e., numerical order at the end of this volume. For readers' information on changes, supplements, and forthcoming publications, each volume will conclude with a survey of all published and forthcoming studies.

The "Africa-Studies" and "African Research Reports" are issued by Weltforum Publishing House, Munich, in co-operation with publishing houses in the United Kingdom and the United States. Volume 88 is the first publication in a new series of "Afrika-Studien", which - printed photomechanically with changed format - links up numerically with the volumes published hitherto.

PREFACE

Agricultural research, considered from the point of view of the development planner, is an industry which is expected to produce applicable innovations, which increase output, employment and welfare. The profitability of this industry, assessed in terms of the national economy depends on the relevancy of the research work. Relevant are those lines of research that are likely to yield innovations

- which produce high additional returns to the natural economy, and
- which may be expected to attain high rates of adoption.

Whether or not innovations will be readily adopted by the smallholders is very difficult to know in advance. Farms, in particular smallholdings, are very complex systems and the behavioral functions of the decision-makers, the farmers, are usually but partly understood. It is important therefore to have an effective feed-back system between agricultural research and the farmers, so that ideas generated by research can be tested under actual farm conditions and problems which appear in farming are brought to the research workers' attention.

The analysis of the existing farming systems clearly is the appropriate starting point for the interaction process between research and farmers. Farm system analysis does not imply that agricultural research workers should generally produce innovations which fit into existing farming systems. It may be relevant to do research which improves existing systems, for instance by producing varieties which are adapted to intercropping or multiple cropping. It may also be relevant to produce innovations which introduce something entirely new or which require the complete replacement of the established land use pattern by new ones. Both approaches to resource allocation in research have to be considered and in one location the improvement approach may be relevant and in another one the transformation approach. In both cases however, it is necessary to know what is and why things are as they are. An analysis of this type is submitted herewith.

Hans Ruthenberg

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For the idea of the study, the intensive support during field data collection as well as great assistance in analysing and writing my work, I would like to thank Professor Dr. H. RUTHENBERG, University of Hohenheim, Dr. J.C. FLINN and Dr. B.N. OKIGBO, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

During my stay in Nigeria I was a Research Fellow at IITA and thus able to enjoy all the facilities available. I am particularly grateful for the excellent working conditions within the Agricultural Economics Subprogram of the IITA and the pleasant working atmosphere with the members of the Institute.

Dr. F.R. MOORMANN cooperated in the design and conduct of the study and was responsible for the soil survey. Dr. R.G. DUMSDAY and Mr. L.B. WILLIAMS helped to clarify economic issues in many discussions. Mr. J. BRINKWORTH assisted in writing computer programmes for preliminary analyses of the field data.

During field work in Eastern Nigeria I benefited from the knowledge about local agricultural methods of Mr. W.N.O. EZEILO of IITA and Mr. J.K. OBI of the Federal Agricultural Research and Training Station. Mr. R.O.M. OFFOR of Shell-BP provided data about the agricultural project in Uboma. The Ministry of Agriculture and Natural Resources supplied several most helpful enumerators for the field work. The main debt is to all enumerators and survey farmers who assisted and cooperated throughout the survey period.

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Johannes Lagemann

SUMMARY

The study examines the land use systems of smallholders in high population density areas of Eastern Nigeria.

From a historical review it is concluded that increasing population density reduces farm size and hence the number of years for which the land lies fallow. Without the adoption of technical innovations, the output of the fields declines as a result of this process.

The testing of the hypothesis which is derived from the historical background is carried out with data collected during an intensive farm level survey in three villages which differ markedly in population density. The approach adopted in this study is characterized by two major points:

- The total output of the fields - and not the output per crop - is the important parameter for comparison of different land use intensities, and interactions between fields are taken into consideration.
- The farm and the household are taken as a unit, and consequently farm and off-farm activities are included in the assessment of the economic situation of the smallholders.

The analysis of the data shows that soil fertility, and hence total crop production per hectare and per farm, declines the higher the population density. Farmers react to declining soil fertility and yields by concentrating production on small compounds around the houses which receive mulch and manure from household refuse, from the outlying fields and from land under fallow. The output of the compounds is therefore much higher than the more extensively used fields, which regain their fertility only through the bush fallow period. These remarkable adaptations slow down the impoverishment, but they have not succeeded in stopping the process.

Another result is that the income derived from off-farm sources is higher the greater the population density. The decline in income from farming is more than compensated by the benefits from the non-agricultural sector.

The description and analysis of the existing farming systems are followed by an attempt to relate the findings to possible avenues for developing continuous cropping systems:

- Production of tree crops (especially oil palms) on upland fields is an established type of land use which provides high returns to labour. Tree crops could be combined with arable

crop production which receive large quantities of mulching material supplied from the cover crop grown under the trees.

- Data on production of wet rice in hydromorphic valley bottoms in the survey area indicate high outputs and much employment for a large number of people.
- Particularly interesting seems to be the development of a multi-storey cropping system which increases the yield on areas near the houses. This proposal is still in the beginnings of the stage of trial and error, and experiments have to show whether this avenue of development is attractive enough for the smallholders to increase food production.

The proposed improvements require high inputs of mineral fertilizer and insecticides, which stresses the importance of institutions which are able to organize effectively the supply of agricultural inputs.

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<u>Important Conversion Rates used in this study:</u>

1 Naira (₦)	=	4.0 DM
1 Naira (₦)	=	1.6 US $
1 Naira (₦)	=	320.0 fr CFA
1 Naira (₦)	=	100 Kobo
1 ha	=	2.47 acres
1 sq. km	=	0.39 sq. miles
1 inch	=	2.5 cm
1 foot	=	0.3048 m
1 mile	=	1.61 km
1 kg	=	2.2 lb
DM	=	dry matter

INTRODUCTION

Most of the land in Eastern Nigeria is farmed by smallholders who cultivate their fields using traditional practices. The farms in this region are very small, and most of the households receive off-farm income. Part-time farming is typical in the area under consideration.

The traditional system of bush fallow (1-2 years of crop followed by six or more years of fallow) appears able to meet the food requirements of a low-density population. With increased population densities, the same amount of land must support two to three times the population than was the case about 100 years ago. By shortening fallow periods and extending the area under cultivation, food production has seemed to keep pace with increased population. Nowadays, the traditional system continues to produce the majority of the food requirements, but if food crop production is to increase, and if the welfare of small farmers is not to suffer, an increase of food production in this traditional sector is necessary.

Little is known about the organisation of smallholder farming in the area. However, as pointed out by CLEAVE,

> " before any consideration can be given to possible developments on African smallholdings and the means by which these can be brought about, it must be determined what farmers are now doing, what factors govern their actions, and what pressures there are to change the pattern of agriculture that results" (1).

The purpose of this study is therefore to provide qualitative and quantitative information about the prevailing land use system in order to understand "why things are as they are". This type of information is not only required for planning purposes but also for the guidance of research into relevant lines of work.

Eastern Nigeria has a climate (some 2200 mm rainfall per year) and soil types (deep acid sands) which are typical of large areas in the lowland humid tropics of Africa (2). However, population densities in Eastern Nigeria are in general much higher than in other regions of rural Africa.

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(1) CLEAVE, J.H.: African Farmers: Labour Use in the Development of Smallholder Agriculture. Praeger, New York, 1974, p.31.

(2) The physical environment of the study area is described in Appendix III.

As the objective of the study is to examine changes in resource productivity (land and labour) as pressure on land use increases, three villages were chosen for the study to provide information on farming systems under differing intensities of land use. Specifically, as shown in Map 1, the villages were:

- Okwe (identified as village L) some 15 km south of Umuahia, represents an area of relatively low population density (100 to 200 persons per square km),
- Umuokile (village M) located 18 km from Owerri on the Owerri-Umuahia road, represents an area of medium population density (350 to 500 persons per square km), and
- Owerre-Ebeiri (village H) located some 2 km south of Orlu, represents an area of very high population density (750 to 1000 persons per square km (1).

In keeping with the objectives of the study, marked differences in population density were the dominant criterion for selecting the three villages. Similarity between the villages was sought in relation to:

- soil types and vegetation,
- climatic conditions,
- access to markets, and
- ethnic group.

And indeed the three villages are very similar as to soils and climate. Farmers belong to the same ethnic group, and are in a fairly similar situation regarding social and cultural change. All villages have easy access to roads and markets. There are, however, differences in the distances to the nearest sizable markets (2).

The study consists of three major sections:

1. The first section provides a historical review of land use systems in Eastern Nigeria and gives a perspective on the emerging problems.
2. The second section describes how farming systems have changed in relation to changes in land resources. Farm and household are treated as a unit. Most activities (farm and off-farm) of the household

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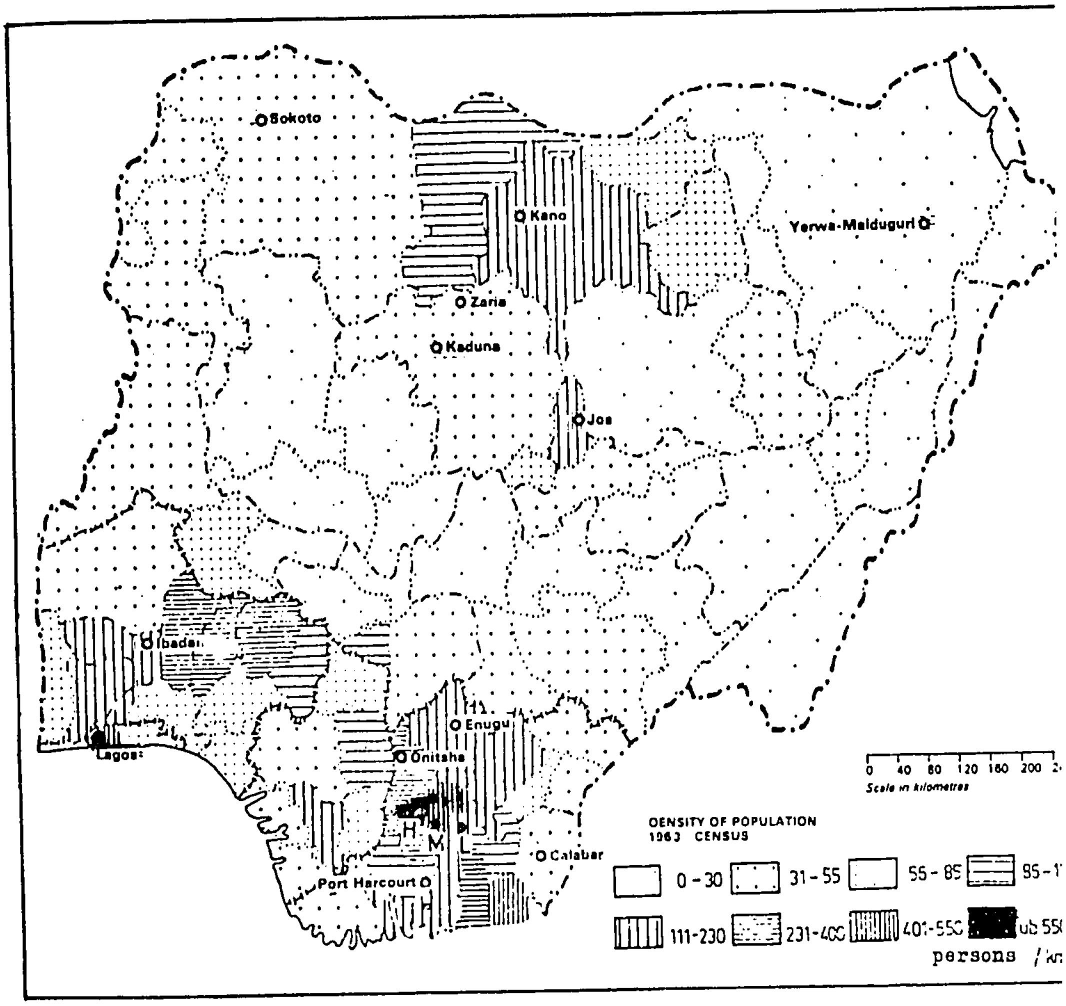
(1) Population densities are derived from the census in 1963. More detailed information on actual densities are given in Appendix IV.

(2) A justification of the village selection is given in Appendix IV.

Map 1: Population density in the Federation of Nigeria



L = Okwe M = Umuokile H = Owerre-Ebeiri

Source: CORVINUS, F. (unpublished draft).

members are interrelated, which made it necessary to study all major enterprises in their environment.

3. The third section of the study contains an assessment of the relevance of a number of proposed strategies for increasing productivity within these traditional systems.

Several aspects of the study were written up while the author was at the International Institute of Tropical Agriculture (IITA). Hence reference is made in the study to papers which were prepared as part of his responsibilities at the Institute while the survey was in progress.

A. THE PROBLEM

I. BOSERUP's Hypothesis

Ester BOSERUP was concerned with the relationship between population growth and food production. Instead of using the MALTHUSIAN approach Pg = f (Fs) (1), in which population growth is seen as the dependent variable, she used the inverse function: Fs = g(Pg)

> " Population growth is ... regarded as the independent variable which in its turn is a major factor determining agricultural developments" (2).

With examples from different countries, BOSERUP demonstrated that successful changes within agricultural systems have occured when population densities were increasing. She argues that the adoption of new land-use systems is a consequence of increasing man/land ratios:

> " As long as the population of a given area is very sparse, food can be produced with little input of labour per unit of output and with virtually no capital investment, since a very long fallow period helps to preserve soil fertility. As the density of population in the area increases, the fertility of the soil can no longer be preserved by means of a long fallow, and it becomes necessary to introduce other systems which require a much larger agricultural labour force. By the gradual change from systems where each cultivated plot is matched by twenty similar plots under fallow to systems where no fallow is necessary, the population within a given area can double several times without having to face either starvation or lack of employment opportunities in agriculture" (3).

Permanent cultivation seems to her to be only the result of population density and she "dismisses the idea that agricultural systems are adaptations to natural conditions ..." (4).

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(1) Pg = Population growth; Fs = Food supply.

(2) BOSERUP, E.: The Conditions of Agricultural Growth: The Economics of Agricultural Change under Population Pressure. Aldine, London, 1965, p. 11.

(3) Ibid, p. 117.

(4) GOULD, P.R.: Toward a Model of Population-Land Relationships, in: PROTHERO, R.M.: People and Land in Africa South of the Sahara. Oxford University Press, London, 1972, p. 331.

LUNING has shown for the case of Northern Nigeria that BOSERUP's hypothesis is far too optimistic:

> " Farmers have not yet learned, or are as yet unfamiliar with the methods to combat these encroaching dangers and appear to be powerless against them ... The MALTHUSian picture of a situation resulting in starvation or migrations is still with us in some parts of the world and should not be dismissed as lightly as BOSERUP does" (1).

It is believed that both hypotheses mentioned above, the pessimistic one of MALTHUS and the optimistic one of BOSERUP, are oversimplifications of reality. It seems evident that men are able to change cultural practices and also adopt systems which enable them to feed their increasing populations. Depending on the natural and social conditions, this process will (sooner or later) reach a stage which it might be difficult to go beyond within the traditional setting. If such a situation occurs starvation and/or migration of people are inevitable.

The following hypothesis shall be tested for the case of Eastern Nigeria: that with growing population density the present farming systems lead to impoverishment of soils which then produce at a low-level equilibrium.

- During this process increasing adaptations have occurred and are still occurring.
- These adaptations slow down the process of impoverishment, but they are insufficient to stop the process of "involution" (2).
- Technical innovations are able to change the situation significantly.

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(1) LUNING, H.A.: Economic Aspects of Low Labour-Income Farming Agricultural Research Reports 699, Wageningen, 1967, p.74.

(2) "Involution is the attainment of higher total income in the area accompanied by a lower income per head because of population increase. Evolution is the attainment of higher income per head". See: RUTHENBERG, H.: Farming Systems in the Tropics, 1st edition. Clarendon Press, Oxford, 1971, p.48 (quoted in the following as RUTHENBERG, H.: Farming Systems).

II. Genesis of the Farming System in Eastern Nigeria

1. From Shifting Cultivation to Degraded Fallow Systems

Farming in Eastern Nigeria has gone through similar changes to farming in other regions of the humid tropical lowlands of Africa. The rainforest which prevailed several centuries ago was inhabited by only a few people, who lived mainly as hunters and gatherers (1). Shifting cultivation was practised, involving a few years of cultivation alternating with a long period of fallow. Under this system trees and bushes could regrow to a secondary forest.

> " Trees and shrubs alone have the necessary depth of rooting, the capacity to make use of a large part of rainfall throughout the whole year, and the ability to retain in their own structure or in their leaf litter, a substantial portion of the nutrient material available" (2).

The analysis of soil samples from an area in South-Eastern Nigeria which was still under high secondary forest shows the good state of fertility, particularly in the surface soils (see: Table 1).

Table 1: The Orlu Series under High Secondary Forest. Oil Palm Research Station Benin. Vine, 1949

Depth (in.)	Coarse	Fine	Silt	Clay	pH	Base exchange capacity	Exchangeable Hydrogen	Exchangeable base	% Carbon	% Nitrogen
0- 2	74.6	12.0	3.0	10.4	7.1	8.5	0.7	7.8	1.91	0.14
2- 6	77.8	12.0	1.1	9.1	6.4	3.4	0.7	2.7	0.60	0.05
6-16	70.7	13.9	1.3	14.1	5.1	3.4	2.2	1.2	0.43	0.04
16-30	64.8	13.6	1.6	20.0	4.4	3.4	2.6	0.8	n.d.	n.d.
30-48	55.3	9.8	1.2	33.7	4.5	3.8	3.0	0.8	n.d.	n.d.
48-72	50.8	10.2	1.1	37.9	4.5	3.8	2.9	0.9	n.d.	n.d.

Source: GROVE, A.T.: op.cit., p.76.

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(1) GROVE, A.T.: Land Use and Soil Conservation in Parts of Onitsha and Owerri Provinces. Geological Survey of Nigeria, Bulletin No.21, Lagos, 1951, p.22.

(2) RUTHENBERG, H.: Farming Systems, op.cit., pp.47-48.

No precise figures on population densities for the 1940's are available for the region. It is generally taken for granted that the system of shifting cultivation can sustain only a few people. GEERTZ (1) argues that in the rainforests of south-east Asia, in an ecologically balanced shifting economy, no more than twenty to fifty people can live per square kilometre with guaranteed subsistence.

A continuous increase in population (2), the production of more food crops and the expansion of more export crops - oil palms in this case - has led from shifting cultivation to bush fallowing. FAULKNER and MACKIE reported in 1933:

> " In large parts of Nigeria, especially in the provinces of the South-West, which have a moderate density of population, say 100 or 200 to the square mile, all high forest has already disappeared; and the shifting cultivation there would be more accurately described as a system of rotational "bush fallows", in which the time in fallow exceeds the time that the land is cultivated" (3).

OBI and TULEY indicated that

> " in the past, when the time period between each cycle of cutting and burning was always in excess of seven years and often considerably longer, the Bush Fallow developed as a stable ecological system" (4),

and they continued:

> " It can be seen that Bush Fallowing has many merits in the preservation of soil fertility. The soil is exposed for a minimum period of time by mixed cropping, the root system of the fallow is largely left intact, the fallow recovers quickly and the ratio of cover to exposure is large" (5).

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(1) GEERTZ, C.: Agricultural Involution.The Process of ecological change in Indonesia. University of California, Los Angeles, 1963, p.26.

(2) HELLEINER indicates that several centuries ago migration occurred, probably from the northern to the southern regions, resulting in a higher population density than had previously been the case. In: HELLEINER, G.H.: Peasant Agriculture, Government and Economic Growth in Nigeria. Econ. Growth Centre, Yale University, 1966, p.3.

(3) FAULKNER, O.T. and MACKIE, J.R.: West African Agriculture. Cambridge, 1933, p.44.

(4) OBI, J.K. and TULEY, P.: The Bush Fallow and Ley Farming in the Oil Palm Belt of South-East Nigeria. Land Res. Div., Surbiton, Surrey, England, Misc. Report 161, 1973, p.1.

(5) Ibid, p.5.

The stability of the system depends on the number of years that the land remains under fallow. NWOSU mentioned a "basic rotation" with a fallow period of seven years:

1st year:	yams, early maize and vegetable, cassava
2nd year:	cassava followed by bush fallow
3rd - 9th year:	bush fallow.

It is probable that in "distant history" when population pressure was not a matter for concern, this rotation was the only one in use around the villages (1). Such long periods of fallow had to be abandoned as population density increased.

> " The obvious problem ensues when the villages become so close and the number of inhabitants so great that unused land is minimal or no longer available. The length of fallow progressively decreases with resulting degradation of vegetation and deterioration in the soils" (2).

The process of impoverishment was particularly severe in the highly populated areas around Onitsha and Owerri, where the population in 1933 was between 400 and 500 and even more per square mile. As FAULKNER and MACKIE reported:

> " There the system has really broken down already, and the yields are very poor, even allowing for the inherently poor nature of the soil: the farmers continue the system, because they (and ourselves too in that area) know of nothing better" (3).

More detailed studies were undertaken after the second world war. GROVE (4) reports an average density of 300 persons per square mile in the area in the late 1940's and argues that this is probably the maximum number of people for which there is an assured food supply (5). The distribution of the population is most uneven, and "some communities are suffering from an acute

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(1) NWOSU, N.A.: Some Indigenous Cropping Systems of Eastern Nigeria. (Mimeo), F.A.R.T.S., Umudike, 1974, p.5.

(2) VERMEER, D.E.: Agricultural and Dietary Practices among the Tiv, Ibo and Birom Tribes, Nigeria. University California, 1964, p.168.

(3) FAULKNER, O.T. and MACKIE, J.R.: op.cit., pp.44-45.

(4) GROVE, A.T.: op.cit., p.21.

(5) BENNEH mentioned a maximum number of 150 per square mile in the forest region of Ghana. See: BENNEH, G.: Small Scale Farming in Ghana. Geogr. Research Institute, Budapest, 1971, p.138.

shortage of land and from soil deterioration accelerated by that shortage"(1).

GROVE describes the process of declining soil fertility as follows:

> " The fertility of the soils depends on the accumulation of plant debris, its decay, and incorporation in the surface layers of the soil. As the fallow period shortens with increasing population pressure, the annual addition of organic material is also reduced owing to the degradation of the vegetative cover. On sandy soils in a hot climate, it is probably true to say that, owing to the rapidity of oxidation, the cumulative increase of organic matter from year to year is extremely small. Thus in the absence of manuring, such lands must remain at a low level of fertility" (2).

BASDEN, after having analysed some soil samples from different localities in Eastern Nigeria, wrote that soil experts "expressed surprise that any crops could be induced to grow in them" (3).

Similarly descriptions are given by VERMEER:

> " Peasants here indicate that in the approximate 35 years since the opening of this area to cultivation, soil fertility, as reflected in crop yield, has decreased" (4).

Quantitative data on agricultural production per unit area in the region seem to be very scarce. One exception is the information collected by MARTIN, which provides a rough estimate of the productivity of the farming system in Eastern Nigeria (see: Table 2).

Unfortunately in MARTIN's work there is no indication of the length of fallow prior to cultivation. Like many other authors, MARTIN reports that:

> " the fallow period has been progressively shortened in recent years as the mortality rate has fallen, population grown, and pressure on the land increased, and it is now almost certainly too short for land to regain full fertility" (5).

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(1) GROVE, A.T.: op.cit., p.21.

(2) Ibid, p.17.

(3) BASDEN, G.T.: Niger Ibos. Frank Cass & Co.Ltd., London, 1966.

(4) VERMEER, D.E.: op.cit., p.158.

(5) Ibid, p.7.

Table 2: Average Yields and Seed Rates of the More Important Food Crops

Crops		Yield kg/ha	Seed rate kg/ha	Net Yield kg/ha	Loss in store %
Yams	Yellow yams	9430	1572	7858	20
	Water yams	5614	673	4941	10
	Mkpuk (a)yams	6736	2245	4491	25
	Akpa (b)yams	7859	1347	6512	5
Maize	Local	561 (dry grains)	18	543 (dry grains)	
Cocoyam		5120	1179	3941	20
Cassava		10104	0	10104	
Telfaria		2807	0	2807	

(a) "white round" the most favoured for food.
(b) A poor yam for food, used for gin.

Source: MARTIN, A.: The Oil Palm Economy of the Ibibio Farmer. Ibadan University Press, 1956, p.6.

In addition to the rapid decline in yields, the shortening of the fallow period has resulted in soil erosion where land is not flat. JOHNSTON asserts with regard to the Owerri district:

> " The beginning of large-scale gully erosion in parts of this area is an indication of the final collapse of the system of bush fallowing as a result of increasing population pressure"(1).

2. The Change in Cropping Pattern

The expansion of cropping and the reduction in fallowing was accompanied by a change in cropping pattern. The first Europeans to bring new crops to the West African coastal areas were Portuguese traders in the 16th century. MORGAN and PUGH mention maize, cassava, groundnuts, sweet potatoes and

(1) JOHNSTON, B.F.: The Staple Food Economies of Western Tropical Africa. Stanford University Press, California, 1963, p.9.

American cotton (1). The colonial agricultural departments later introduced higher oil-yielding, thin-shelled varieties of oil palm from the East Indies (2), and rice was introduced by traders and missionaries, but this crop was little cultivated in Eastern Nigeria before 1939. Of the crops mentioned above oil palms and cassava have made the highest impact.

Before the 19th century the contact with European merchants was mainly along the coastal area, and food production was encouraged near the slave ports (3). After that period and the advent of colonial rule, cultivation for export, mainly of palm oil, but also of dried coconut kernels, became a major task of the colonial administration. First records of palm oil exports are given from the middle of the 19th century:

> " In 1840 approximately 12,000 tons of palm oil were shipped from West Africa to Liverpool, of which three quarters came from the Niger delta" (4).

> " Imports of 30,000 tons of palm oil through Liverpool were reached in 1851" (5).

The development of production and exchange was further stimulated through the construction of roads and railways and the introduction of new methods of transport (6). New regions inside the country were opened up, and the export of oil palm products increased steadily. The newly created purchasing power of the local farmers encouraged internal exchanges (7), and through the "long distance trade" farmers purchased salt, fish and, later, clothes:

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(1) MORGAN, W.B. and PUGH, J.C.: op.cit., p.470.

(2) Ibid, p.487.

(3) With the abolishment of the slave trade, the trade in palm oil and palm kernels gained in importance:

> "the abolition of the slave trade caused some economic revolution in the locality, for this abolition shifted interest to palm oil. This was so because prior to the abolition little or no interest was given to palm oil production".

See: MBAH, I.A.: A History of AHIAHARA from the early Time till 1905. University of Nigeria, Nsukka, 1973, p.43.

(4) MORGAN, W.B. and PUGH, J.C.: op.cit., p.402.

(5) MANSFIELD, G.B.: A Short History of Agriculture in the British Colonies. Oxford, 1960, p.56.

(6) "As early as 1896 the Foreign Office, which then controlled the protectorate, has emphasised the importance of roads as arteries of trade". See: ANENE, J.C.: Southern Nigeria in Transition 1885-1906. Cambridge, 1966, p.289.

(7) NWAHIRI, L.O.: Nguru Mbaise before the coming of the British. University of Nigeria, Nsukka, 1973, p.43.

> " ... in 1937, with the price of palm oil higher, clothes were more numerous and the younger men were increasingly taking to shorts and shirts or singlets" (1).

The income from palm oil became the economic mainstay of the people, and in 1959 the National Economic Council could report that "Nigeria is the world's largest exporter of palm kernels and oil, and provides 50% of the world trade in kernels and over 30% in palm oil" (2).

The agricultural departments of the British administration encouraged cultivators to develop large and small plantations with densities of 125 to 150 trees per ha. Hand presses were introduced in the villages of the main oil palm belt, and later power-operated Pioneer oil mills which doubled the extraction efficiency compared with the traditional method. However, the introduction of this new technology was not without problems. For example, "opposition has come from the women who lose their perquisites of kernels and a portion of the oil, and from farmers who find only good quality fruit is accepted" (3). This is one of the reasons why processing of oil palm bunches has so far been done by hand as the work of women.

Oil palm plantations have been stimulated by the Ministry of Agriculture, and as SMOCK points out "this has been the principal way in which the Ministry has made an impact on the communities surveyed" (4). Farmers have recognised the economic importance of improved oil palms, and the demand for seedlings is very high.

In the survey area, however, oil palm production has experienced a gradual change in objectives. Initially it was a major export crop grown on virgin land. Then oil palms became to some degree incorporated into the bush fallow system, producing kernels for export and fat from the epicarp for home consumption. With increasing land shortage, oil palms have become fully incorporated into the subsistence crop.

The increasing land shortage has also had its impact on the output per tree. There are no data to confirm this, but observations indicate that oil palm in lower density areas look much more vigorous than in highly populated areas.

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(1) GREEN, M.M.: Ibgo Village Affairs. Frank Cass and Co.Ltd., London, 1964, p.33.

(2) National Economic Council: Economic Survey of Nigeria 1959. Lagos, 1959, p.23.

(3) MORGAN, W.B. and PUGH, J.C.: op.cit., p.487.

(4) SMOCK, D.R.: op.cit., p.16.

The decline in soil fertility due to overcropping has made its initial impact on yields from arable crops. In the long run also oil palm output has suffered from the loss of nutrients. The genesis of oil palm production in the area consequently goes from an export crop with vigorous growth to a poorly producing subsistence crop, shading depleted land cropped in an intensive fallow system.

The change in oil palm production was accompanied by a change in the cropping pattern of arable farming. Originally food starches were obtained mainly from yams and cocoyams. It it thought that cassava began to spread most rapidly in the late 19th century, when the problems of shorter fallows became more acute. Several authors have indicated that cassava surpassed yams in total production several decades ago (1). The main reasons for the increase of cassava production are that:

- increasing population density and declining soil fertility implemented a change to a crop with more calories but less demanding on soil fertility;
- cassava production has much lower labour requirements than yams, the traditional staple food crop;
- harvesting can be done according to the food requirements of the families;
- when processed into gari it can easily be stored and transported.

Although the importance of cassava differs between the regions, it has now become the major staple crop in Eastern Nigeria.

3. Attempts at Continuous Cultivation

The problem of declining soil fertility resulting from the washing and leaching of the principal soil nutrients led to the question of whether continuous cultivation could be introduced. Researchers conducted experiments with green manuring in order to replace fallowing. For this reason a six-year trial rotation incorporating different cover crops was set up in 1924 at the Agricultural Research Station at Umudike. "Most fallow experiments on this station in the early days were centred on the comparison between the native practice (bush fallow) and continuous cropping with green manures incorporated"(2). During the first years the reports were optimistic:

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(1) See: BASDEN, G.T.: op.cit., p.395, SMOCK, D.R.: op.cit., p.1.

(2) EGWUONWU, J.A.: Soil Fertility Studies at Umudike since 1923. Agr.Res. and Training Station, Umudike-Umuahia, 1966, p.9.

> " To one who has been acquainted with the farm and its history from the beginning, however, there seems to be evidence which indicates that by further experimenting with the rotating of food crops and green manure, it will eventually be possible to formulate a system of perpetual cultivation which will commend itself to the natives in thickly populated areas as an alternative to the present or shifting method of cultivation" (1).

After the completion of the experiment a total failure had to be reported:

> " As a result of seven years experimental work with continuous cultivation, incorporating green manuring, it has now been established that the system as practised at Umuahia is not compatible with the maintenance of soil fertility.
>
> 'The native system' comprises two years cultivation followed by four years bush, while the continuously cultivated plots (at Umudike) have been under a six years' rotation including three green manure crops (Mucuna), two of a year's duration each, and one of half a year. Test crops of yams and maize were taken in 1931 and showed that whereas the fertility of the 'native' plots was just as high as it had been in 1925, that of the continuously farmed plots had fallen practically to nil. Some of the latter, in the past, gave negative yields when allowance was made for planting material" (2).

The results in Table 3 show a decrease of 61.5% with continuous cultivation compared with the native bush fallow system.

> " On the failure of green manuring at Umudike, a series of trials was carried out on such deeper rooted legumes as Tephrosia, Pigeon Pea and Crotolaria spp., but none of these compared favourably with planted fallows of A. barteri" (3).

Some years before the second world war, experiments were conducted with farmyard manure which gave the following indications (4):

- Farmyard manure and compost gave increased yield responses.

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(1) A.R.S. Umudike: Annual Report, 1926, p.1.

(2) A.R.S. Umudike: Annual Report, 1931, p.1.

(3) OBI, J.K. and TULEY, P.: op.cit., p.6.

(4) EGWUONWU, J.A.: op.cit., p.12.

- Farmyard manure and compost in combination with lime where required gave higher responses than without lime.
- On a weight basis, farmyard manure was better than compost in crop yield response.

Continued cultivation has been practised over a period of 20 years by the Rural Education Centre at Umudike based on a heavy dressing of vegetable compost, one in each rotation (1). The data "show the yield trends over twenty years of cropping, and demonstrate that given adequate organic manuring, continuous cropping is possible" (2) (see: Fig.1.)

Table 3: Native Practice versus Continuous Cultivation. Summary of Yam Yields in kg/ha

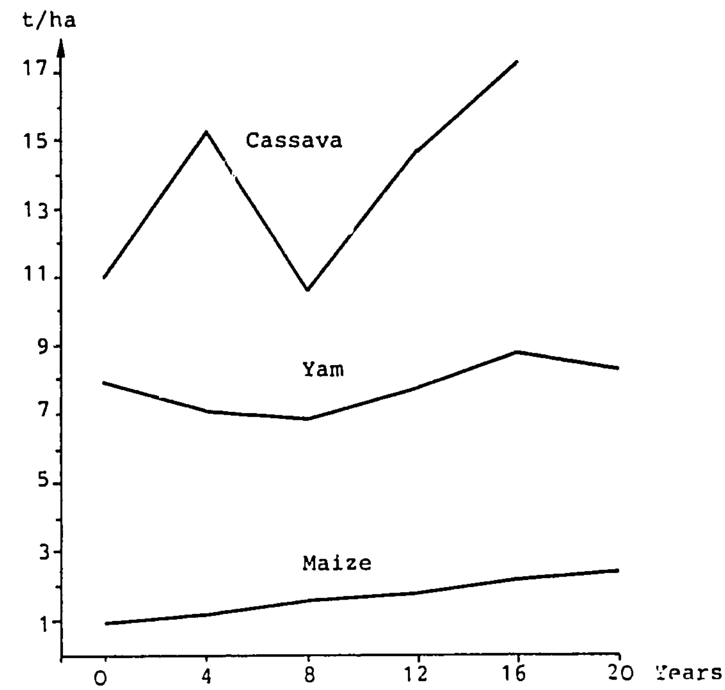
Mean of 14 native practice plots	12204
Mean of 13 continuous cultivation plots	4697
% decrease of continuous cultivation over native practice (control)	61.5
Plot size	0.1 ha
Spacing	1.22 m staggered on 1.83 m ridges.

Source: EGWUONWU, J.A.: op.cit., p.9.

(1) Quantitative data are not available.

(2) OBI, J.K. and TULEY, P.: ibid, p.8.

Fig.1: Combined 4-Year Averages of Annual Yield from all Rotations. Rural Education Centre Umuahia. 1940-1960



Source: OBI, J.A. and TULEY, P.: op.cit., p.19

It is obvious that the use of farmyard manure cannot replace the bush fallow system because of the limited availability of this material. The search for a feasible technology which is able to hold or even improve soil fertility under continuous cultivation has not found an adequate answer and this is still one of the main problems for research in the humid tropics.

4. The Tendency towards a Low-level Equilibrium

The efforts to increase food production during the colonial period and after independence have proved to be insufficient to support a growing population.

Farmers have adapted to the increasing scarcity of land firstly by non-farm activities:

- migrating to more fertile areas or to cities - in particular the better educated tend to move to the cities;
- most of the younger people turning to off-farm employment - they go as carpenters, sawyers, mechanics or petty traders (1).

In addition they have adapted their farming system mainly in two ways:

- cultivation of cassava has expanded at the expense of yams, a crop which yields less than cassava on infertile soils;
- cropping on small compound plots, where manure and animal waste is heavily applied, has been intensified.

The process of adaptation - as a result of increasing land scarcity - seems to be more pronounced:

- the less land is available,
- the more sandy the soils are, and
- the more humid the climate is.

These efforts are, however, insufficient to prevent the process of "involution". More people are subsisting on degraded land, and efforts to increase output by land use intensification are yielding very low marginal returns.

SMOCK refers to highly populated areas of Eastern Nigeria and writes: "many farmers have become desperate and are willing to try almost anything if it offers hope of an increased return" (2).

(1) GROVE, A.T.: op.cit., p.23.

(2) SMOCK, D.R.: op.cit., p.20.

B. THE ROOT CROP OIL PALM FARMING SYSTEM

I. The Resource Base

1. The Structure of the Households

The average household in the survey area had eight membe.s. The head of the household was usually married to one wife and they had six children. In Okwe (L), which has less pressure on land than the other villages, 48% of the men were married to more than one wife.

Not all household members were resident during the survey. In Owerre-Ebeiri (H) and Umuokile (M) on average 1.8 members were staying outside the villages as students, apprentices, house servants, traders, civil servants etc. Whereas in Okwe (L) on average only 0.4 members were not occupied at home. As a result the total man equivalents (ME) resident within the household differed between the villages. The highest manpower force was found in Okwe (L) with 4.0 man equivalents in comparison with 3.1 man equivalents in Owerre-Ebeiri (H) and 2.6 man equivalents in Umuokile (M) (see:Table4).

Table 4: Average Number of People and Man Equivalents of Farm Families in Three Villages in Eastern Nigeria, 1974

Labour class	Owerre-Ebeiri (H)		Umuokile (M)		Okwe (L)	
adult males (16-60 years)	1.3	Coef. Var.	0.9	Coef.Var.	1.2	Coef.V
adult females (16-60 years)	1.4	as %	1.3	as %	2.3	as %
adult males (over 60 years)	0.2		0.1		0.4	
adult females (over 60 years)	-		-		0.2	
large children (8-15 years)	2.3		1.9		2.3	
small children (under 8 years)	1.8		1.3		1.9	
household members away from home	1.8		1.8		0.4	
Total Persons	8.8	39	7.3	40	8.7	39
Total ME (a) at home	3.1	34	2.6	53	4.0	52
ME available for farm work (b)	2.5	40	2.4	58	3.9	53

Source: compiled by the author.

(a) Man equivalent used in the study for quantification of the labour capacity per household is given in Appendix II.

(b) The ME for a part-time farmer was reduced to 0.5.

It is important to note that on average 1.8 household members in villages with medium and high populations are away from home. They supply, however, significant amounts of money to the remaining family members. In addition part-time farming (1) plays an important role in the study area. Farmers themselves or other household members work in the villages or nearby townships as traders, cyclists, truck pushers, oil palm processers, raffia palm tappers, carpenters, etc. The higher the population density and the smaller the farms the more important is off-farm employment: in Okwe (L) 20% of the farmers are part-time farmers; in Umuokile (M) 32% and in Owerre-Ebeiri (H) 80% of the farmers were found to derive more than 50% of their net family income from off-farm activities and in this way can substantially increase their standard of living. This is reflected in the number of man equivalents available for agricultural work. Umuokile (M) and Owerre-Ebeiri (H) have on average 2.4 and 2.5 man equivalents available for farm work and Okwe (L) 3.9 man equivalents, which indicates a higher labour force where land is more available and the pressure of earning an additional income is not so pronounced.

2. Farm Sizes

The hectarage under cultivation in the survey year was found to be larger than that reported in the Rural Economic Survey of Nigeria for E.C.S. There the majority of the farmers (57%) cultivated an area of less than 0.2 ha (2). In this survey it was found that only 37% of the respondents cultivated such a small area. The average and modal values differed between the villages (see: Fig.2).

The area cultivated per farm decreases with increasing population density. Okwe (L) has on average 0.4 ha (1 acre) under cultivation, Umuokile (M) 0.27 and Owerre-Ebeiri (H) the smallest area of 0.23 ha.

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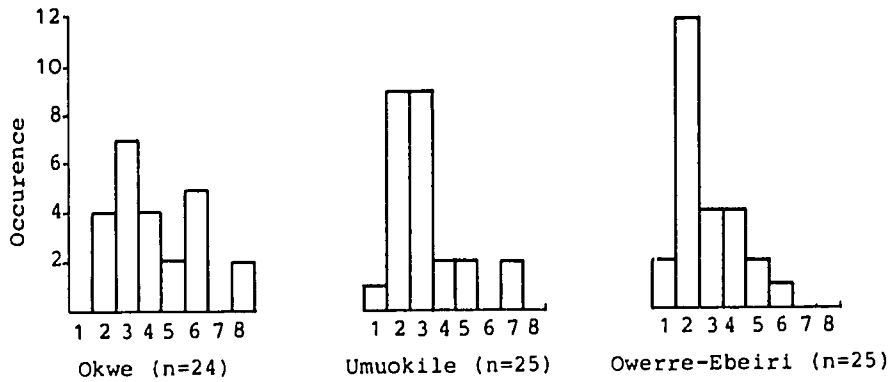
(1) A farmer is defined as a part-time farmer in this study when more than 50% of his net family income is derived from off-farm sources.

(2) Federal Office of Statistics: Rural Economic Survey of Nigeria, 1970-71, Lagos.

Fig.2: Frequency Distribution of Cultivated Area in Three Villages in Eastern Nigeria, 1974

Class	ha	Class	ha
1	0-0.1	5	0.41-0.5
2	0.11-0.2	6	0.51-0.6
3	0.21-0.3	7	0.61-1.0
4	0.31-0.4	8	> 1.01



$\bar{x}$ = 0.4 + $\bar{x}$ = 0.27 $\bar{x}$ = 0.23

+) If two oil palm plantations (with 2 and 3.6 ha), owned by two of the sample farmers, were included, the average size for Okwe (L) would be 0.63 ha.

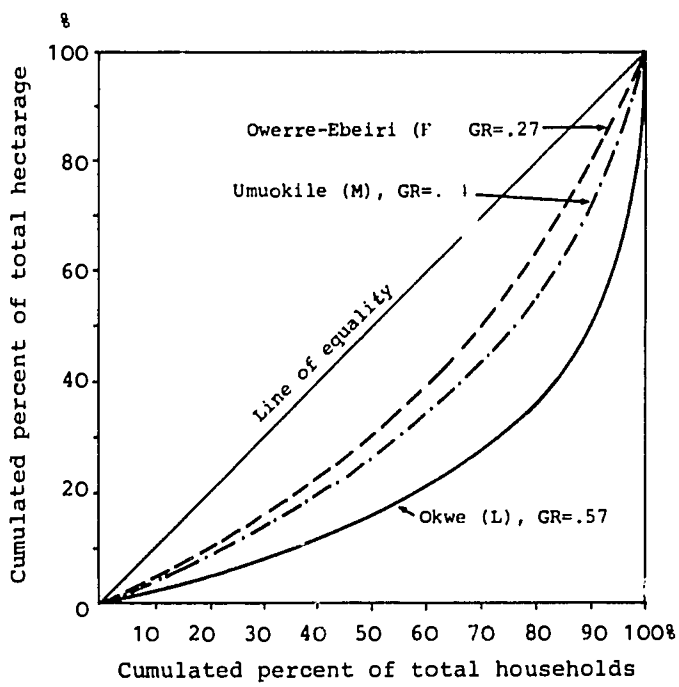
Source: compiled by the author.

The distribution of cultivated hectarage between households is by no means equal. It has to be considered, however, that most of the inequality in land distribution is due to intervillage differences (see: Fig.3). The Gini Ratios (GR) (1) of the distribution of cultivated area in the three survey villages

(1) "The Gini Ratio (GR) is defined as the area between the diagonal (or line of equality) and the Lorenz Curve as a proportion of the total area under the diagonal". See: BOYNE, D.H.: Changes in the Income Distribution in Agriculture. In: Journal of Farm Economics, Vol.47, Dec.1965, p.1220. Formula: GR = 1 - hi (li + li-1). See: PIESCH, W.: Statistische Konzentrationsmaße. Mohr, Tübingen, 1975, p.43.

increases from .27 in Owerre-Ebeiri (H) to .34 in Umuokile (M) and even .57 in Okwe (L). Land distribution is therefore more unequal the more land is available for farming and the lower the importance of non-farm employment (1).

Fig.3: Relationship between Number of Households and Cultivated Areas in the Three Survey Villages, 1974



Source: compiled by the author.

(1) Similar inequality in land distribution was found in a study of Yoruba Smallholders. See: FLINN, J.C.: Resource Use, Income and Expenditure Patterns of Yoruba Smallholders. IITA, Ibadan, Nigeria, 1974, pp.4 et seq.

A comparison of the resource base of land must include the areas under bush or grass fallows from which farmers receive annual returns in the form of fruits from various trees, firewood, livestock feed (leaves), bush meat and further mulching material for the compound fields. The fields under bush fallow were not measured, but they were estimated by assuming that the area under cultivation each year does not change significantly. Total farm size is on average 2.4 ha in Okwe (L), 1.0 ha in Umuokile (M) and .40 ha in Owerre-Ebeiri. These figures indicate a population density per square km of about 250 in Okwe (L), 500 in Umuokile (M) and about 1,200 in Owerre-Ebeiri (H) (1), which seems to be realistic when compared with the figures collected during the 1963 census.

The increasing pressure on land was found to result in a transition from communal to private land ownership. Inheritance through the patrilineal system is the usual way of acquiring land, with 73% of all fields in the three villages being inherited in this way (2).

The typical farm is divided into several fields which are scattered throughout the land controlled by the village. The lower the man/land ratio the greater the distance was found to be from the house to the fields. For example in Okwe (L) the distant fields were often up to one hour's walk away. On average farmers own 4-5 plots in Okwe (L) and 6-7 plots in both Umuokile (M) and Owerre-Ebeiri (H). This results in smaller plot sizes the higher the pressure on land (see: Table 5).

The existing fragmentation of the holdings serves as a means of reducing the risks of production. Each household owns plots with different soil types and soil fertility levels and with different water holding capacities. Consequently there is always a high chance that some of the plots will yield as expected and the minimum of subsistence requirements is secured. On the other hand the fragmentation is an obstacle to any kind of mechanized production.

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(1) The area not usable for cultivation is estimated as 25% in Okwe (L), 30% in Umuokile (M) and 35% in Owerre-Ebeiri (H). GRENZEBACH used 30% for an area with a population density of 600 p/km^2. See: GRENZEBACH, K.: Luftbilder: Indikatoren für regionale Komplexanalyse. In: Die Erde, Zeitschrift der Gesellschaft für Erdkunde zu Berlin, 105. Jahrgang, 1974, p. 104.

(2) More detailed data on land tenure in the three survey villages is given in Appendix IV.

Table 5: Average Number of Plots and Size of Plots in Three Villages in Eastern Nigeria, 1974

	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
Number of plots (a)	4.4	4.4	6.6
Size of plots	880 m^2	620 m^2	340 m^2
CV as %	89	114	73

(a) All compound and non-compound plots are included.

Source: compiled by the author.

3. Livestock

The prevalence of tsetse flies in the area limits the range of livestock which can be kept in Eastern Nigeria. Hence the major livestock are goats and chickens as opposed to cattle. Table 6 shows the total and average number of livestock kept by the survey farmers in the three villages. On an average the households own two goats and 15 chickens. It is quite obvious that the importance of livestock increases simul'aneously with the population density.

Table 6: Total and Average Number of Livestock in Three Villages in Eastern Nigeria, 1974

Village		Goats	Sheep	Pigs	Chickens	Ducks	Others(a)	Total
Okwe (L)	total	33	-	1	218	4	30	286
	average	1.38	-	0.04	9.08	0.17	1.04	11.7
Umuokile (M)	total	47	14	-	374	3	24	462
	average	1.96	0.58	-	15.58	0.13	1.0	19.3
Owerre-Ebeiri (H)	total	81	13	1	515	-	1	611
	average	3.24	0.52	0.04	20.6	-	0.04	24.4

(a) Includes dogs, cats and rabbits.

Source: compiled by the author.

The higher the population density the larger are the compound fields which are fertilized with animal dung. Goats in particular are reared - among other reasons to be mentioned later - for the production of animal manure.

4. Capital Equipment

Farmers in Eastern Nigeria are hoe cultivators. Different types of hoe serve for different activities: short-handled hoes are used for cultivation and weeding. The hoe for the latter activity is usually smaller than the hoe for cultivation of the soil. A special long-handled hoe ("ube") is used for digging yam holes.

Cutlasses are used for clearing the bush, cutting small trees and other purposes. Climbing ropes, tapping knives and calabashes serve for tapping the palm wine from raffia trees. Crops and fruits are transported on the head in baskets or buckets. In most cases bicycles are used for transporting the products to the local markets. Agricultural production and processing depend almost entirely on human power. An exception is the power-operated gari grater, and in Owerre-Ebeiri (H) several farmers (who process oil palm fruits from other people) have invested in hand-operated oil presses, which increase the output and the quality of palm oil. The farm implements owned by a farmer in Umuokile (M) are typical for the three villages and are a good example for the study area (see: Table 7). The current replacement value of capital items used in farming is in the order of ₦ 68.00.

Most of the farmers are still living in simple mud houses, but an increasing number are building cement-houses with tin roofs. Farmers with a high off-farm income through trading - mainly in Owerre-Ebeiri (H) - tend to live in better houses than the others.

5. Conclusions

The information on the resource base indicates that a great number of people live mainly by farming tiny plots with hand tools. Subsistence production prevails and the food demand of household members is such that there is very little scope for commercial farming. What we find is a peasantry in a high population density area living by mining soils, with traditional farming techniques, and without capital formation. Non-farm employment is the only recognised possibility of escaping from the low-level equilibrium trap.

Table 7: Farming Equipment Owned by a Small Farmer in Umuokile (M)

Item	No	Replacement Value (N)	Total Value (N)	Years useful life
hoe (ube)	1	.40	.40	5
hoes	6	.40	2.40	4
cutlass	5	1.50	7.50	4
rake	1	1.00	1.00	4
shovel	1	2.50	2.50	2
files	2	.50	1.00	1/3
climbing ropes	3	2.00	6.00	1/2
calabash	3	.40	1.20	1
jars	3	1.50	4.50	10
tapping knives	2	.50	1.00	2
baskets	5	.75	3.75	1
buckets	4	2.50	10.00	4
mortars (oil)	2	2.00	4.00	10
mortars (pepper)	1	.60	.60	10
Total replacement value			68.35	

Source: LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: op.cit., p.34.

II. The Organisation of Land Use (1)

The main source of farm income, as in other regions of West Africa, derives from crops, with livestock playing only a supplementary role within Eastern Nigeria. Cassava and yams provide most of the calorific requirements, where-

(1) In this section considerable use has been made of the paper by LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: Root Crop/ Oil Palm Farming Systems: A Case Study from Eastern Nigeria. IITA, Ibadan, Nigeria, 1975.

as oil palms produce the major part of the fats and are the main source of cash income from the farms.

The land use pattern reflects the outcome of a continuous process of adaptation of farming to increasing land shortage and declining soil fertility.

1. Spatial Organisation of Cropping

There exists a spatial differentiation in land use which becomes more pronounced the higher the population density (1). Fig.4 shows the layout of the three survey villages in Eastern Nigeria. Okwe (L) and Umuokile (M) are clustered villages with the major fields outside the village, whereas Owerre-Ebeiri (H) consists of scattered dwellings with fields close to them. On most holdings three types of plots have to be distinguished:

- The compounds have a high density of trees and a large range of food crops and vegetables. They are situated around the houses. The sizes of the compounds vary from about 200 to 1000 square metres; the compounds tend to be larger in areas of higher population density due to food being relatively more scarce. (2)
- Near fields, close to the compound, are usually dominated by oil palms and other useful trees, and produce food crops within an intensive bush-fallow system. The fallow period varies from five years (in lower population density areas) to only one year in areas where there are more than about 700 persons per square kilometre.
- Most of the starchy food is produced within an extensive bush-fallow system on the distant fields. They are larger in size than the near fields and have a low density of trees. In some areas the fields are open, mainly where land is not so scarce.

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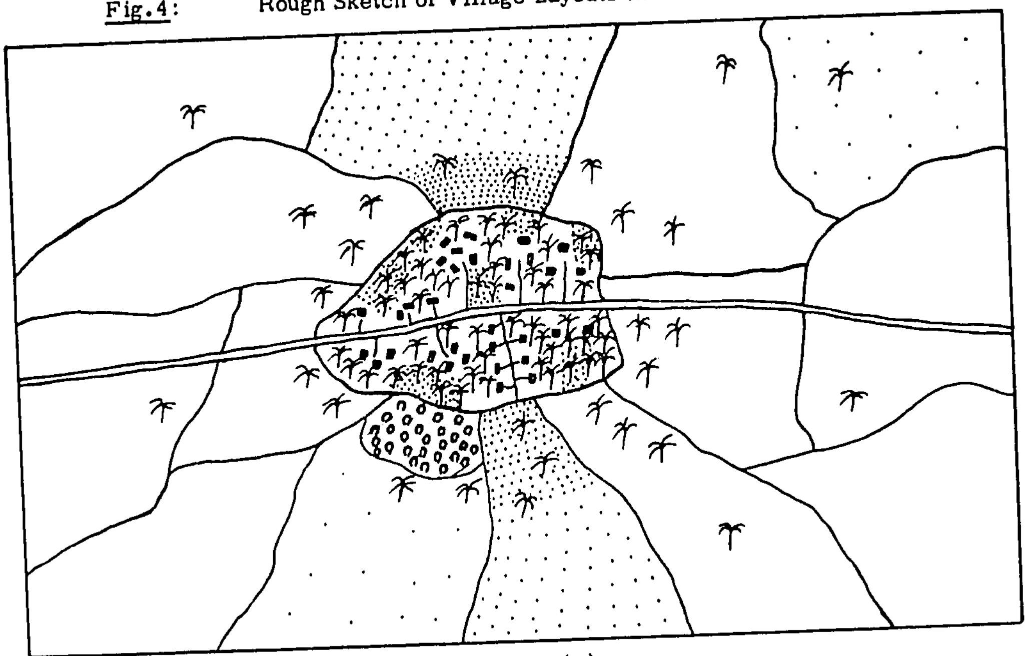
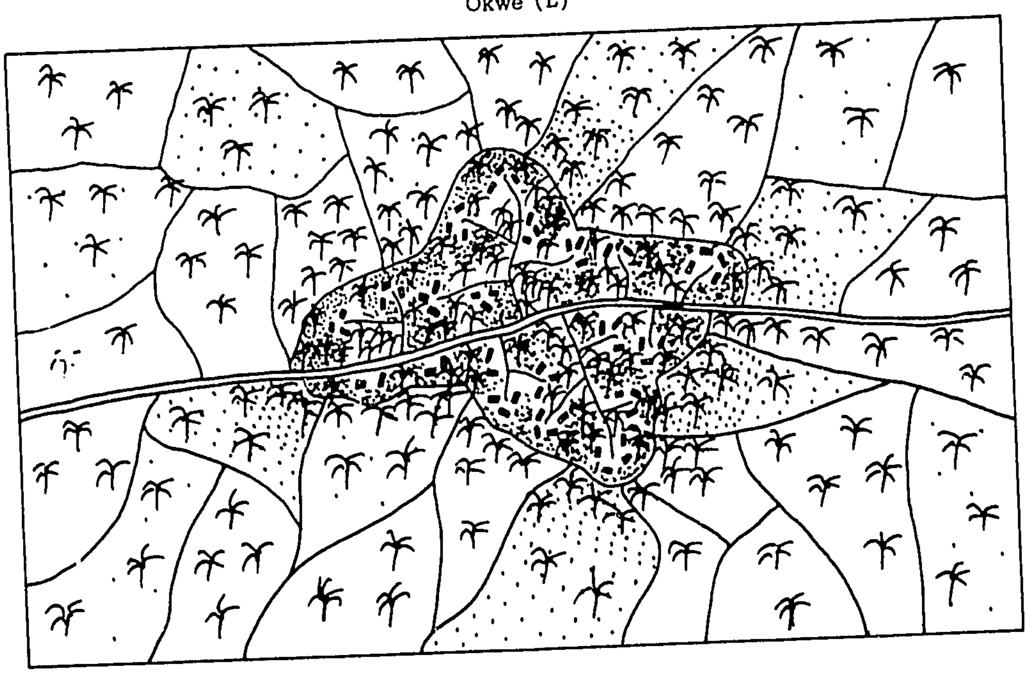
(1) The spatial distribution of plots increases the time for walking to and from fields. CLEAVE suggests that this activity may account for up to 30% of the time the farmers devote to agriculture. Under these circumstances, the cost of delivering inputs to fields and of exporting produce (typically by head-loading) is high, at least in terms of physical energy requirements and time. See: CLEAVE, J.H.: Labour Use in the Development of Smallholder Agriculture. Praeger, New York, 1974, pp.34 et seq.

(2) Compound farming is not practised in Okwe (L). Land there is more ample than in the other villages, and farmers have not been forced, up to now, to intensify their cultivation on small areas.

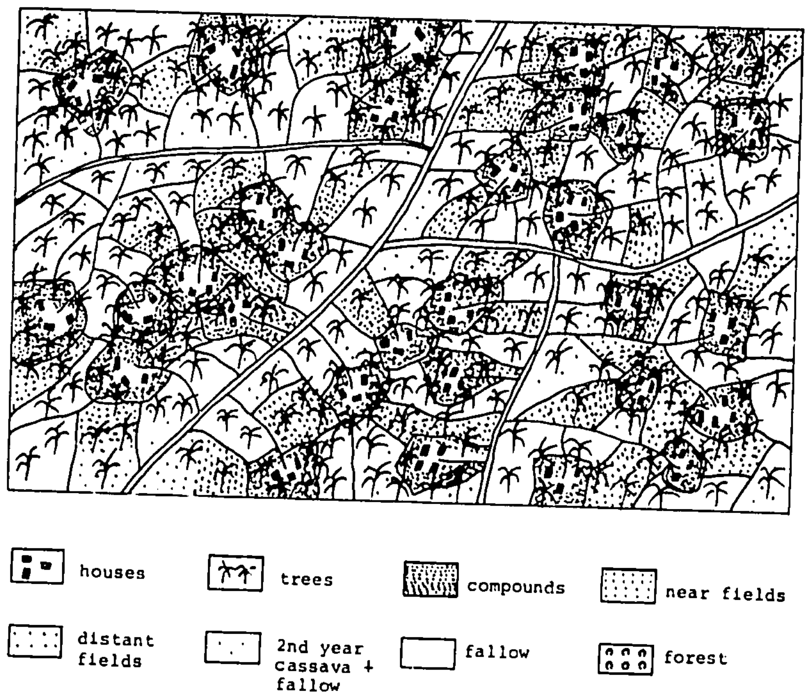
Fig.4: Rough Sketch of Village Layouts in Eastern Nigeria



Okwe (L)



Umuokile (M)



Owerre-Ebeiri (H)

Source: compiled by the author.

- Fallow land of both the near and distant fields in addition to building up soil fertility and structure (1) provides fruits from various trees, including oil palms, oil bean and breadfruit, palm wine from raffia, building materials and firewood from various trees and bushes, and they provide mulching material for the compound.

180 years ago THÜNEN (2) described the tendency towards an intensification of smallholder farming in Europe which resulted in rings of varying degrees of fertility, since the areas close to the villages and markets had been fertilized longer and better than the more distant fields. This was due - he argued -

(1) See: GREENLAND, D.J.: Bringing the Green Revolution to the Shifting Cultivator. IITA, Ibadan, Nigeria, 1975, p.4.

(2) THÜNEN, J.H. v.: Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie. I.Teil, 1. Aufl., Hamburg 1826. In: Sammlung sozialwissenschaftlicher Meister, Bd.13, Jena, 1910.

to the differences in transportation costs. Fields close to the markets had therefore a higher value, and farmers were stimulated to use these fields more intensively.

Similar "circles" or "zones" can be found in the smallholder farming of Eastern Nigeria around each village or house.

2. Compounds

Directly round the house, where manure, mulch and ashes are applied, there is a dense growth of tree and arable crops with different requirements for available nutrients, water and sunshine. The further away a field is from the house, the less manure and mulch is applied. The compounds are not strictly separated from the nearby fields; indeed, there is only a gradual transition from one type of field to the other.

Compound farming is not a special land use system found only in Eastern Nigeria; it can be found worldwide in tropical regions where land scarcity has forced farmers to intensify production on small fields. In the case of northern Ghana BENNEH writes:

> " The compound farming system, based on permanent cultivation of land immediately surrounding a homestead is found in the northern region of Ghana. The fertility of the soil is maintained with refuse from the compound, the droppings of goats, sheep, poultry and night soil. In order to increase the area under permanent cultivation, women and children are encouraged to deposit refuse further afield. The crop sequence also involves a deliberate inclusion of legumes like groundnuts and bambara beans in the outer zone to help increase the nutrient status of the soil" (1).

Another example is given by FRIEDRICH, who writes of the Wahaya agriculture in Tanzania that it:

> " is based on a process of fertilizing by way of domestic refuse, ashes, mulch and manure. The export of nutrients is small, limited as it is to the sales of dried coffee. We note instead

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(1) BENNEH, G.: Small-scale Farming Systems in Ghana. Geographical Research Institute, Budapest, Dec. 1971, p.142.

> a substantial import of nutrients by the purchase of food, the gathering of fuel, the employment of mulch, and the fact that the cattle are being grazed on nearby pastures and kept in stables. These factors result in a decided increase in soil fertility, especially close to the hut" (1).

Similar intensive land use systems seem to have developed on the highly populated Gazelle Peninsula of New Britain. Crop production is based on banana cultivation, interplanted with coconuts, cocoyams and yams.

> " The villagers using this system are very short of land and obtain a lot of their food from other sources apart from locally grown crops ... there is a parallel here with the West African farmer in areas of high population density who has intensively farmed gardens near his house (compound land) and less intensive ones some distance from the dwelling (distant farmland)" (2).

Compound farming is thus a type of land use which is of general importance in the humid tropics. In the case of Eastern Nigeria it is characterized by a number of specific features which distinguish it from field farming.

a) Cropping Principles

In traditional agricultural systems farmers usually grow a number of crops in each field. This is particularly pronounced in the compounds of the survey villages where a large number of tree and arable crops were found. A multi-storey system (3) is predominant.

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(1) FRIEDRICH, K.H.: Coffee-Banana Holdings at Bukoba. In: RUTHENBERG, H.: Smallholder Farming and Smallholder Development in Tanzania. Afrika-Studien Nr.24, München, 1968, p.188.

(2) BOURKE, R.M.: Food Crop Farming Systems used on the Gazelle Peninsula of New Britain. In: Proceedings, 1975, P.N.G. Food Crops Conference, p.10.

(3) A "multi-storey system" is defined as the growing of two or more arable and tree crops (with different heights) in the same field at the same time.

Multi-Storey System

A multi-storey physiognomy with perennial and annual crops is typical of the compounds. The crops can be divided on a height basis into 10 different groups:

Tree crops

- Oil palms, coconuts (20 - 25 m);
- Breadfruit, raffia palm, oil beans, pears (12 - 20 m);
- Colanut, mango (8 - 15 m);
- Orange, grapes, lime, paw-paw (5 - 10 m);
- Bananas, plantains (3 - 8 m).

Arable crops

- Yams (3 - 6 m);
- Maize (1.5 - 2.5 m);
- Cassava, cocoyam, pepper, telferia (1 - 2 m);
- Groundnuts, melon, vegetables (0.1 - 0.3 m).

Various trees form the upper part of the storey whereas arable crops grow under the shade of the trees. The leaf canopy becomes denser the closer it is to the ground, and hence reduces erosion by absorbing rainfall, shades the land and so reduces soil temperature, provides a leaf litter for nutrient recycling, maintains reasonable levels of organic matter and conserves soil moisture during dry periods.

An intensive crop survey was undertaken in 88 compound plots in which all arable and tree crops were counted and recorded at the height of the vegetation period (June). The results show that cocoyam is the most important arable crop in the compounds (see: Fig.5). It is, like yam, which is the second major crop, relatively shade tolerant (1).

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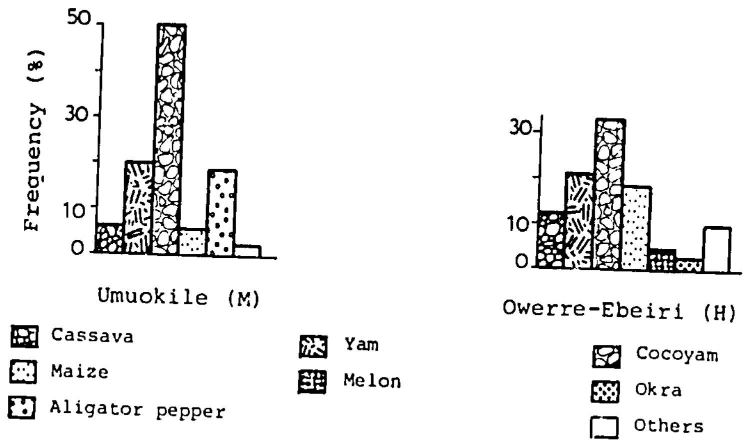
(1) See: PHILLIPS, T.A.: An Agricultural Notebook. Longman, Nigeria, 1964, p.21.

Fig. 5: Average Occurrence of Major Arable Crops in Compounds of Two Villages in Eastern Nigeria, June 1974.



Source: compiled by the author.

Results of experiments in farmers' fields indicated that yams tended to be less sensitive to shade than cassava and maize. Preliminary data indicated a reduction in yield of 9% in comparison with about 50% for cassava and 30% for maize when grown under shade as opposed to in the open (see: Table 8).

As well as the trees, cereals and root crops, a range of vegetables (1) (telferia, bitter leaf, water leaf) and creeping crops (melon, groundnuts) are grown in the compounds.

Beans and cowpeas are intercropped with taller growing species or, as in the case of Owerre-Ebeiri (H), usually grown along the borders of the com-

(1) The analysis of some nuts, seeds and leaves growing on compounds show a relatively high protein content, e.g. egusi 33.8%, calabash seeds 35.4%, white melon seeds 36.3% (see: Appendix XI).

Table 8: Maize and Yam Yields in Farmers' Fields, with and without Fertilizer, on Shaded and Unshaded Plots, Root Crop/Oil Palm Systems Survey, East Central State of Nigeria, 1974

Village	Owerre-Ebeiri (H)	Umuokile (M)	Okwe (L)	Mean yield
	t/ha	t/ha	t/ha	t/ha
Maize (a)				
shade, no fertilizer	.30	.15	.66	.37
no shade, no fertilizer	1.13	.02	.45	.53
shade, with fertilizer	.29	.94	.80	.68
no shade, with fertilizer	1.82	.66	2.01	1.50
Yams				
shade, no fertilizer	1.75	7.90	15.50	8.38
no shade, no fertilizer	2.75	9.20	15.50	9.15
shade, with fertilizer	3.25	12.00	13.00	9.42
no shade, with fertilizer	5.25	12.00	19.00	12.08
Cassava (b)				
shade, no fertilizer	2.43	3.58	2.32	2.78
no shade, no fertilizer	5.00	7.35	14.31	8.89
shade, with fertilizer	4.01	3.58	2.55	3.38
no shade, with fertilizer	11.84	9.42	21.98	14.41

(unreplicated plots)

(a) Maize yields in the medium density village are not representative due to damage by goats.

(b) Cassava yields on shaded plots in the low density village are not representative due to falling branches from palm trees.

Source: unpublished data of OKIGBO, B.N., IITA, Ibadan, Nigeria.

pounds. Bananas and plantains occupy places where latrines have previously been sited. Compounds are sometimes fenced by hedges consisting of cassava varieties.

On average, nine different arable crops were found in the compounds of Owerre-Ebeiri (H) and six in Umuokile (M). All different plants of trees, shrubs and arable crops are recorded by OKIGBO (1) from four compounds in the medium and high density villages. The total number of species on all plots was above 40, with an average of 47. This range of crops with its high density approximates to "the bush or forest conditions, representing an ecosystem of marked stability" (2).

The density of cropping in the compounds was found to increase with land scarcity (see: Table 9). Although the actual density is much higher, due to the fact that only the four main arable crops (3) were included, the figures indicate an increase of 41% in tree crop density and 42% in arable crop density in Owerre-Ebeiri (H) compared with Umuokile (M).

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(1) Detailed results from OKIGBO are provided in Appendix XII.

(2) OKIGBO, B.N.: Fitting Research to Farming Systems, Based on Observations and preliminary Studies of Traditional Agriculture in Eastern Nigeria. IITA, Ibadan, 1974, p.17.

(3) Yams, cocoyams (1 plant = 1 stand), cassava, maize (3 plants = 1 stand). A comparison of these figures with densities from outer fields is not possible for two major reasons:

1) The number of crops grown on compounds is higher than on outer fields, and hence a higher percentage of crops is not included from compounds.

2) Yams grown in compounds are usually bigger and require more space.

Table 9: Average Density of Cropping in Compounds at the Height of the Vegetation Period, June 1974

Village	Trees and shrubs stands/ha	CV as %	arable crops stands/ha	CV as %
Umuokile (M)	759	83	22000	32
Owerre-Ebeiri (H)	983	76	31800	58

Source: LAGEMANN, J., FLINN, J.C. and RUTHENBERG, H.: Land Use, Soil Fertility and Agricultural Productivity as Influenced by Population Density in Eastern Nigeria. In: Zeitschrift für ausländische Landwirtschaft, Heft 2, 1976, p.210.

Coefficients of variation compiled by the author.

Phased Planting

Another principle of the cropping practice is the adaptation of the planting time of various arable crops according to their requirements of rainfall and sunshine. Phased planting serves as a means of regulating the supply of food throughout the year and likewise spreads the labour input over the longer planting period which normally constitutes the major bottleneck in the farming calendar.

The compounds are cultivated continuously. Vegetables such as fluted pumpkin (Telferia coccidentalis), vegetable jute (Corchorus olatorus), ofe (Solanum spp.), pepper (Capsicun frutescens) and garden egg (Solanum melongina) are grown all the year round. This is possible as the soil is kept moist during the dry season with waste water from the household. During the peak of the dry season the vegetables are also watered as necessary by the women and children who carry water from the local tap, pond or stream.

The most intensive cultivation period begins with the planting of yam which has been pregerminated in the yam barn (1). In a root crop system pregermination is thus the equivalent of the nursery in a wet rice system.

The next crop, maize, is planted immediately after the yam, and followed by cocoyam and cassava a few weeks later.

Intercropping and phased planting contribute to the fact that the compound is equipped throughout most of the year with a fully developed photosynthetic-active multi-storey leaf area. The effectiveness of turning solar energy into products demanded by the family is probably high.

b) Husbandry Practices

Farmers in Eastern Nigeria do not in general plant on ridges, because the number of tree stumps and roots in a plot would make the preparation of ridges very tedious work. Planting on mounds and on the flat is more usual. The cultivation techniques are adapted to the needs of each plant and to the micro-environment of the surface conditions.

A common feature in compound farming is the extraordinary care with which the various crops are cultivated. The practices differ from crop to crop and most of the farmers treat different species of the same crop in a special way.

Nevertheless the basic concept of cropping pattern and husbandry practices can be found in all compounds of the study area. Variations occur according to the fertility of the soil, household preferences and the amount of land and labour available.

Cultivation

All trees except raffia are pruned or heavily trimmed, so that only a few branches on the very top of the trees remain. This enables more light to reach the ground and facilitates the growth of sunloving crops. The branches that have been lopped off are used for yamsticks, building material and firewood, while the small twigs and leaves are used as mulching material and as feed for the goats. Yams are planted in heaps in roughly straight lines at

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(1) Pregermination is done mainly with a local variety ("Nwanyaghara") which may yield tubers up to 30 to 40 kg weight.

distances varying from 1 to 1.5 metres. The holes which are 50 - 60 cm deep (depending on variety and size of yam sets) are sometimes dug several months before the tubers are planted. In the meantime the farmers fill the holes with leaves from trees and residues from oil palm bunches which later provide manure for the yam plants. The tubers are covered by mounds, on average between 30 - 40 cm high and varying according to the type and size of the yam sets. In this part of Eastern Nigeria large mounds are not used, as the sandy soils are subject to shifting, resulting in large mounds being more easily washed away during heavy rainstorms than smaller ones.

Maize is usually planted on the flat between the mounds and cassava and cocoyam on smaller mounds between the yam heaps. Some farmers plant their cocoyam in holes with a diameter of about 40 cm. When the cocoyam tubers grow above the earth, they fill the holes with mulching materials and compost soil, to provide a steady supply of nutrients to the plants.

After planting, the whole compound is covered with mulching materials which are procured from trees, crop residues and from the bush fallow in order to:

- reduce soil erosion,
- hold the soil moisture content,
- provide manure to the plot, and
- protect the seeds against scratching fowls.

Attention has to be drawn to the fact that compound farming does not involve any general breaking up of the soil comparable to the effect of hoe or plough cultivation. The soil is moved only for the planting of a specific seed or tuber.

Manuring

In their compounds the Ibo practise careful methods of manuring, which is the base of a successful continuous cultivation. Export of nutrients is limited to the edible parts of the harvested crops, all residues remaining in the fields. The import of organic materials from outer fields, fallow land and through household purchases is substantial. The goats are stabled during the main crop season and are fed with oil palm leaves, crop residues and household remains. Goat manure is highly valued as a source of plant nutrients. With the practice of manuring systematically, the farmers have built up the fertility of the soil in the compounds. The intensity of fertilizing the soil seems to be higher in Umuokile (M) than in Owerre-Ebeiri (H). The compounds there are smaller, and larger quantities of cassava and oil palm bunches are processed within the households from where most of the crop residues are collected.

The survey farmers practise the following methods of fertilizing:

- mulching: all kinds of smaller branches, twigs and leaves from trees and shrubs are used for mulching the compound. The yam mounds especially are covered with a thick layer of these materials;
- animal waste: dung, mainly from goats, is applied throughout the year to the crops. It is usually applied to individual plants;
- ashes: as with animal waste, ashes are distributed directly around the individual plants;
- composting: this practice is common in Owerre-Ebeiri (H) where grasses from the fallow areas are collected and thrown, together with household remains, into pits where the materials decay. The resulting rich soil is then applied to the crops;
- shifting of latrines: every year the latrines are shifted to another site within the compound. After a period of one cropping season the latrines are filled in, and bananas or plantains are planted, and so receive ample nutrients for many years.

These manuring practices have not been developed to such a degree in the lower populated areas, as represented by Okwe (L). We can assume that the labour-intensive way of building up soil fertility is a result of the people's efforts to overcome the increasing food shortage which results from the high population density.

Harvesting

While some of the leaf vegetables and cassava tend to be harvested throughout the year, the majority of crops have reasonably well defined harvest periods.

For example, maize is the first of the major crops to be harvested, which effectively ends the "hungry season", from late June to August. The majority of the maize is consumed as green or fresh corn on the cob, only a small amount being dried and stored unhusked over the fireplace.

The method and time of harvesting differs between varieties of yams. For example, while some early planted and early maturing varieties (e.g. the white yam D. rotundata) may be harvested in July-August, other late maturing species such as the yellow yam (D. cayenensis) are usually harvested later, even if planted at the same time as the early maturing types. The July-August harvest of white yam, called "milking", is followed by a second harvest which takes place in November to December, when the yam heads that were buried after the first harvest have developed small tubers and the main vines die. These smaller tubers are stored as seedyams for the following planting season. Other varieties of yams such as the three-leafed yam (D. dumetorum) are harvested once from November to December.

The last of the food crops to be harvested (other than cassava) are cocoyam (Xanthasoma spp. and Colocasia spp.), in January and February, after which the plot is prepared for the new cropping season. In most compound farms, cocoyams usually precede yams in the rotation.

c) The Value of Traditionally Grown Plant Species in the Diet

The time sequence through which the major food crops are harvested is shown in Fig.6. These crops, harvested from the compound plots, tend to provide a continuous supply of food for the farm family over the year. It is apparent that in addition to the usually mentioned food crops (e.g. yam, cassava, cocoyam, maize, groundnut), semi-wild protected plants and wild plants are also important sources of food, particularly in supplementing diets during periods of food deficits. Home grown food is most scarce in March, April and May, the so-called "unwu" or hungry season which occurs after the yam barns have been emptied and the major staples planted but before the early season crops are harvested.

A nutritional analysis of a number of the more important traditional foodstuffs consumed by farm families in the region are listed in Appendix XI. Many of these foodstuffs are higher in protein and essential amino acids than the "basic" foodstuffs. Thus, in addition to providing sustenance during food deficit periods of the year, these indigenous species are extremely important sources of protein, essential amino acids, vitamins and minerals in the diet (1).

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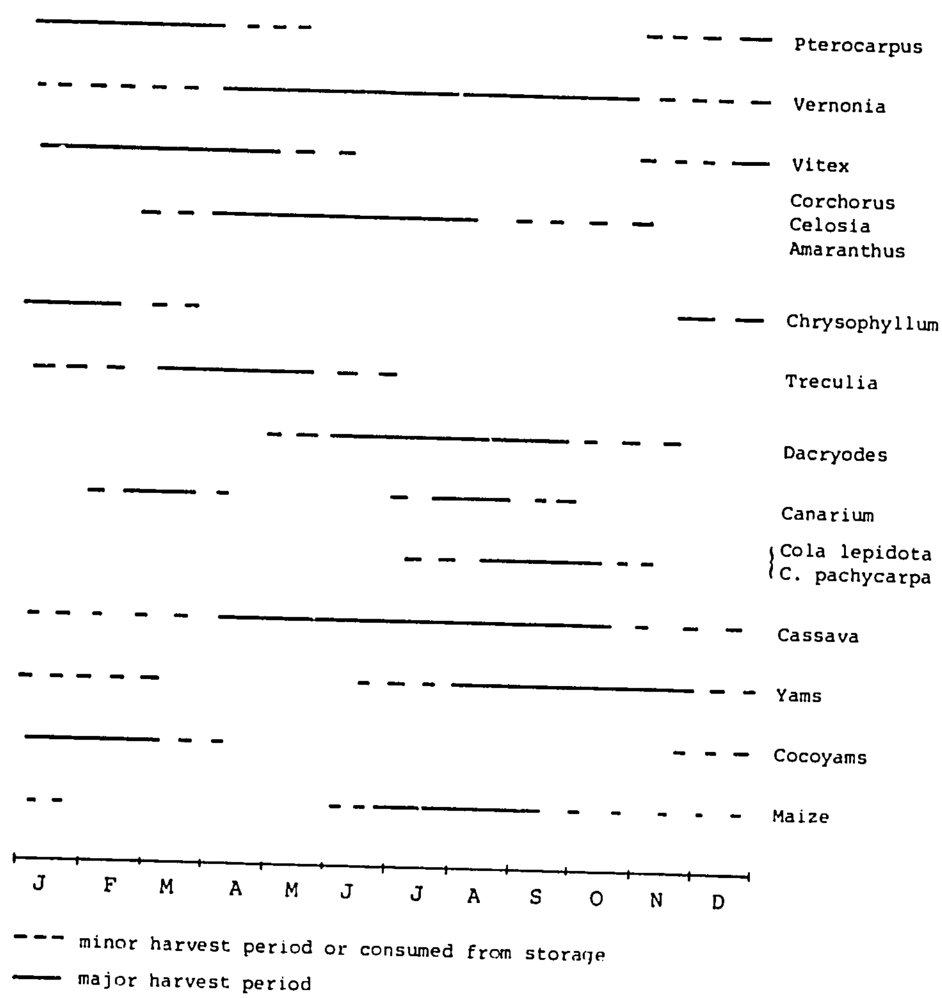
(1) In many so-called development programmes the emphasis is removed from the cultivation of traditional foodstuffs: it is "modern" to concentrate on the exotic species. Thus it is possible for farm families to end up with a worse diet than was historically the case.

Fig. 6: Time Sequence of Harvest and Availability of Major Annual Staples and Leaf Vegetables as Compared with Fruit and Leaf Vegetable Perennials Found in Compounds in Eastern Nigeria



Source: LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: op.cit., p.21.

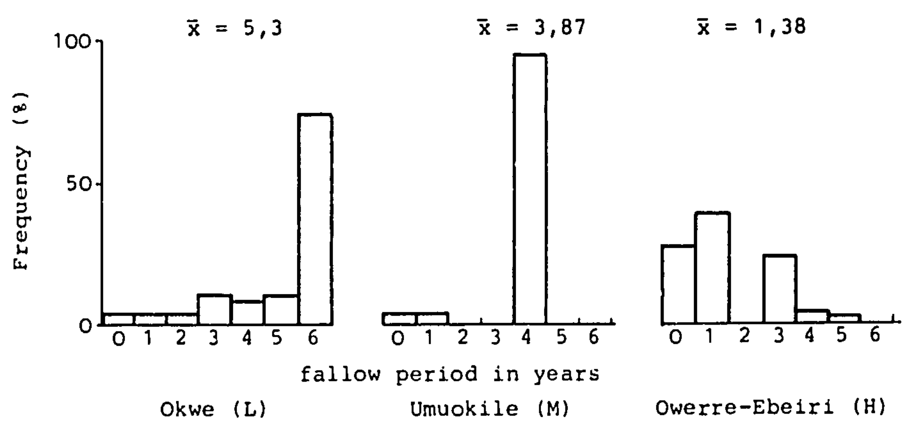
3. Near and Distant Fields

Continuous multi-storey cropping in the compounds contrasts with field farming on plots belonging to the households. In the compounds soil fertility is maintained by fertilizing. The outer fields are cropped in a fallow system through which soil fertility is regenerated, and the length of the fallow varies with the population density.

The frequency distribution in Fig.7 shows the pronounced differences of fallow periods on outer fields in the three survey villages which decline according to availability of farm land. The length of fallow tends to be more uniform in the low and medium density villages, whereas in Owerre-Ebeiri (H) where the rotational cycle does not occur in blocks around the village, the variation of the fallow period is high.

Farming of fields is characterized by a number of cropping and husbandry principles which differ in several respects from those in the compounds.

Fig. 7: Frequency Distribution of Fallow Periods on Outer Fields in Three Villages in Eastern Nigeria



Source: compiled by the author.

a) Cropping Principles

Intercropping

On both field types of the villages with medium and high populations and on near fields in low density areas, annual crops are grown under a tree canopy. As the pressure on land use decreases, tree cover tends to diminish on the outlying zones. Indeed, the outlying fields of the high population areas - in terms of the tree canopy at least - tend to resemble the near fields on the less densely populated areas.

In any case, however, the number of trees and shrubs per hectare is far less than in the compounds. 300 - 500 trees and shrubs per hectare are usual for outer fields, whereas in the compounds 700 - 900 trees and shrubs per hectare are typical.

Oil Palm, raffia palm, colanut, coconut and oil beans are the most important trees on the outer fields. The cultivation of cassava, intercropped with yam, cocoyam, maize and other arable crops (see: Fig.8) increases the further away the fields are from the compounds (1). The importance of cocoyam and yam declines.

In all cases plant densities are extremely high. Most fields carry more trees and shrubs than commercial tree crop plantations (oil palm plantations have usually a density of about 150 trees per hectare). In addition 13,000-40,000 stands of arable crops are found(for sole cropping of maize 10,000-15,000 stands - or 30,000-45.000 plants - per hectare are recommended in most cases). This is partly due to the fact that most plants are not vigorous due to lack of soil fertility. The other related reason is the deliberate effort by the farmers to maintain a dense vegetation in order to reduce leaching and erosion.

Apart from these general characteristics, there are important differences between the three villages:

- The number of arable crops grown in one field at the same time is about twice as high in the densely populated village (H) as in the other less densely populated villages (M and L) (see: Table 10).
- The density of tree and arable crops increases from the low to the highly populated village (see: Table 11). The data indicate an increasing land use intensity when land becomes scarce.

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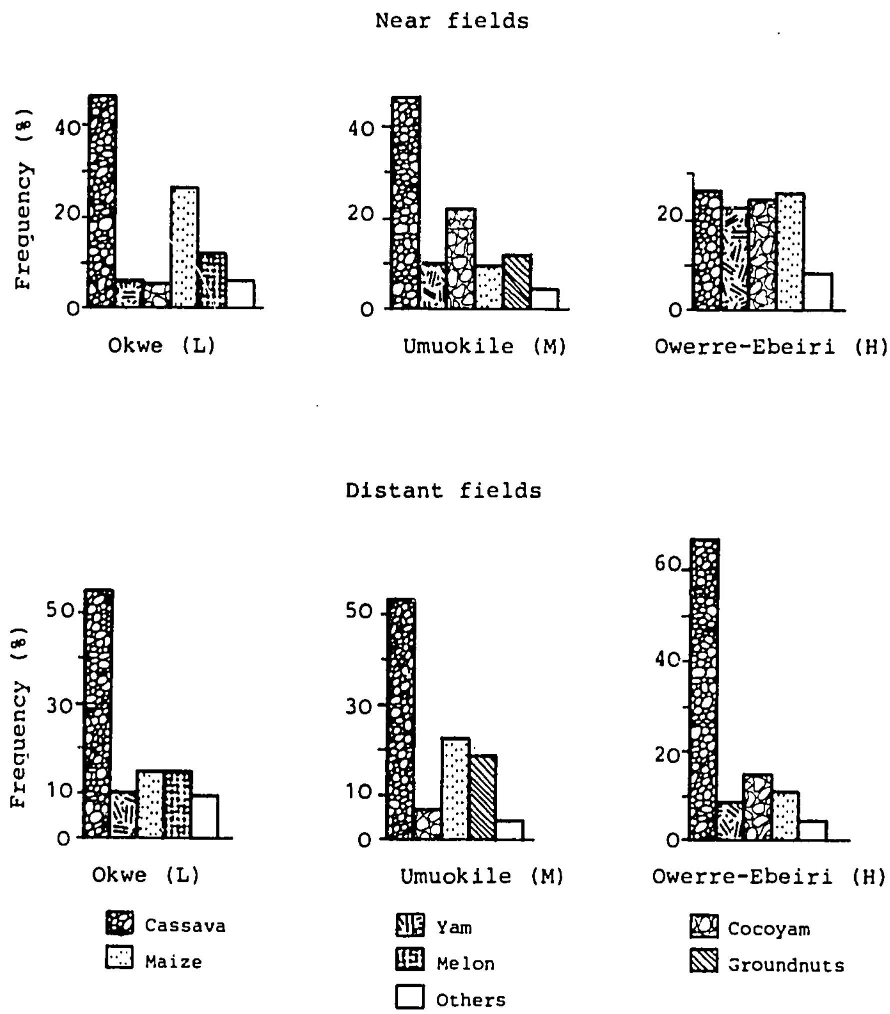
(1) Typical crop mixtures are provided in Appendix XII.

Fig. 8: Average Occurrence of Major Arable Crops in Near and Distant Fields



Source: compiled by the author.

Table 10: Average Number of Arable Crops Grown on Near and Distant Fields in Three Villages, June 1974

Village	near fields		distant fields	
	No. of crops	CV as %	No. of crops	CV as %
Okwe (L)	3.6	38	3.2	48
Umuokile (M)	2.8	33	2.8	35
Owerre-Ebeiri (H)	6.6	39	6.0	58

Source: compiled by the author.

Table 11: Average Tree and Arable Crop Density per ha on Near and Distant Fields, June 1974

Village	near fields			
	tree crops		arable crops	
	stands/ha	CV as %	stands/ha	CV as %
Okwe (L)	312 (a)	147	13522	47
Umuokile (M)	340	61	21125	54
Owerre-Ebeiri (H)	523	84	40368	33

	distant fields			
	tree crops		arable crops	
	stands/ha	CV as %	stands/ha	CV as %
Okwe (L)	93 (b)	161	12175	52
Umuokile (M)	354	125	19012	71
Owerre-Ebeiri (H)	406	63	36516	23

(a) Tree crops are grown on 43% of all fields.
(b) Tree crops are grown on 19% of all fields.

Source: LAGEMANN, J., FLINN, J.C. and RUTHENBERG, H.: op.cit.,p.211. Coefficients of Variation compiled by the author.

The cropping pattern is related to the length of the fallow period and the resulting status in soil fertility. Farmers established the fact that vegetative growth is less on infertile soils and they have adapted their cropping to the changing conditions:

- With a higher density of cropping, the soil can be more effectively covered in order to reduce the leaching of available nutrients and to reduce soil temperature.
- Different compatible crops utilise nutrients more efficiently and can affect each other in a positive way (e.g. the introduction of legumes in the cropping mixtures).

The way the farmers in the highly populated villages have adapted to the soil fertility of their various plots is shown by the negative correlation coefficients between the number of crops grown in a field and the soil fertility indicators, although it is only significant for organic matter (see: Table 12).

The lower the soil fertility status, the greater the number of stands and species grown on a given piece of land. Phased planting and mixed cropping are apparently tools to counteract the yield-depressing effect of a decline in soil fertility.

Table 12: Correlation Coefficients between Number of Crops Grown in One Field and Soil Fertility Indicators for Near Fields in Owerre-Ebeiri (H), 1974

	Org.C.	pH	Ca + Mg	K	P
Number of crops	- 0.43 (a)	- 0.10	- 0.10	- 0.20	- 0.20

(n = 81)

(a) significant at the 5% level.

Source: compiled by the author.

Phased Planting

Farmers usually plant all crops as early as possible (after the first rains), without a long time period between the different crops. Within a month all the crops are planted, which allows the plants to cover the soil before the major rainstorms occur (1).

Although the principle of phased planting is not so pronounced as was the case in the compounds, it was found that:

- maize is usually the first crop to be planted (maize responds very well to the ash from the burn, in particular on acid soils), and
- in the highly populated village (H) cassava is planted throughout the rainy period, due to the fact that starchy food is very scarce and farmers cultivate as much land as available. Another reason might be that farmers are trying to distribute the labour input more equally over the year.

The cassava planted later than June is usually not intercropped. Pepper nurseries are prepared in the cassava fields (on beds) in August and September, and transplanting follows some weeks later.

Crop Rotation

Actually, crop rotation in the sense of a systematic rotation of crops is not practised in the study area. The cropping period of 1 - 2 years is followed by a fallow period, and the cycle starts again usually with the same cropping mixture. An exception is the growing of cocoyam, which is often alternated with yams (2). Fallowing in low population areas still occurs in blocks (as shown in Fig.4 on pages 28/29) consisting of the fields of several farmers:

" In the less populated areas the same fallow and rotational cycle is followed on the distant farms by every farmer, so

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(1) SMOCK, D.R. reported from observations in Eastern Nigeria that "in each community there is a rather rigid order in which crops are supposed to be planted, and in no two places is the same pattern followed. The greatest variation in planting times is found with cassava". In: op.cit., p.3.

(2) Typical crop rotations are provided in Appendix XII.

that in any particular location he leaves his land fallow at the same time as his neighbours and grows yams and the like at other locations at the same time as they do. Where the population pressure on the land has shortened the fallow period, this uniformity has disappeared" (1).

We infer from this that increasing population density and subsistence food demands tend to dissolve the "block fallowing" arrangements. Proper sequences in crops which predominate in more extensive land use systems are increasingly replaced by varying crop associations which provide a more continuous occupation of the land.

b) Husbandry Practices

Clearing and Burning

Farming activities start during the first three months of the year with clearing and burning of the bush fallow and trimming of most of the trees. In Owerre-Ebeiri (H) grasses are found (e.g. Imperata cylindrica), because with a fallow period of 1-2 years bush-fallowing has been replaced by grass-fallowing. Burning of the bush has the following advantages:

- It kills most grasses and weeds, so that the first weeding needs to be done relatively late.
- "The alkaline ash raises the pH and availability of cations in the surface soil " (2).
- Nutrients like P, K and Ca are made available in soluble form, which stimulates the growth of plants during the early growing period (3).

On the other hand there are some disadvantages inherent in the system :

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(1) OLUWASANMI, H.A., DEMA, I.S. and others: Uboma: A Socio-Economic and Nutritional Survey of a Rural Community in Eastern Nigeria, The World Land Use Survey, Occasional Papers No.6, London, 1966, p.87.

(2) NYE, P.H. and GREENLAND, D.J.: The Soil under Shifting Cultivation. Commonwealth, Agr. Bureaux, 1960, p.73.

(3) REHM, S.: Landwirtschaftliche Produktivität in regenreichen Tropenländern. In: Umschau 73 (1973), Heft 2, pp.44 et seq.

- "The carbon, nitrogen and sulphur in the fallow and litter are lost in the burn (but not the amounts in the soil humus)" (1).
- The fire damages trees like oil palms, raffia palms, etc.
- There is a build up of fire-tolerant, low-productive species.

Burning is, however, still an indispensible part of the system. Crops in bush fallow rotations depend on the pH effect of the burn, and in grass fallow systems the burning of the grass is still considered to be more advantageous than composting - in particular in terms of return to labour.

Cultivation

Most of the crops are planted on the flat or on slightly raised heaps. An exception is yam which is grown on small mounds on pieces of land where farmers think soil fertility is relatively high. The yam sets used in the near and distant fields vary in size, depending on the variety, the quantity of yam available and whether the sets are expected to produce ware yams or sets for planting. In general, on near and distant fields the yam sets are smaller than those planted in the more fertile compound area.

When planting cassava, farmers use a hoe to dig small holes about 40 cm in diameter and 5 to 10 cm deep. Two and sometimes three cassava cuttings are laid flat in the hole and covered so that several shoots sprout from the nodes on each cutting. In Owerre-Ebeiri (H) farmers plant the cassava cuttings at an angle, resulting in fewer shoots per cutting.

Yam beans are trailed up along the remaining sticks from the bush fallow, whereas groundnuts and melon (egusi) are planted on the flat ground and cover the soil within a period of four to six weeks.

Manuring

Mulching and manuring is not a common practice in the low and medium populated villages, except for yams in Umuokile (M). For this, the farmers cut dry grass and palm fronds from the surrounding bush and "cap" the yam mounds to protect the tender shoots against the heat of the sun and to conserve moisture in the mound. A disadvantage of this practice (of which the farmers are aware) is that termites, which are prevalent in the area, are

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(1) NYE, P.H. and GREENLAND, D.M.: op.cit., p.73.

attracted to the plots. In the village with high population density, the soil is covered with mulching materials from trees and grasses. Ashes and goat manure are applied in small quantities to the individual plants during the first part of the growing season. These labour-intensive practices contribute towards sustaining yields on land which otherwise would yield extremely low returns.

In summary, production on near and distant fields, even though there are differences between the villages, is by no means as carefully organised as production on compounds. Consequently yields on the outlying plots are much lower, as will be shown in the following chapters. The fields contribute, however, to the output of the compounds by providing most of the starch (root crops) and fat (oil palms) for the household members, and in addition they supply most of the organic matter for mulching the compounds. The interactions between compounds and outer fields are very pronounced.

III. Soil Fertility Status of the Fields

Arable farming without exogenous inputs is "wasteful in the sense that through the deliberate removal and transplantation of produce, and by the involuntary disturbance of the natural order in ways that can increase the rate of loss, nutrients are removed from the soil and are not replaced. Sooner or later it is inevitable that such a system must lead to either temporary or permanent reductions in soil fertility." (1)

In a traditional system, bush fallowing is used to re-establish soil fertility. Figure 9 shows the massive increase in nitrogen during fallowing and the rapid loss of nitrogen with fire-clearance and farming. Originally soil fertility in the three survey areas was rather similar, and soils were almost identical (see Appendix IV). Varying cropping intensities and varying lengths of fallowing, however, have changed the situation and wide differences in soil fertility are now found in the area.

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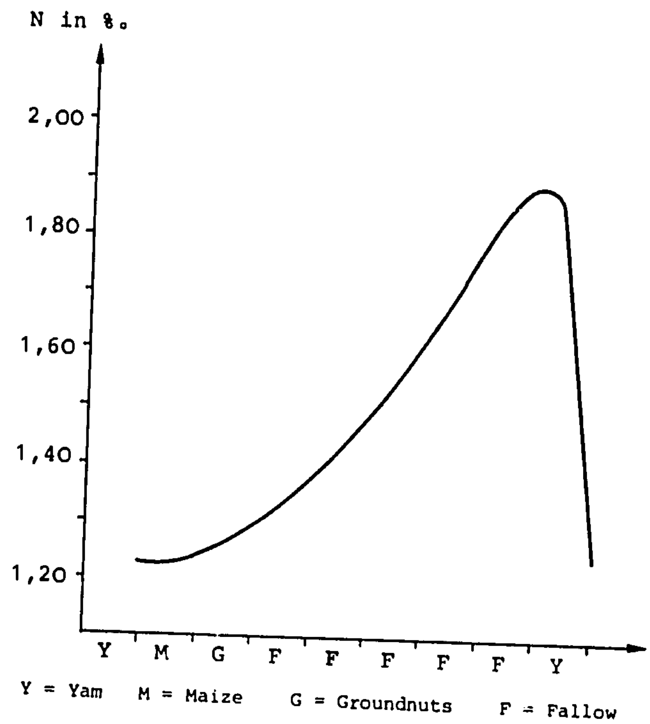
(1) McARTHUR, J.D.: Some general Characteristics of Farming in a Tropical Environment, in: RUTHENBERG, H.: Farming Systems, op.cit., p.12.

Fig. 9: Development of Nitrogen in the Soil in the Traditional Rotation of Baoulée, Ivory Coast



Source: CADILLON, M.: Evolution du sol sous une rotation Baoulée traditionelle, IRAT, Bouaké , (undated), p.24.

Farmers in areas with less fertile soils try to concentrate soil fertility on small plots at the expense of soil fertility on the major fields. All household refuse and manure is concentrated on the compounds, which in Umuokile (M) average 300 square metres in size, and in Owerre-Ebeiri (H) 600 square metres. The supply of refuse and manure per unit area is influenced by the amount and kind of products processed by the household (peelings from cassava and yam tubers, residues from oil palm bunches, husks from maize cobs, etc.) as well as by the import of mulching material from the outlying fields and the fallow areas. Farmers in Umuokile (M) have larger outer fields than is the case in Owerre-Ebeiri (H). They import more nutrients and organic matter, and concentrate these materials on a smaller compound area. This concentration of soil ameliorating factors is reflected in the soil fertility indicators.

Table 13 indicates that compound soils contain much more Ca+Mg, K and P than soils of near fields and that a much higher content of nutrients was found in near fields than in distant fields. Soil fertility clearly declines with increasing distance from the house, while traditional shifting cultivation systems normally show the opposite: soil fertility increases with the distance from the hut, because fallowing increases also. The other important finding is that soils are poorer the higher the population density, and it seems reasonable to assume that this is so because more overcropping (decrease in fallow periods) has occured.

It has to be noted that the main fields not only support the staple food production but also supply nutrients and organic matter to the compounds. The data indicate the details:

- No significant difference (1) between compounds and outer fields was observed in the level of organic matter and nitrogen. The loss of organic matter and nitrogen due to continuous cultivation was offset by mulching and depositing household refuse.
- The pH of the compound soils had not deteriorated when compared with near and distant fields ; indeed, it had significantly increased due to the import of alkaline materials (shells, bones, ashes).
- Calcium + magnesium, potassium and phosphorus were also significantly higher in the compounds than in outer fields, due to the import of plant nutrients from non-compound fields and from beyond the farm, and of ash and household refuse.

Two trends are apparent from the data on soil fertility:

(1) Within a village compound plots are more fertile than near fields, and near fields tend to be more fertile than distant

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(1) Results of tests of statistical significance of the differences between the mean values are given in Appendix VIII.

Table 13: Means and Coefficients of Variations of Soil Fertility Indicators of Compounds, Near and Distant Fields in three Survey Villages with Differing Man/Land Ratios in Eastern Nigeria

	Okwe (L) (a)	Umuokile (M)		Owerre-Ebeiri(H)	
Compounds		n = 25		n = 63	
		mean	CV as %	mean	CV as %
Org. C %	n.a.	2.06	49.9	1.06	40.7
pH	n.a.	5.06	8.5	5.06	11.5
Ca+Mg me/100 gm	n.a.	3.50	57.2	2.77	71.2
K me/100 gm	n.a.	0.14	54.2	0.17	72.5
P me/100 gm	n.a.	36.18	74.1	19.18	72.8
N me/100 gm	n.a.	0.168	41.9	0.085	41.7

Near fields	n = 35		n = 32		n = 81	
	mean	CV as %	mean	CV as %	mean	CV as %
Org. C %	2.35	17.7	2.30	42.0	1.20	52.8
pH	4.59	8.8	4.71	7.7	4.45	9.1
Ca+Mg me/100 gm	1.64	124.1	1.90	73.1	1.28	101.9
K me/100 gm	0.09	60.0	0.06	46.3	0.11	82.0
P me/100 gm	25.01	99.0	10.58	123.1	9.77	46.9
N me/100 gm	0.178	32.0	0.170	32.1	0.092	50.8

Distant fields	n = 33		n = 44		n = 17	
	mean	CV as %	mean	CV as %	mean	CV as %
Org. C %	2.37	19.8	1.94	47.4	1.00	14.0
pH	4.47	9.9	4.71	6.9	4.26	5.4
Ca+Mg me/100 gm	0.89	127.6	1.61	59.3	0.69	55.6
K me/100 gm	0.08	61.4	0.05	22.6	0.08	32.3
P me/100 gm	9.78	107.1	8.03	48.4	9.98	43.0
N me/100 gm	0.169	25.9	0.151	28.0	0.067	100.8

(a) Okwe does not have well developed compounds.

Source: Soil Sampling under the Direction of F.R. MOORMANN, Pedologist at IITA. Soil-chemistry analysis conducted by Analytical Services Laboratory IITA, Ibadan.

fields. Soil fertility indicators improve with increasing land use intensity. This may be explained by fertilizing practices and by the effect of tree crops, where the root systems act as nutrient pumps.

(2) Between the villages there are pronounced differences in the fertility status of the soils. The higher population density and subsequently less fallowing result in lower levels of organic matter, nitrogen (1) and phosphorus in the soils of the medium and high density villages. The effort of mulching the fields in Owerre-Ebeiri (H) is apparently not enough to maintain soil fertility, but it seems to prevent a further decline in the depleted soils, or at least reduces the rate of nutrient decline. If soil fertility is to be maintained without fallowing, then counteracting efforts by the farmers have to be very intensive, comparable to those practised in the compounds - moderate efforts do not seem to be very effective.

A common feature of all plot types is the large variation in the magnitudes of soil fertility indicators other than for the low pH (see Table 13). As mentioned in the previous chapter, farmers adapt cropping patterns, cropping densities and husbandry practices to the suitability of the soil in their various fields. Nevertheless, with the currently available technology substantial improvements in productivity only seem to be possible when large quantities of fertilizing materials are applied to the fields.

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(1) The contribution of non-symbiotic nitrogen fixation of a bush fallow is very important: "Field experiments over 3 years in Ibadan, Nigeria, in the lowland humid tropic zone, showed accumulations of 595 kg N ha $^{-1}$ year $^{-1}$ for regenerated bush without legumes, and 90 kg N ha^{-1} under the grass Cynodon plectostachyus.
See: DART, P.J. and DAY, J.M.: Non-Symbiotic Nitrogen Fixation in the Field, in: Soil Microbiology, Butterworths Scientific Publications, London, 1975, p.35.

IV. Crop Production

The comparison of output for different crop mixtures (e.g. cassava, vegetables and oil palms) requires a common denominator. It is obvious that the unit usually used, "tons/ha", is not appropriate when such heterogeneous crops are combined. Thus, the total output of all fields was measured in terms of three common denominators: kilocalories/ha, kg of dry matter/ha and Naira/ha. The conversion rates of all crops into calories and dry matters are provided in Appendix XIII. As the correlation between the yield measured in calories and dry matter was very high (r = 0.98), the following discussion is in terms of kg of dry matter/ha and Naira/ha.

1. Total Output per Cultivated Hectare

a) In Physical Terms

As was discussed in the previous chapter, the differences in land use intensity between plot types and villages influence the soil fertility and, as will be demonstrated, the output of the farming systems.

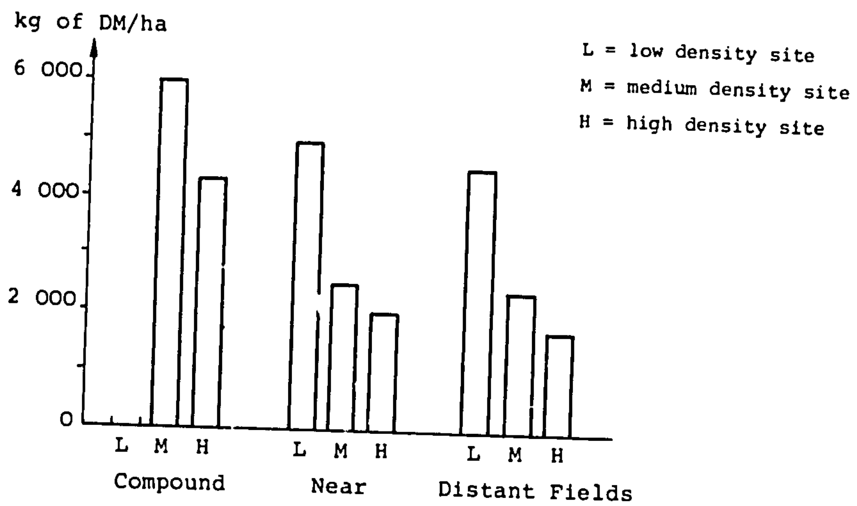
In Figure 10 it is shown that:

- within the same plot type yields fall from the low to the high density village;
- within the villages, yields decline the further the fields are from the house.

Yields on outer fields in Okwe are much higher compared with the other two villages, and this partly suggests why intensive compound cropping has not yet developed there. Umuokile (M) and Owerre-Ebeiri (H) show marked differences in yield between outer fields and compounds. Farmers in these highly populated areas apparently find it more productive to concentrate farming on a small area and produce on the outer fi..us within an extensive system of cultivation. The degree of soil mining on the outer fields tends to be higher the more acute the land shortage, which results in poorer soil fertility and in lower yields on the outer fields.

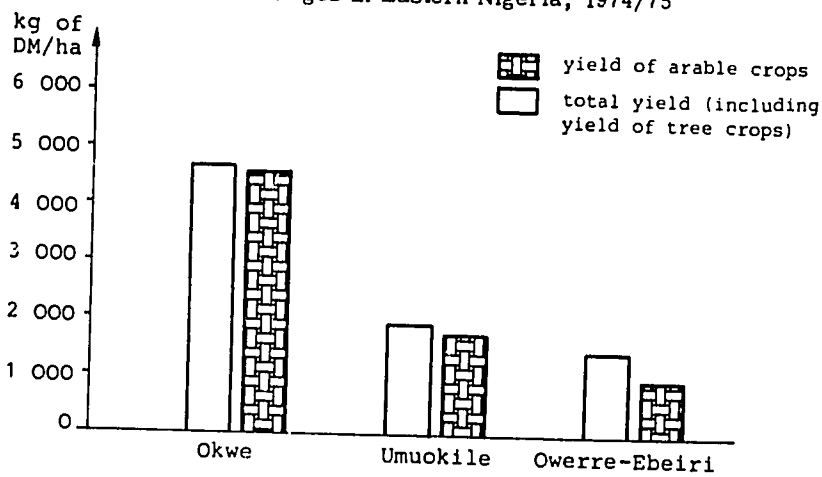
The shift towards compound farming which occurs with increasing population density is accompanied by the growing importance of trees. Figure 11 shows that the total yield per hectare of arable and tree crops on outer fields de-

Fig. 10: Average Total Dry Matter Production per ha on Compounds, Near and Distant Fields in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

Fig. 11: Average Dry Matter Production per ha from Arable Crops and Average Total Dry Matter Production per ha on Outer Fields in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

clines only slightly from Umuokile (M) to Owerre-Ebeiri (H). This result leads to the conclusion that tree crops, with their deeper rooting systems, are not as sensitive to depleted soils as are the arable crops.

More important than this is the fact that compounds in the densely populated village yield less than in the medium populated village, in spite of the fact that the plant densities are much higher in Owerre-Ebeiri (H) than in Umuokile (M). Both villages are sited, however, on soils of about the same original fertility (see Appendix IV). It is reasonable to assume, therefore, that the quantities of organic materials are insufficient to maintain soil fertility in the compounds of the highly populated village. Furthermore, depleted outer fields may supply mulching material which has less nutrients than that of more fertile fields.

The ingenuity of farmers achieves a slowing down of the process of soil depletion, but -- given the climate and the soils of the area -- it is apparently insufficient to stop the process of soil mining. The farming system seems to be beyond the stage where human effort could regain a balanced land use system without the import of nutrients from the outside.

b) <u>In Monetary Terms</u>

A comparison of the output in terms of value (Naira) shows that the compounds produce five to ten times as much per ha as the outer fields (see Table 14). The intensively cultivated compounds in Umuokile (M) produce crops valued on average at ₦ 3100.00 per ha. This is extremely high and can only be explained by the special attention which is paid to all crops growing on the small areas around the houses and huts.

The value of output per cultivated ha also declines from the low to the high population villages. An exception is the near fields in Owerre-Ebeiri (H), where about 68% of arable crops consist of yams, cocoyams and maize, which have a much higher value than cassava.

Table 14: Average Output per Hectare (a) (in Naira) in Three Survey Villages in Eastern Nigeria, 1974/75

Village	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
Compounds			
value ₦/ha	-	3100	1786
of which: tree crops	-	34 %	25 %
arable crops	-	66 %	75 %
Near fields			
value ₦/ha	811	290	445
of which: tree crops	1 %	5 %	40 %
arable crops	99 %	95 %	60 %
Distant fields			
value ₦/ha	616	314	295
of which: tree crops	0 %	10 %	41 %
arable crops	100 %	90 %	59 %

(a) - The yield figures are net values, allowances being made for planting material.

- For inter-village comparison, prices from a major market in Eastern Nigeria (Onitsha) were used (see Appendix VI). The prices from 1973 were taken in order to make a comparison with other survey data more meaningful. The high inflation rate in 1974/75 has increased the food prices by more than 50 %.

Source: LAGEMANN, J., FLINN, J.C. and RUTHENBERG, H.: op.cit., p. 215.

2. Output of Arable Crops per Cultivated Hectare

a) Total Yield of Arable Crops (1)

The per hectare output of dry matter from arable crops (see Table 15 and Figure 12) shows a similar pattern to the total output per hectare (including tree crops):

- the higher the population density the lower the yield,
- the greater the distance from the house the lower the yield. Differences in output between near and distant fields are, however, no longer significant.

Table 15: Total Yield of Arable Crops in kg of Dry Matter/ha in Three Villages in Eastern Nigeria, 1974/75

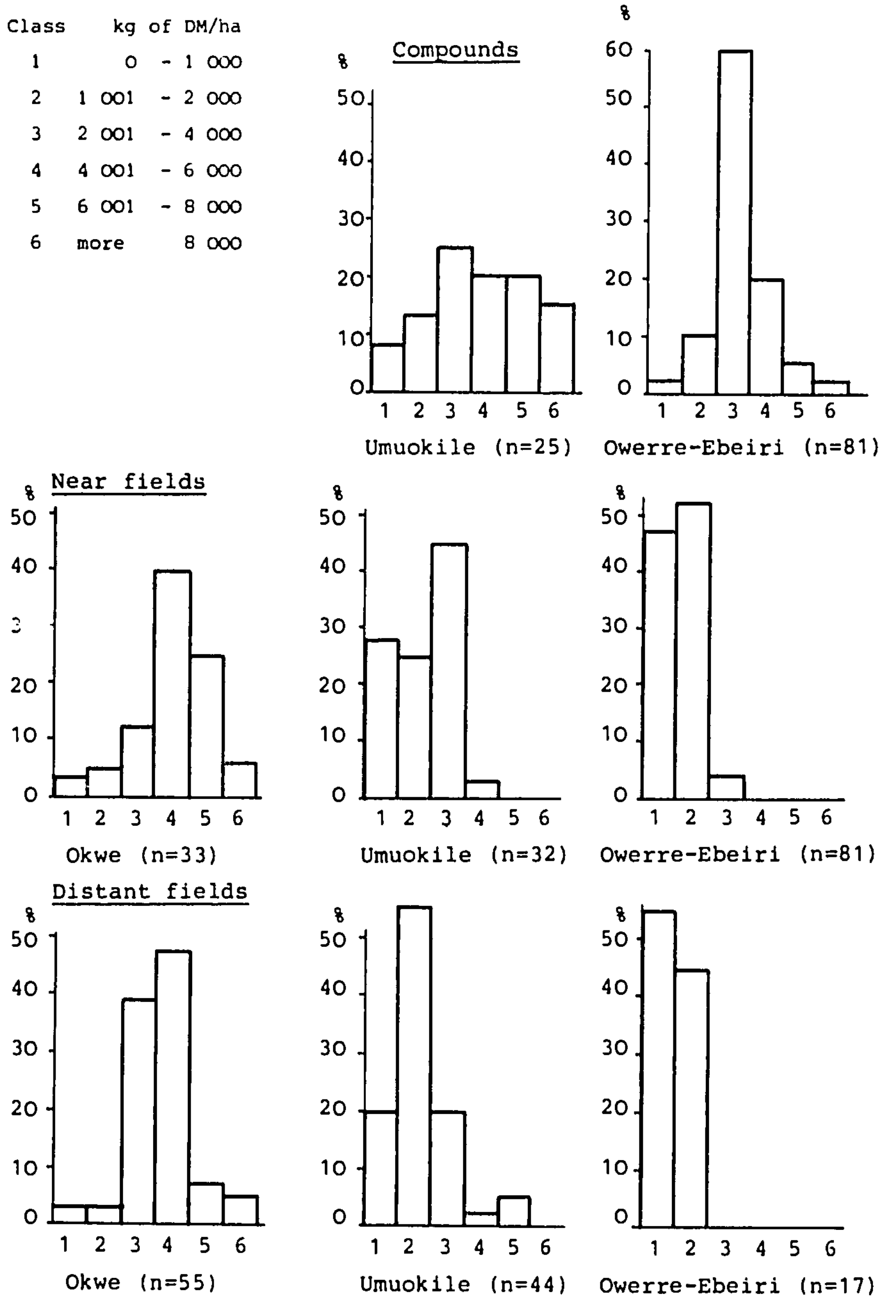
	Compounds		Near fields		Distant fields	
	mean	CV as %	mean	CV as %	mean	CV as %
Okwe (L)	-	-	4676.5	45.6	4436.4	39.5
Umuokile (M)	4539.7	59.1	1944.6	58.4	1762.5	69.3
Owerre-Ebeiri (H)	3348.2	44.8	1041.9	42.2	948.9	50.0

Source: compiled by the author.

(1) The yield data are results from the intercropping system; sole cropping was not found in the survey area. Thus a comparison of sole cropping was not possible in this study The most complete data comparing these cropping systems is that of NORMAN, D.W.: An economic survey of three villages in Zaria Province 2. Input-Output Study, Vol.I., Ahmadu Bello University, Zaria, Nigeria, 1972 (quoted in the following as NORMAN, D.W.: Zaria Study).

Fig. 12: Distribution of Total Dry Matter Production of Arable Crops on Compounds, Near and Distant Fields in Three Villages in Eastern Nigeria, 1974/75

Class	kg of DM/ha
1	0 - 1 000
2	1 001 - 2 000
3	2 001 - 4 000
4	4 001 - 6 000
5	6 001 - 8 000
6	more 8 000



Source: compiled by the author.

Noteworthy are the great variations (see coefficients of variation) not only between the villages but also within the villages, even in the case of the same plot types. Probably it is not only natural conditions which vary within the different groups, like soil fertility, rainfall, slope, number of trees and stumps, diseases and pests, but also the individual husbandry practices and labour inputs which are different. These variations are also typical in other areas of tropical farming. (1)

The variation of the observed output indicates that an increasing land shortage does not produce more homogeneous yield patterns.

b) Cassava Yields

A comparison of the productivity of land in the three survey villages is only meaningful when all crops are included in the analysis. However, the great importance of cassava, in physical as well as in monetary terms, makes it relevant to give special attention to this crop, which in Eastern Nigeria is cultivated mainly on outer fields.

The large differences in cassava yields which occurred between the three villages are demonstrated in Table 16. Okwe (L), where the bush fallow period is the longest, produces on average 10.8 tons per ha, which is about three times as much as Umuokile (M) and five times as much as Owerre-Ebeiri (H). These data verify very clearly the tentative conclusion of the Cassava Benchmark Survey in the former East Central State of Nigeria that ".... yields seem to be lower where the population pressure of land is the highest" (2).

The variations within the villages are quite pronounced, especially in Umuokile (M), where termites (Macrotermes subhyalimus) attack cassava cuttings, particularly during dry spells.

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(1) See: ATTEMS, M.: Bauernbetriebe in tropischen Höhenlagen Ostafrikas, Afrika-Studien Nr.25, München, 1967, p.99. ROTENHAN, D. von: Bodennutzung und Viehhaltung im Sukumaland, Tansania, Afrika-Studien Nr.11, p.79.
Experimental error (inaccuracy in recording field data) probably also contributes to the high variation of the output.

(2) EZEILO, W.N.O., FLINN, J.C. and WILLIAMS, L.B.: National Accelerated Food Production Project: Cassava Producers and Cassava Production in the E.C.S. of Nigeria, IITA, 1975, p.11.

Table 16: Cassava Yields Intercropped on Outer Fields in Three Villages in Eastern Nigeria, 1974/75

	Okwe (L) (n=89)	Umuokile (M) (n=76)	Owerre-Ebeiri (H) (n=72)
tons/ha	10.8	3.8	2.0
₦/ha	432.00	152.00	80.00
range tons/ha	3.4-20.6	0.8-9.4	0.8-5.7
CV as %	34.3	59.6	40.6

Source: compiled by the author.

3. Total Output per Hectare and Year of the Crop and Bush Fallow Cycle

The total yield per hectare and year on outer fields amounts to 650 kg of dry matter in Okwe (L), 461 kg in Umuokile (M), and 994 kg in Owerre-Ebeiri (H) (see Figure 13).

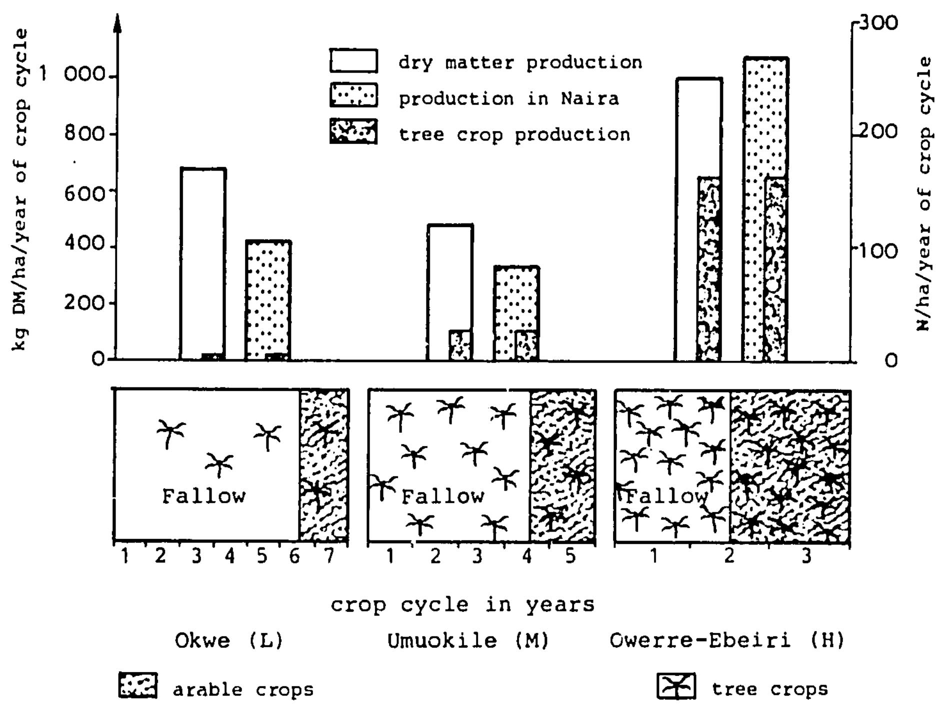
With a five and a half year fallow the output per hectare and year is thus much higher than with a three and a half year fallow, i.e. in the medium density village increasing the crop acreage at the expense of fallowing is reducing total output per hectare and year on the outer fields in terms of dry matter as well as in monetary terms. By adhering to their traditional practice of reducing fallowing in the case of food shortages, farmers in Umuokile (M) apparently (1) tend to act irrationally, because with less cropping total output would be higher. This seems to indicate that the theory of the optimising peasant (2) is not true for the farmers in the medium density village. Farmers in Umuokile (M) could produce more with less cropping and more fallowing on a given area.

(1) A very important part of total yield per ha/year is the output from trees, because they produce annually. Due to the fact that the data on tree crop yields are not as reliable as the data on arable crops (see Appendix II) the results of total output per ha/year of the cropping cycle have to be treated with caution.

(2) SCHULTZ, T.W.: Transforming Traditional Agriculture, New Haven, New York, London, 1964, pp. 28 et seq.

There is a possible explanation for their "irrational" actions:
Farmers generally in shifting or fallow systems reduce fallowing when there are pressing food requirements. This is a cultural habit and it seems not unreasonable to assume that the process of shortening the fallow has been overdone and that the process of "trial and error" has not yet given the correct answer in the rapidly changing setting.

Fig. 13: Average Total Yield Per Hectare and Year of Cropping Cycle (Crop Period + Fallow Period) on Outer Fields in three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

It is interesting to note that "irrationality" no longer applies to the reduction in fallowing at Owerre-Ebeiri (H). Less fallowing in the high density village yields more in terms of dry matter as well as in monetary terms. The explanation is to be found in the change in cropping pattern and in husbandry practices. A high density is the main reason for the higher yield per hectare and year of the cropping cycle in Owerre-Ebeiri (H) compared with the other two villages. More yams are grown and attain much higher prices than cassava, the main arable crop in the other two villages. Farmers in Owerre-Ebeiri(H) apply mulch and manure to their outer fields, and a large number of different crops are planted on the same field. These adaptations increase the output per hectare and year of the crop and bush fallow cycle, but nevertheless yields are at a low level and with the small farm sizes in Owerre-Ebeiri (H), the households are forced to buy a large quantity of their food requirements.

V. Yield Relationships

The study of relationships helps to provide an understanding of the system from which the data come (1). The farming system with which we are dealing is complex; the relationships and interrelationships are numerous and indirect effects are to be expected. Past experience with tropical smallholder farming indicates that the following hypotheses are important in this case:

- Yields depend on the length of fallowing prior to cultivation.
- Yields are related to soil fertility indicators.
- Yields are a function of husbandry practices (cropping densities, time of planting, number of times weeded and labour input).

1. Factors Influencing Crop Yields

a) Fallow Period

Prior to collecting the field data, the relationship between the length of the bush fallow and the yield was taken hypothetically to form a curve with gradually decreasing marginal returns. Such a relationship was postulated by

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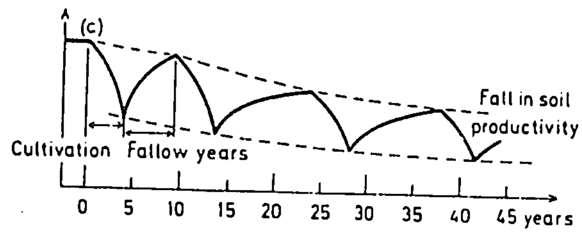
(1) PENNY, D.H.: Hints for Research Workers in the Social Sciences, Dept. of Agr. Econ, Cornell Univ., 1973, p.47.

GUILLEMIN and RUTHENBERG:

> " Figure 14 shows what happens as the fallow is shortened (R =·46) (1). The fallow is no longer sufficient to restore soil productivity and the yields per ha fall ... the result is a continuous degrading process." (2)

Fig. 14: The Relation between Length of Fallow and Soil Productivity in Shifting Cultivation



Source: GUILLEMIN, R.: Evolution de L'agriculture autochthone dans les savannes de l'Oubangui, Agron. Trop. 12, nos.1,2,3, 1956. Cited by RUTHENBERG, H.: Farming Systems, op.cit., p.46.

The length of the fallow period prior to the current cultivation was ascertained for all farmers' plots. Fallow periods on outer fields in the three villages ranged from zero to seven years. The data were analysed via least squares regression in order to examine the relationship between length of fallow and output of the fields. Results of the regression analysis with the empirical data from 261 outer fields are shown in Table 17.

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(1) R = 46 means that 46% of the arable land is cultivated annually.

(2) RUTHENBERG, H.: Farming Systems, op.cit., p.46.

Table 17: Relationship between Output of Outer Fields in kg of Dry Matter/ha and Length of Fallow Period in Three Villages in Eastern Nigeria, 1974/75

		r	F
	Linear functions		
yield in kg/DM/ha from arable crops	Y = 218.91 + 641.34x (15.31)++	0.69++	235++
yield in kg/DM/ha from total crops	Y = 926.21 + 514.58x (11.27)++	0.57++	127++
	Cobb Douglas functions		
yield in kg/DM/ha from arable crops	Y = 1685.81 $x^{0.14}$ (8.39)++	0.46++	70++
yield in kg/DM/ha from total crops	Y = 2038.56 $x^{0.08}$ (4.72)++	0.28++	22++
	Quadratic functions		
yield in kg/DM/ha from arable crops	Y = 1179.83 - 482.45x (-3.64)++ + 180.32x^2 (8.83)++	0.77++	191++
yield in kg/DM/ha from total crops	Y = 1959.15 - 693.43x (-4.78)++ + 193.83x^2 (8.67)++	0.69++	119++

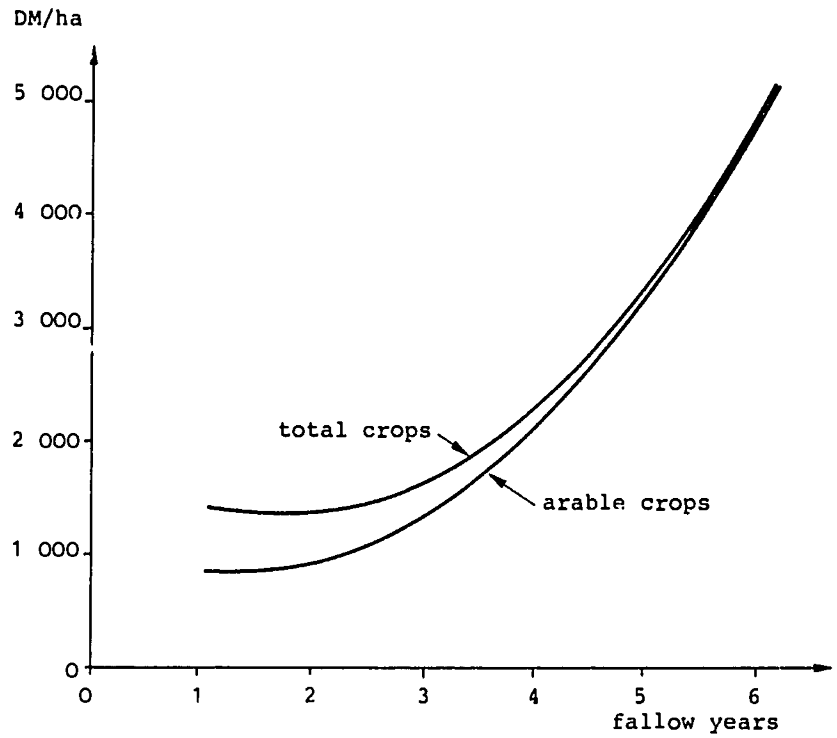
number of observations = 261

+ significant at the 5% level; ++ significant at the 1% level: these symbols are used throughout the study. Figures in brackets are the student-t values.

Source: compiled by the author.

All the functional forms are valid from a statistical viewpoint, however, the quadratic functions explain the relationship best. It might therefore be hypothesized that the soil type influences the type of relationship: on light or sandy soils - such as prevail in Eastern Nigeria - the productivity increases are non-linear with increasing marginal returns (see Fig. 15), whereas on heavy or clay soils the productivity will probably increase with decreasing marginal returns (1).

Fig. 15: Relationship between Total Output of Arable Crops on Outer Fields and Length of Fallow Period Prior to Cultivation



Source: compiled by the author.

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(1) The explanation refers only to the range of observations (0-7 years fallow).

The most important conclusions from the regression analysis are as follows:

- The significant relationship between yield of arable crops and length of fallow indicates that the latter variable is an important factor influencing yield in this type of land use system. (Fallow explains 60% of the observed variation in total yield of arable crops.)
- Within the range of observation, the marginal return of each year of fallow increases. The added return for two years fallow is estimated to be 239 kg dry matter/ha, and for six years fallow it is 1681 kg dry matter/ha. It may be assumed that decreasing marginal returns will apply for longer fallowing, but this cannot be verified from the available data.
- When the yield from tree crops is taken into account (see function with yield of total crops as the dependent variable), we find that the yield level is much higher on plots with no or few years of fallow, but the annual increase of total production due to fallowing is lower than in the case of arable crop production only (1).

In summary, the length of the fallow period, which is influenced by the population density, is an important explanatory variable of the crop yield in Eastern Nigeria. There is a rapid decline in output the shorter the fallow period. In other words, the higher the pressure on land or the population density the lower the yields.

b) Soil Fertility

More insight into the relationships between yield and soil fertility and husbandry factors is obtained by a closer analysis of the returns of arable crops. Reliable data were in fact obtained. Arable crops were harvested and weighed by the enumerators themselves, whereas the yield from tree crops were derived from questioning the farmers (2). It seems to be appropriate therefore to concentrate on the relationships between return of arable crops and influencing factors.

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(1) This refers to a fallow period of up to 4 years. Tree crop production is insignificant on fields with 5 or 6 years' fallow.

(2) See: Methodology in Appendix II.

The correlation coefficients between yield of arable crops and soil fertility indicators - distinguishing between compounds and outer fields - are listed in Table 18.

Table 18: Correlation Coefficients between Total Yield of Arable Crops in Dry Matter/ha and Soil Fertility Indicators on Compounds and Outer Fields in Three Survey Villages in Eastern Nigeria, 1974/75

	df	Org.C.	pH	Ca+Mg	K	P
Compounds	86	0.19	0.15	0.19	-0.04	0.05
Outer fields	260	0.34++	0.02	-0.07	-0.08	0.19++

Source: compiled by the author.

Generally the relationships are not significant, but there are two indicators on the outer fields, which have a relatively close relationship to arable crop yields: organic matter and phosphorus. Organic matter especially is significantly correlated to the length of the fallow period (r=0.47) on outer fields.

- No significant relationship was found between pH, calcium plus magnesium, potassium (1) and crop yield. These indicators apparently show that root crops do not respond very much to these indicators, when the yields are at a low level(2).
- In the compounds, where soil fertility is much higher than in the outer fields, positive (except potassium) but not significant relationships are found.

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(1) The mean potassium levels were extremely low on all plot typ in the three villages (except for compounds in Owerre-Ebeiri) which might be the major reason for the non-existence of any relati...ship.

(2) Explanation was given by KANG, B.T., soil fertility specialist at IITA.

c) Husbandry Practices

The correlation coefficients between three husbandry variables and arable crop yield are listed in Table 19 and show the following results:

- Time of planting is significantly related to the output on compounds as well as on outer fields in all three villages. The negative correlation supports farmers' experience that late planting reduces the yield of their crops. The data suggest that farmers who planted their crops later than others suffered a worse labour bottleneck during planting time or that these farmers paid more attention to off-farm activities.
- Number of weedings undertaken on the fields is positively, although not significantly, related to crop yield.
- No relationship is found between labour input and yield.(1) The method of labour data collection was only sensitive enough on the depleted soil in Owerre-Ebeiri (H) (outer fields), where a significant relationship was found:

$$R = 0.33^{++}, \quad df = 96.$$

Table 19: Correlation Coefficients between Total Yield of Arable Crops in Dry Matter/ha and Various Indicators of Husbandry Practices of Compounds and Outer Fields in Three Villages in Eastern Nigeria, 1974/75

	df	planting time	number of weedings	labour input
Compounds	86	-0.28^{++}	0.11	0.01
Outer fields	260	-0.28^{++}	0.07	0.03

Source: compiled by the author.

(1) No relationships between labour and output was found either in the highly controlled maize study in the three villages. See: FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize using "Improved Technology" in South-Eastern Nigeria. IITA, Ibadan, Nigeria, 1976, p.8 (quoted in the following as FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize).

An important variable is the crop density. Due to the fact that crop densities differ very much between the villages, all relationships have been calculated separately for each village.

The correlation coefficients are listed in Table 20. All correlations are positive, and increase from the low to the highly populated village. The lower the soil fertility the more important seems to be a high crop density.

Table 20: Correlation Coefficients between Total Yield of Arable Crops and Crop Density on Different Plot Types in Three Villages in Eastern Nigeria, 1974/75

Village	Okwe (L)	Umuokile (M)		Owerre-Ebeiri (H)	
Field	outer	compound	outer	compound	outer
r	0.12	0.12	0.19	0.33^{++}	0.33^{++}
df	86	23	73	61	96

Source: compiled by the author.

d) Arable Crop Yields, Fallow Period, Soil Fertility and Management

The major variables mentioned before are included in a regression model in order to explain the observed differences in arable crop yields and to estimate the relative importance of each factor.

Three functions (linear, Cobb Douglas and quadratic types) estimated are listed in Table 21. The quadratic function is the most robust (1), and the further discussion of factors influencing crop production is thus based on this function.

(1) Although some factors seem to be poorly estimated.

Table 21: Factors Influencing Total Yields of Arable Crops on Outer Fields in Three Villages in Eastern Nigeria, 1974/75

Linear function — R^2 = 0.49; F = 41^{++}

$$Y = 231.88 + \underset{(0.52)}{64.54x_1} + \underset{(1.80)}{13.20x_2} + \underset{(11.79)^{++}}{616.66x_3} - \underset{(-0.82)}{52.73x_4} - \underset{(-0.40)}{31.20x_5} + \underset{(1.40)}{0.19x_6}$$

Cobb Douglas function — R^2 = 0.41; F = 30^{++}

$$Y = 1366.49\; \underset{(0.81)}{x_1^{0.07}}\; \underset{(2.43)^{+}}{x_2^{0.14}}\; \underset{(6.65)^{++}}{x_3^{0.11}}\; \underset{(-1.35)}{x_4^{-0.06}}\; \underset{(1.94)}{x_5^{0.09}}\; \underset{(-7.76)^{++}}{x_6^{-0.05}}$$

Quadratic function — R^2 = 0.64; F = 38^{++}

$$Y = 579.19 + \underset{(3.39)^{++}}{1980.08x_1} - \underset{(-3.47)^{++}}{502.52x_1^2} + \underset{(0.17)}{3.62x_2} - \underset{(-0.19)}{0.06x_2^2} - \underset{(-3.58)^{++}}{477.00x_3} + \underset{(7.53)^{++}}{162.78x_3^2}$$
$$-\underset{(-0.84)}{194.62x_4} + \underset{(0.11)}{2.34x_4^2} + \underset{(0.44)}{76.02x_5} - \underset{(-0.94)}{22.84x_5^2} - \underset{(-1.38)}{0.35x_6} + \underset{(2.44)^{+}}{0.00x_6^2}$$

Number of observations: 261

Y = total yield of arable crops in kg/DM/ha

x_1 = Org.C.; x_2 = Phosphorus ; x_3 = fallow years ; x_4 = planting month; x_5 = month to first weeding; x_6 = tree density

Source: compiled by the author.

Compared with the one variable model on page 65 the increase of the coefficient of multiple determination is not pronounced (just 5%). This indicates that beside the fallow period the other variables are of minor importance or the coefficients are poorly estimated.

<u>Org.C.</u>: The signs of the regression coefficients indicate - other things being equal - that, within the range of observations, Org.C. has a positive effect on yields of arable crops, although with decreasing marginal returns. The coefficients are highly significant.

<u>Soil Test Phosphate</u>: The level of phosphorus in the soil was also positively related to the aggregate production with decreasing marginal returns. However, the coefficients are not significant.

<u>Fallow Period</u>: Within the range of observations, the marginal returns of the fallow years prior to cultivation increases rapidly. The coefficients are highly significant and support the hypothesis that the length of the fallow period is the most important factor influencing the yield on outer fields.

<u>Planting month</u>: The coefficients indicate that - other things being equal - later planting reduces the aggregate production of arable crops. However, the coefficients are not significant.

<u>Months to 1st weeding</u>: If weeding is carried out within (about) the first two months after planting, it has a slightly positive effect on yields. From this period onwards, the later the first weeding the lower is the expected yield of arable crops. As in the case of the planting month, these coefficients also are not significant.

<u>Tree density</u>: Tree density has almost no effect on yields of arable crops. This is surprising, because the shade effect from trees was postulated to have a negative influence on the output of arable crops. It might therefore be possible that these negative effects are overlapped by positive effects like a) recycling nutrients from the subsoil to the topsoil and b) prevention of the negative effects of heavy rainfalls. Only the second coefficient is significant.

The function explains 64% of the observed variation in yields. The analysis does show that significant variables which affect aggregate production are the fallow period and the Org.C. content of the soil. Increasing fallow periods would seem to have the most dramatic influence on arable crop production.

2. Maize Yields, Soil Fertility and Management (1)

The farmers in the survey grew maize as a sole crop using a new variety, mineral fertilizer and recommended management practices. Fields with no or few trees were selected for growing this maize, in order to minimize interactions between trees and maize. The major soil fertility indicators and management factors were recorded from all 69 fields in the three villages, and were included in a regression model (see Table 22).

Planting Date: The sign of the regression coefficient indicates, other things being equal, that later planting results in lower maize yields.

Days to First Weeding (DAP): Within the range of observations, a one per cent increase in the number of days between planting and first weeding increased yields by 0.35 per cent. The positive sign is reasonable, as early weed growth after the burn was minimal, and, as most farmers only weeded once, the one weeding gave superior results if performed later than very close to planting, when weed competition was minimal.

Days to Thinning (DAP): While a later first weeding than was recommended seemed desirable, delaying thinning reduced final yields - a one per cent delay in thinning date reduced yields by 0.44 per cent.

Second Weeding: Twenty seven farmers weeded their maize twice. Thus x_4 was a dummy variable ($x_4 = 1$, no second weeding; $x_4 = 2$, second weeding) the positive sign indicates that the second weeding had a beneficial effect on yield.

It is interesting to observe that the second weeding of a sole crop of maize significantly influenced yields, while no such relationship was found with traditional mixed cropping.

(1) This section draws heavily on the paper by FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize, op.cit.

Table 22: Factors Significantly Influencing Maize, Yields on Farmers' Fields in Three Villages in Eastern Nigeria, 1975

Variable		Mean Value	Range Min	Range Max	Cobb Douglas function(a) b_i	t value
x_0	Constant				$0.9636 \cdot 10^{-5}$	7.83^{++}
x_1	Planting date(b)	25	5	48	-0.0135	0.45
x_2	Days to first weeding, DAP	33	7	65	0.3469	3.25^{++}
x_3	Days to thinning, DAP	17	7	53	-0.4368	2.12^{+}
x_4	Dummy for second weeding	-	1	2	0.4450	2.80^{++}
x_5	Density at harvest ('00)	184	106	346	0.7152	4.23^{++}
x_6	Organic carbon	2.90	2.00	3.71	1.2353	2.88^{++}
x_7	Phosphorus	20.73	1.36	49.95	0.1761	2.58^{+}
x_8	Base saturation	66.00	18.08	98.44	0.8300	7.44^{++}
R^2 (adjusted for degrees of freedom)						0.73
F ratio $n_1 = 8$, $n_2 = 56$						22.513
Durbin Watson Statistic						1.894
S_{yx} (tons/ha)						0.375

(a) $\hat{Y} = b_o \cdot x_i^{b_i}$ where $\hat{Y}$ is estimated yield in tons/ha.

(b) Number of days after March 15th 1975 crop was sown.

+ = Significant at the 5% level, ++ Significant at the 1% level

Source: FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize, op.cit.

Maize Density at Harvest: As anticipated, within the range of maize densities, a one per cent increase in density increased maize yields by 0.72 per cent.

Organic Carbon: The yield of maize was quite sensitive to the level of organic carbon in the surface soil, with a one per cent increase in the level of this variable increasing yields by over 1.23 per cent.

Soil Test Phosphate: The higher the level of soil test phosphate, the higher the expected yield of maize. It was predicted that a one per cent increase in STP would increase yields by 0.18 per cent.

Base Saturation: The coefficient predicts that increasing the base saturation by one per cent will increase maize yields by 0.83 per cent.

The analysis with the data from the relatively "simple system" (sole crop maize as opposed to intercropping or a multi-storey system), where management factors and fertilizer treatments were controlled as far as possible, shows that 73 per cent of the observed differences in maize yields between the plots could be explained in terms of soil fertility and management factors.

The base saturation and the organic carbon levels of the soil appeared to be the most critical soil factors, while the density of the crop at harvest was found to be the most important management factor.

VI. The Livestock Economy

1. The Role of Livestock

Farmers in Eastern Nigeria produce their main food requirements through the cultivation of arable crops and tree crops. Livestock production plays only a supplementary role, and it is not necessarily expected to constitute a normal diet item. In general, livestock is kept on a small scale and little attention is paid to the animals.

In discussions with farmers and those knowledgable about the region it was found that livestock serves the following purposes:

Financial Reserve

Smallholders in Eastern Nigeria have few possibilities of protecting themselves against sudden demands for cash such as occur with crop failures or sickness of family members. If such problems do occur, farmers have to borrow money from relatives and local credit clubs, or they sell some animals to get the required cash. In this sense, goats and chickens are kept partly as a financial reserve. Besides these cases of emergency, the 'saved capital' is cashed in order to finance the education of children.

Social and Cultural Importance

Animals and poultry are slaughtered on special occasions such as family feasts (birth of a child, burial ceremonies), group or village festivals, and sacrifices. The importance of sacrifices is declining in the area, and in most cases only small chicks are used for this purpose.

Source of Manure

Animal waste is regarded as very useful manure for the crops in areas with high population density. Goats in particular are often kept in small stables close the house, and the farmers apply the dung very carefully to the crops in the compound area.

Conversion of Non-marketable Products

The livestock is fed with non-marketable products. Goats are mainly fed with oil palm fronds, but also with leaves and twigs from other trees and bushes. During the dry season they are left free to range and forage for themselves in the fields (where they cause extensive damage to cassava plants) or in the compound and kitchen area, where they find residues from processed crops (e.g. cassava peelings and households wastes).

Chickens are also not fed with marketable products. They collect their feed themselves or serve like other animals (including dogs) as 'compound sweepers'.

2. Livestock Diseases and Distribution of Risks

Diseases are one of the major constraints to increasing livestock production. Owing to the absence of veterinary facilities, farmers are forced to sell their livestock in the case of an epidemic and then must re-stock afterwards. (1) Some farmers try to decrease the risk of disease losses in livestock by sharing the ownership of livestock with relatives or friends.

Ownership of the common livestock (goats and chickens) is spread over a large number of family and non-family members (see Table 23). The distribution is larger the more important livestock is to the smallholders (2), and it seems noteworthy that the heads of household own fewer goats (which require the most work) when land becomes scarce and the farmers are engaged more in off-farm activities.

3. Importance of Bush Meat

The increase in population density has decreased the bush fallow area which is the main hunting ground in Eastern Nigeria. Only a few animals have remained, like antelopes and grass cutters, which are rare items in the diet of the farmers in Owerre-Ebeiri (H) and Umuokile (M). Wild animals are more available round the low density village, where they are caught by hunters with traps or shot. Eight of the 24 survey farmers in Okwe (L) specialized in hunting. Besides the bush meat consumed in the household, in a period of 12 months the survey families sold bush meat valued in total Naira 160.00.

This amounts to the same cash income as that derived from livestock in the whole village.

4. Returns of the Livestock Economy

The estimated total livestock production (3) for the 74 survey farmers was Naira 2902.00, with an average value of about Naira 39.00 per household.

The value of livestock production per household increased from the low to the high population village (see Table 24). However, the total supply of meat was slightly higher in Okwe (L) than in Umuokile (M) due to the importance of bush meat.

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(1) OLUWASANMI, H.A., DEMA, I.S. and others: op.cit., p.96.

(2) Compare with Table 6, p.24.

(3) Inventory changes in livestock were not recorded in the study. It was assumed that opening and closing inventories were the same.

Table 23: Ownership of Goats and Chickens (as a Percentage) in Three Villages in Eastern Nigeria, 1974

	Goats			Chickens		
Owners	Okwe	Umuokile	Owerre-Ebeiri:	Okwe	Umuokile	Owerre-Ebeiri:
A	66.7	53.8	33.2	18.2	52.1	15.0
B		7.7	14.3	18.2	17.4	30.0
C	11.1	7.7	9.5	4.6	8.7	5.0
D			9.5			
E		15.4	4.8	27.3	13.0	30.0
A+B		15.4	14.3	22.7	4.4	5.0
A+C			4.8			
A+D	22.2					
B+C			4.8	9.0	4.4	15.0
B+D			4.8			
Total	100	100	100	100	100	100

A = head of household; B = wife (wives); C = children ;
D = others (outside the household); E = whole household.

Source: compiled by the author.

Besides intensification of crop production as man/land ratios increased, farmers put more effort into livestock keeping in order to increase food supply and cash income from their farms. This development goes hand in hand with an increase in size of the compounds which are fertilized with animal manure.

Table 24: Gross Return from Livestock Production (in Naira) in Three Villages in Eastern Nigeria, 1974/75

	Goats	Sheep	Chickens	Ducks	Dogs	Bush meat	Total livestock	Average farmer
OKWE (L)								
Total production (a)	323	-	158	3	15	(480)	499	21
No.of farmers who sold livestock	5	-	17	1	1	8	(979)	(41)
Coefficient of Variation as %	55	-	100	-	-	115		
UMUOKILE (M)								
Total production	465	42	230	12	204	(4)	957	38
No. of farmers who sold livestock	6	3	17	1	6	3		
Coefficient of Variation as %	53	67	87	-	84	76		
OWERRE-EBEIRI (H)								
Total production	794 (94)b)	125	515	-	12	-	1446	58
No. of farmers who sold livestock	7	1	23	-	1	-		
Coefficient of Variation as %	47	-	63	-	-	-		
Total	1582	167	903	15	231	484	2902 (3382)	39 (46)

Notes: (a) about 2/3 of total production was consumed in the households. (The figure above was derived from interviewing the farmers by Questionnaire, Form L 10, Appendix V.)

(b) The weekly records indicated a production of 94 Naira derived from a total of 81 goats. This figure is clearly wrong and the average production per goat in the other two villages was used, which is ₦ 9.80 per goat.

Source: compiled by the author.

VII. The Labour Economy (1)

In the survey area, farm and non-farm work is carried out by both men and women. Children are also engaged in farming and other activities, but 95% of them attend primary or secondary schools which occupy most of their time.

1. Use of Time

The activities of the household members can be divided into six classes:

- farm work in the fields;
- farm-related work in the yard (processing, storage and livestock);
- marketing of products ;
- household work (repairs, cooking, cleaning);
- off-farm activities ;
- social activities and resting.

The actual farm work in the fields (without the walk to and from the fields) requires 203 man-hours per man equivalent per year in the three survey villages. The labour input per man equivalent increased with increasing pressure on land: one man equivalent in the low density village worked 188 man-hours per year; in the medium density village the figure averaged 191 man-hours, whereas in the high density village one man equivalent worked 231 man-hours per year.

The labour input figures are biased downwards for two major reasons:

- Most of the work is done by wives and older children. The actual hours spent on field work are thus much higher than the figures suggest.
- Minor farm operations and harvesting of cassava, which is in general done two to three times per week, are not included in the data.

Nevertheless, the figures on field work are much lower than those derived by other researchers in West Africa. For example, for the case of Northern

(1) The text provides only summarized Figures and Tables, more detailed data being given in Appendix VII.

Nigeria, where land is much more available, NORMAN (1) recorded on average 609 hours worked by male adults. For the Lower Volta River in Ghana, CLEAVE (2) reported 696 hours per year and farmer, and from a survey in Gambia he reported 589 hours per male adult and 1081 hours per female adult (in the last case, hours include time spent walking to and from fields). The figures from Eastern Nigeria reflect the small farm sizes, and particular attention has to be paid to time spent by the part-time farmers on other activities.

Full information on the use of time in the survey households is not available. The information collected proved to be incomplete and unreliable. Some idea is given by the data from one farmer (cultivated area 0.46 ha) at Umuokile (M) (see Fig.16):

- His labour capacity is 2.1 man equivalents (ME), which is 3528 man-hours per year (assuming 7 man hours per ME per day with 20 working days per month). Thereof 19% are used for field work, 22% for farm-related work and 17% for marketing. Total work of this kind amounts to 2060 man-hours per year of the total 2.1 ME, which is 58% of the capacity.
- 14% of total work is performed by hired labour which is recruited from within the village or from neighbouring villages.
- The actual number of hours spent in the fields is less than the other farm activities, except in February and March, when clearing and burning are the major farm operations.

The inclusion of household work, off-farm activities, and social activities would have decreased the relative portion of work in the fields. This indicates very clearly that working hours per day calculated from field work alone underestimates substantially total hours of productive activities.

Figure 17 shows the distribution of major activities in the house and yard of three survey households in Eastern Nigeria. (3) 300 hours per month and per household were spent on average for this type of work, which amounts to up to four hours per person per day. Agricultural work apparently takes

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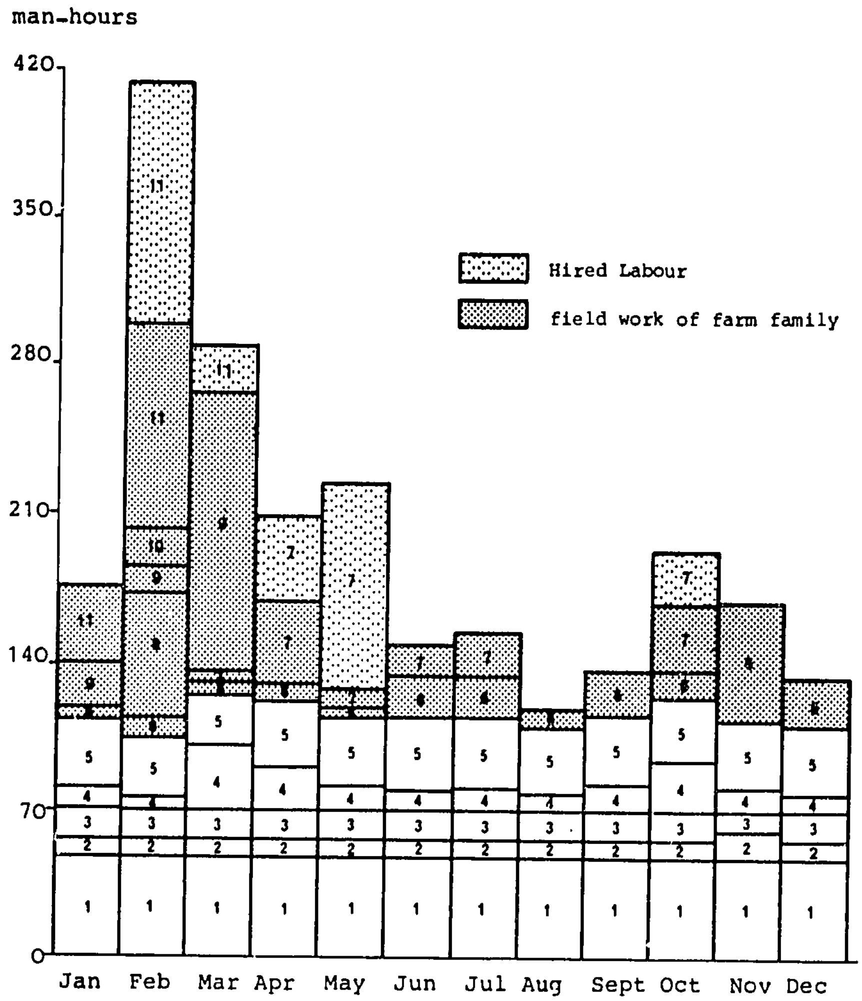
(1) NORMAN, D.W.: Zaria Study, op.cit., p.23.

(2) CLEAVE, J.H.: op.cit., pp.38 et seq.

(3) 12 households filled in a daily questionnaire providing details of major activities. A lot of data were missing or not usable. Three cases could be used for analysis, however, even though the figures provide only rough information.

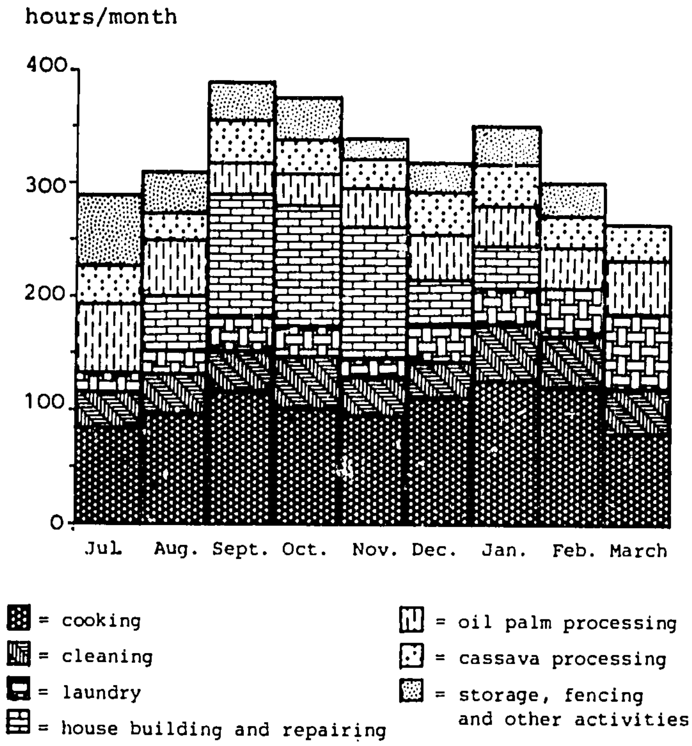
Fig. 16: Distribution of Farm Activities over the Year of One Farmer in Umuokile, Eastern Nigeria, 1974/75



1 - Marketing
2 - Collection of firewood
3 - Collection of livestock feed
4 - Oil palm processing
5 - Cassava processing
6 - Harvesting of food crops
7 - Weeding
8 - Staking
9 - Planting
10 - Burning
11 - Clearing

Source: LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: op.cit., p.23.

Fig. 17: Distribution of Major Activities in House and Yard from Three Survey Households in Eastern Nigeria, 1974/75



Source: compiled by the author.

only a fraction of the available time. When the data of other activities are added to this, like field work, marketing (market day is at least once a week) and off-farm activities, the roughly estimated working hours per person are in the order of eight hours per day. This figure is higher than the working hours usually quoted for people working in traditional agricultural settings, (1) but this is mainly due to the inclusion of activities which are not directly related to agriculture. Farm related activities and marketing, which tend to remain fairly constant throughout the year (see Fig. 16), play a very important role in the time schedule of the small scale farmers, and increasingly so as population densities become higher.

2. Distribution of Field Work throughout the Year

The main cultivation period is the first four to five months of the year, where about 60 to 80% of the total field work is required (see Figure 18). Clearing and burning starts at the end of the dry season, in January and February. In Owerre-Ebeiri (H) the major part of clearing is done in March and April. Farmers in this village start the cultivation period on their outer fields when the moisture content of the soil is relatively high, in order to reduce the risk due to unreliable rainfall at the beginning of the cropping season. (2) Furthermore clearing in the high density village continues during the rainy season (up to September). As mentioned earlier, cassava on the distant fields is planted throughout the year in order to distribute the labour input over a longer period. This fits better into the system of part-time agriculture which is practised in Owerre-Ebeiri (H).

Preparation of the fields (ridging or mounding mainly in Owerre-Ebeiri (H)) is done immediately after the plots are cleared, and followed by planting of the various crops. By the end of May most of the crops are in the ground, except the remaining cassava in Owerre-Ebeiri (H).

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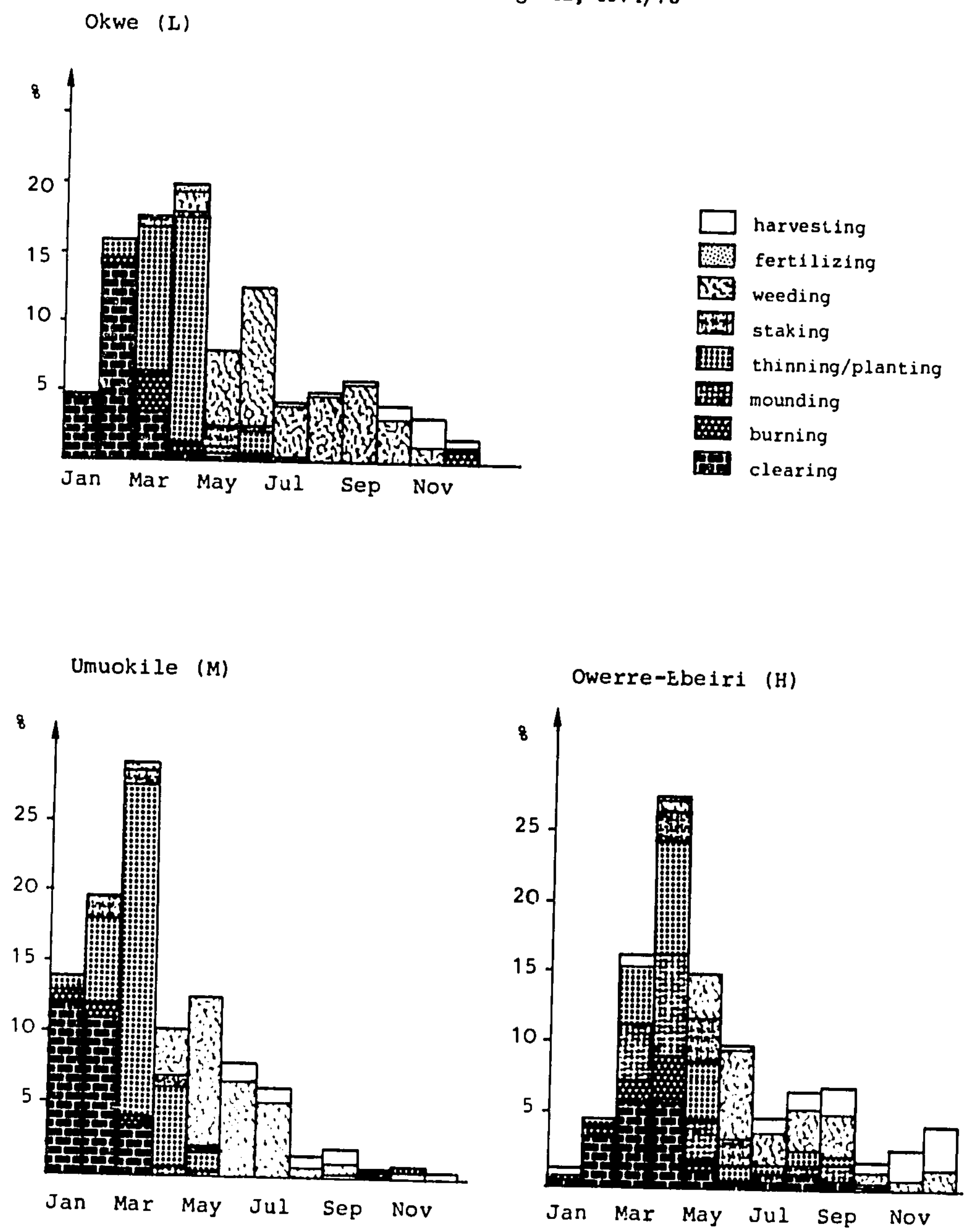
(1) OLUWASANMI, H.A., DEMA, I.S. and others estimated 5.8 working hours for a rural area in Eastern Nigeria. Beside field work, work on livestock, domestic work and other work was included. For the Congo de SCHLIPPE calculated 6 hours per person per day.
A detailed summary on labour use in tropical agriculture is given by CLEAVE, J.H. He quotes data collected by PUDSEY, which indicated 7.1 to 7.6 hours spent for all activities per day by different groups of farmers, wives and other women. 50% of the available time was spent on non-farm work.
See: OLUWASANMI, H.A. DEMA, I.S. and others: op.cit., p.100; SCHLIPPE, P.de: Methodes de Recherches quantitatives dans l'économie rurale contumière de l'Afrique centrale, Bruxelles, 1957, p.62. CLEAVE, J.H.: op.cit., p.49.

(2) The water-holding capacity of the soils in Owerre-Ebeiri (H) are generally lower than of soils in the other two villages. This is probably due to the shorter fallow period and the resulting low content of organic matter.

Fig. 18: Seasonal Distribution of Field Work in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

The second half of the year is a rather 'slack' period with respect to field work. Weeding and harvesting of yams are the major operations, as shown in Figure 18. Information collected under harvesting does not include sporadically harvested crops like vegetables or green maize cobs nor, importantly, the labour input for cassava harvest. The main staple crop is harvested throughout the year. Observations indicate that the labour requirements increase with an increase in total yield. The labour inputs for cassava differ widely therefore between the three survey villages.

3. Division of Labour between Household Members

In traditional African farming systems the division of labour is usually on the basis of sex. (1) A survey in Eastern Nigeria (conducted in 1965) gave the following results in respect of the division of labour:

> " Generally speaking the men are responsible for the oil palm (harvesting, tapping, pruning, etc.), other tree crops and yams; mostly the women are concerned with the remaining food crops - cassava, cocoyams, maize and vegetables. It must be emphasized that this division of labour is not rigid and some overlapping of responsibilities occurs." (2)

The rigidity in the division of labour seems to have further decreased during the last decade. Although work with tree crops remains in the hands of men (due to difficult activities like climbing high trees) the major part of the annual work on arable crops is shared by all family members and hired labourers (see Figure 19).

The following results are noteworthy:

- The major part of the total labour input is by groups of both sexes.
- 64% of the labour input on arable crops by the farm family is provided by wives and children.
- A major operation for men still is the staking of yams.
- Weeding is mainly done by the wives and children.

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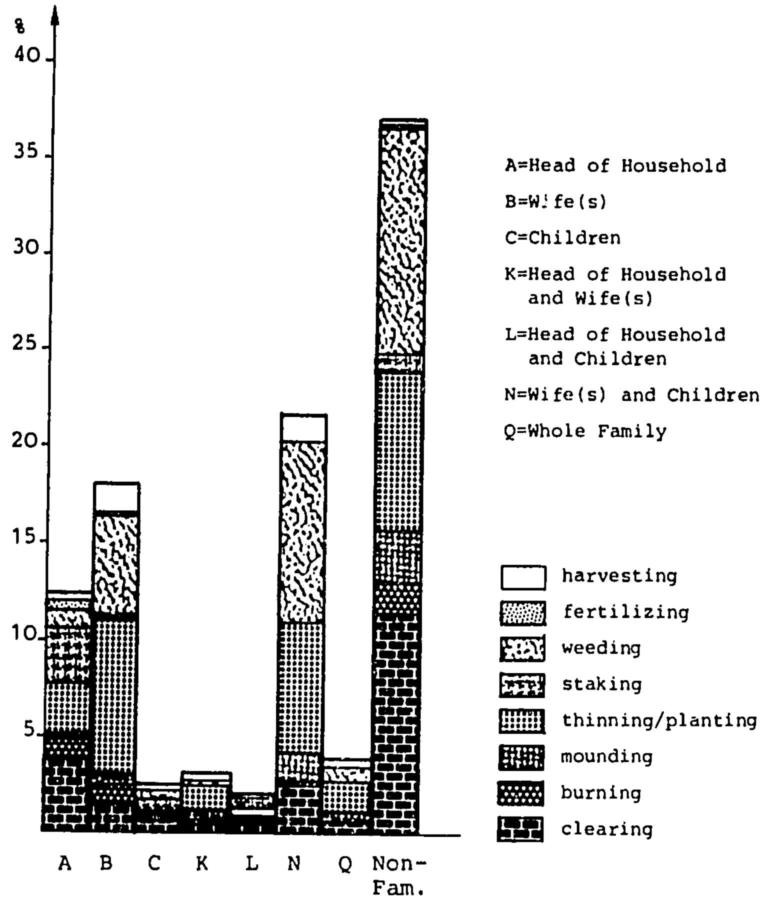
(1) See: SMOCK, D.R.: op.cit., pp. 4 et seq.

(2) OLUWASANMI, H.A., DEMA , L.S. and others: op.cit., p.99.

Fig. 19: Division of Labour between Working Groups in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

These findings are not consistent with the data summarized by CLEAVE (1), who reported that generally most of the time spent on agricultural work is put in by male adults of the farm families.

(1) CLEAVE, J.H.: op.cit., p.32.

In Eastern Nigeria non-farm activities are apparently performed to a greater extent by men, which results in the increasing engagement of women in agricultural work. This is very pronounced in Owerre-Ebeiri (H), where part-time farming is typical.

The variation in the use of non-family labour within the villages is high and seems to increase from the low to the high density village (see Table 25), which is probably due to off-farm employment of farmers. In the low and high man/land ratio villages the cost of hired labour was significantly related to farm size.(1)

In Owerre-Ebeiri (H), where most of the income is derived from off-farm activities, farmers hire more labour the higher their non-farm income. The cost of hired labour was highly significantly related to non-farm income.(2)

The principal uses of hired labour in the three villages was for clearing, planting and weeding (see Figure 19). During the peak of the cultivation period, from February to June, both family and non-family labour was engaged in clearing the land and planting. It is not surprising that the family labour input is significantly higher during this period in comparison with the second half of the year. However, non-family labour continues to be used in those periods, even though family labour appears to be underutilised (see Figure 20).

The hypothesis that there is a significant difference between the monthly input of family labour and the monthly input of hired labour was tested with the chi-square test (3). The result proved that the monthly distribution of family and

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(1) Okwe: $y = 25.455 + 18.312x$, $r = 0.48$, sign. at 5% level

Umuokile: $y = 11.653 - 4.915x$, $r = -0.11$, N.S.

Owerre-Ebeiri: $y = 3.290 + 48.080x$, $r = 0.36$, sign. at 10% level

where y = cost of hired labour and x = farm size.

(2) Owerre-Ebeiri: $y = 1.848 + 0.18x$, $r = 0.77$, sign. at 1% level

where y = cost of hired labour and x = non-farm income

(3) chi-square test according to BRANDT-SNEDECOR, See: SACHS, L.: Statistische Auswertungsmethoden, Springer-Verlag, Berlin, 1968, pp. 448 et seq.

non-family labour in the three villages is the same. This information is consistent with that reported by NORMAN (1), who stated several possible reasons for the non-family labour use throughout the year. For the case of Eastern Nigeria, the most important reason seems to be the fact that there is a division of labour: most farmers employ labourers while they continue with their other occupations.

4. The Use of Family and Non-family Labour

All farmers in the three survey villages employed non-family labour, which was hired mostly on a contract basis or on an "exchange" basis. The smallholders in Okwe (L) with their larger farms cultivated their fields with about 40% of the labour input being provided from outside the farm family (see Table 25).

Table 25: Use of Family and Non-family Labour in Three Villages in Eastern Nigeria, 1974/75

	Okwe(L)	Umuokile(M)	Owerre-Ebeiri(H)
average man-hours of fam.labour per household and per man equivalent	734 (188)	458 (191)	577 (231)
average man-hours of non-fam. labour per household	470	111	200
CV as % of non-fam. labour	64	71	90
non-family labour as % of total labour input	39	20	26
average labour cost in Naira per household	37.17	10.32	14.48
average labour cost in Naira per man-hour	0.08	0.09	0.07

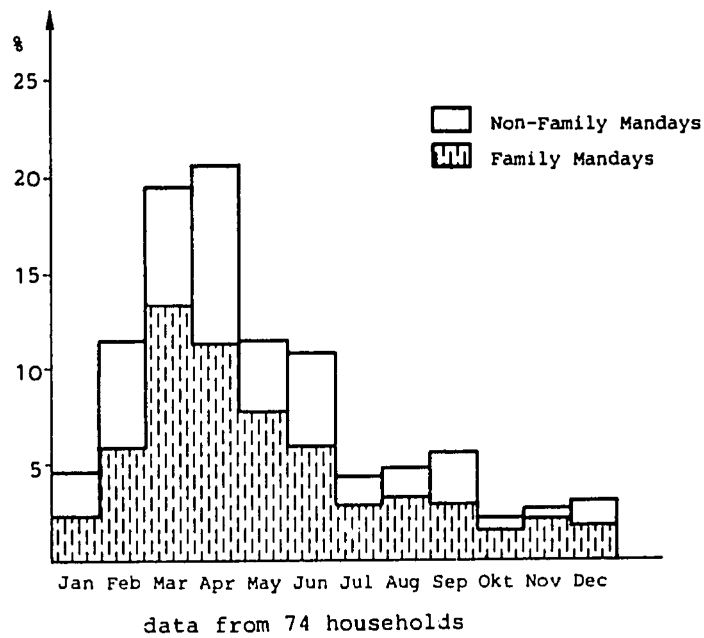
Figures in brackets are man-hours per man equivalent.

Source: compiled by the author.

(1) See: NORMAN, D.W.: Zaria Study, op.cit., p.40.

When the significantly higher labour capacity of the households in Okwe(L) and the relatively few off-farm activities in comparison with the other two villages are taken into consideration, the data indicate that farmers in the area with low population pressure do not work as hard as farmers in areas with scarcity of land: The disutility of labour input above the level which secures a 'satisfactory' income seems to be higher than the costs of hired labour. Due to a higher yield potential in Okwe (L) (longer fallow period) a relatively high income can be derived with less labour input than in the other villages.

Fig. 20: Seasonal Distribution of Family and Non-family Labour in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

The variation of family input over the year is marked, and is determined by the urgency of the various activities which have to be completed. CLEAVE argues "within the limits imposed by physical conditions, the rational farmer will balance effort against urgency - that is, perceived cost against perceived return. "Cost" in this context will be a combination of physical effort, which may be measured in kilogram calories used, and unpleasantness of the task, for which no convenient and quantifiable proxy exists. Return will be the increment of product, valued at its opportunity cost to the farmer, that arises from this effort. ...Potential returns from completing certain farming operations within a specified time (or - as more usually expressed - potential losses from failing to complete the operations within a specified time) may be very high. Further, especially in areas where the growing season is severely limited by climatic conditions, similar operations may be required within the same period on a number of crops. Work days may, in such a case, be lengthened because of competition for time among crops as well as the advantage of completing work in time." (1)

5. Labour Input and Labour Productivity

The analysis of labour input and labour productivity has to be treated with caution, because the method of labour data collection allowed only rough estimates of the actual hours worked in the fields to be made. The available information indicates high labour inputs for all villages and plot types, with an average input of 2909 man-hours per hectare. The labour input in Umuokile (M) seems to be much lower compared with the other villages. Three major reasons might be responsible for the low figures:

- The number of crops grown in one field is less than in the other two villages.
- Clearing takes less time in Umuokile (M) when compared with Okwe (L) due to less regrowth of bush.
- Weeding is performed more quickly than in Owerre-Ebeiri (H), where weeds are not eradicated by burning.

Compared with information reported by NORMAN and ROTENHAN (2), the data for Eastern Nigeria indicate two to six times higher labour inputs. Farmers in other parts of Africa usually work between 500 and 1500 man-hours per hectare.

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(1) CLEAVE, H.J.: Labour use in the Development of Smallholder Agriculture, Praeger, New York, 1974, pp. 55 et seq.

(2) See: NORMAN, D.W.: Zaria Study, op.cit., p.59.
ROTENHAN, D. von: op.cit., p.72.

Table 26: Total Labour Input in Man-hours per Cultivated Hectare on Compounds and Outer Fields in Three Villages in Eastern Nigeria, 1974/75

	Compounds		Outer fields	
	mean	CV as %	mean	CV as %
Okwe (L)	n.a.	n.a.	3010	61
Umuokile (M)	2772	58	2023	73
Owerre-Ebeiri (H)	3353	57	3388	59

Source: compiled by the author.

Intercropping with a large number of arable and tree crops and the small plot sizes are probably the main reasons for the high labour input in the survey villages. Particularly interesting is the fact that the labour input in the compounds is not much higher than in the outer fields. Although this information gives only a rough estimation of the labour input, the data seem to indicate that multi-storey cropping is a more effective traditional system of labour use than open field farming.

Important to note seems to be the high variations of labour input in the villages, which are similar to the variations of other production factors.

Table 27: Average Labour Productivity on Compounds and Outer Fields in Three Villages in Eastern Nigeria, 1974/75

	Naira / man-hour	
	Compounds	Outer fields
Okwe (L)	n.a.	0.23
Umuokile (M)	1.12	0.14
Owerre-Ebeiri (H)	0.53	0.11

Source: compiled by the author.

The estimated labour productivities indicate marked differences between the villages as well as between compounds and the outlying fields within the same villages. We may conclude from the results in Table 27 that:

- the average gross return per man-hour in the compounds is some four to eight times higher than those of the outer fields in the respective villages, and
- labour productivity is found to diminish on compounds and outer fields the higher the population density.

These findings are interesting in several respects. Mixed arable cropping normally produces more per hectare, but less per hour of work (1). Multistorey physiognomies, however, seem to show high labour productivity, and in addition, it has to be considered that work in the shade of the compounds has probably less disutility than in open fields. The labour problem of multistorey farming is apparently less one of maintenance than of establishment. The other important indication is a verification of something which is generally found: a decline in soil fertility is related to a decline in labour productivity.

VIII. Economic Returns and Use of Cash Income

1. Gross Return

According to information provided by the participating farmers, the plant growth during the survey period was typical. The survey year seems to reflect the climatic conditions of an average year (2). However, when reading

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(1) NORMAN reported in his Zaria study that the average production per man-hour input for crop mixture was about 80% of that for sole crops on upland fields. However, during the peak labour demand, in June and July, the average gross return per man-hour input was 23% higher for crop mixtures than for sole crops.
See: NORMAN, D.W.: Zaria Study, op.cit., pp.85 et seq.

(2) The weather records showed a rainfall pattern quite similar to the 42 years' average rainfall at Umudike. See Appendix IV.

the following tables attention should be paid to the fact that prices increased substantially during the survey period. A comparison of the mor. ·tary output with data from other surveys should take into account major differences of prices for various products.

The average gross return of the 74 smallholdings was estimated to be Naira 358.00, but it should not be overlooked that the prices for farm produce are about three times higher than in most other African farming systems (1). Major differences in total output can be seen between the villages (see Table 28). Farmers in the low density village produce within their extensive bush fallow system nearly twice as much as farmers on the depleted soils in the highly populated village. However, within the villages the variations in income are pronounced.

Table 28: Average Values of Total Farm Production in Three Villages in Eastern Nigeria, 1974/75

Village	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
Total production in N	480	321	272
Coef. of variation as %	59.4	57.6	54.4

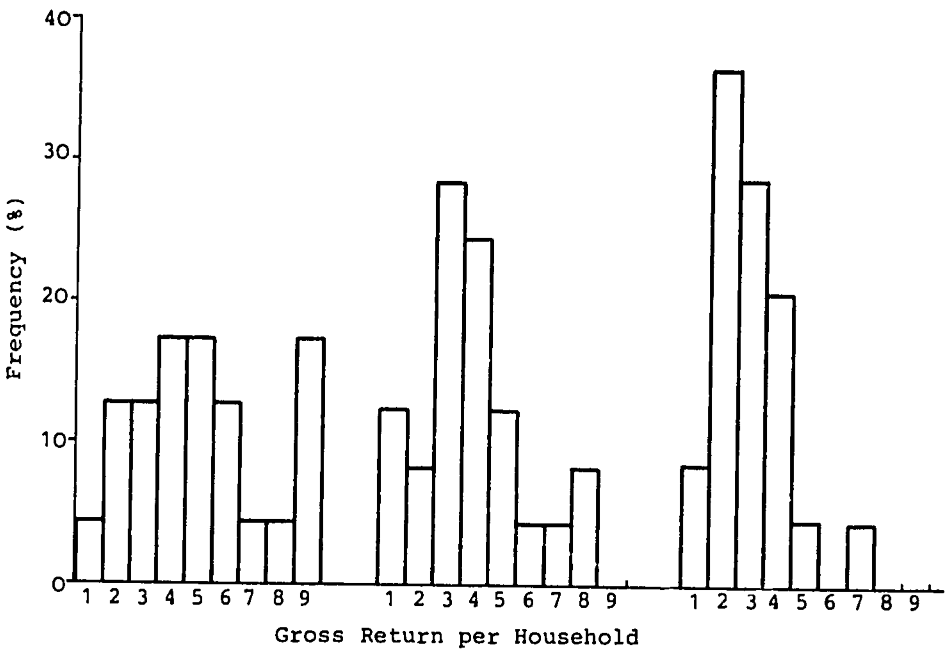
Source: compiled by the author.

The distribution of gross returns (see Fig.21) indicates the range of total production in the three villages as well as major differences between the areas.

Modes of gross returns decrease as well as means the higher the land scarcity. In Owerre-Ebeiri (H) 64% of the survey farmers produced an output valued at between Naira 100.00 and Naira 300.00; in Umuokile (M) 52% produced an output valued at between Naira 200.00 and Naira 400.00 ; whereas total output in Okwe (L) is more equally distributed over all classes. This phenomenon is consistent with the distribution of the cultivated areas in the three villages (see Fig.2 on p.21).

(1) See: RUTHENBERG, H.: Farming Systems, 2nd edition, 1976, op.cit.

Fig. 21: Distribution of Gross Returns in Three Villages in Eastern Nigeria, 1974/75



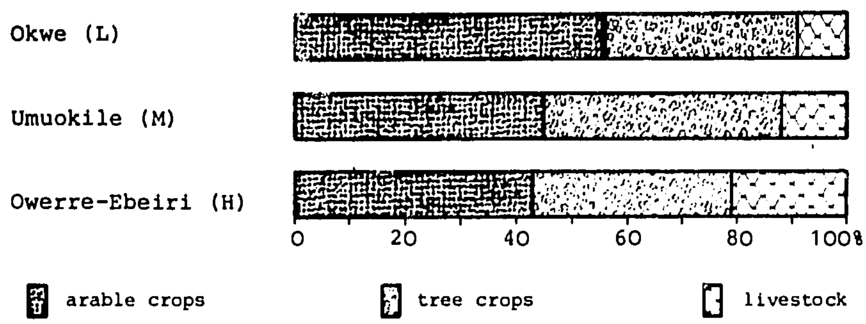
Okwe (L) Umuokile (M) Owerre-Ebeiri (H)

Class	Naira	Class	Naira	Class	Naira
1	= 0 - 100	4	= 301 - 400	7	= 601 - 700
2	= 101 - 200	5	= 401 - 500	8	= 701 - 800
3	= 201 - 300	6	= 501 - 600	9	= > 801

Source: compiled by the author.

Gross returns mainly come from arable crop and tree crop production (see Fig. 22). Although arable crop production is the most important source of gross return, tree crops provide nearly the same return to the farmers except in Okwe (L), where arable crop production is clearly dominant. Livestock production gains in importance from the low to the high population

Fig. 22: Relative Importance of Arable Crops, Tree Crops and Livestock as Sources of Gross Return in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

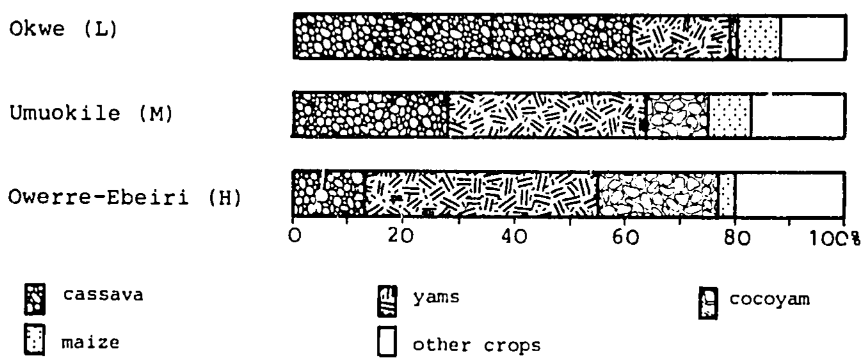
village, and in Owerre-Ebeiri (H) constitutes one fifth of the total farm production.

With increasing land scarcity the relative importance of arable crops declines, which indicates that the farming systems have become more integrated. Arable crops are susceptible to leaching of nutrients, while trees reactivate them from various levels of the subsoil, and livestock provide manure which is applied directly to the crops.

It should not be overlooked in this context that the more integrat[illegible] systems are those with lower productivity per hectare because of reduced soil fertility. The integration of arable crops, tree crops and livestock seems to be more pronounced the more pressing the soil fertility problems.

The contribution of the various arable and tree crops to gross return differ between the three villages as shown in Figures 23 and 24.

Fig. 23: Relative Importance of Arable Crops as Sources of Gross Return in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

It is quite obvious that:

- the gross returns from cassava production decline from Okwe (L) to Umuokile (M) and Owerre-Ebeiri (H), and
- yams and cocoyams gain in importance the higher the population density.

These results are in contrast to information provided in the literature (1), which suggests that cassava production increases at the expense of yams the lower the soil fertility. The inclusion of two factors explains the results of Fig.23:

- Yams in the medium and high density villages are mainly produced on compounds where yields are very high. Cassava is mainly produced on the outer fields.
- Yam prices are on average four times higher than cassava prices(2). In terms of production in physical quantities, cassava production is

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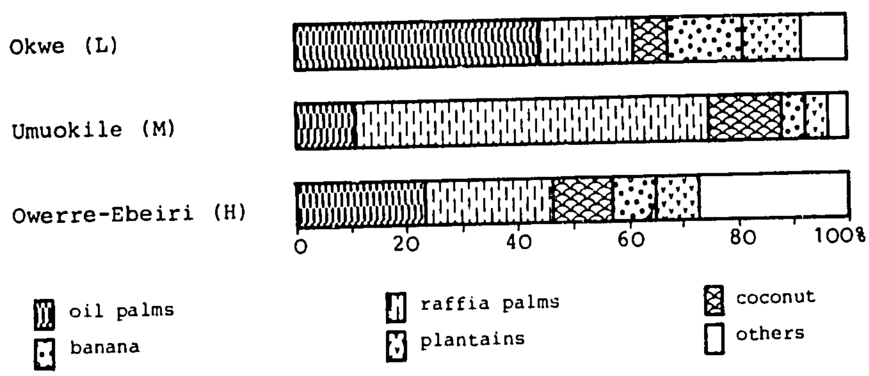
(1) BASDEN, G.T.: op.cit., p.395; SMOCK, D.R.: op.cit., p.1.

(2) See: prices and price variations in Appendix VI.

higher than that of yams even in the highly populated villages. A comparison in terms of calorie supply further increases the importance of cassava in the survey area. (1)

In respect of tree crops, it was found that oil palms and raffia palms are the most important tree crops, followed by coconuts, bananas and plantains (see Fig.24).

Fig. 24: Relative Importance of Tree Crops as Sources of Gross Return in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

Information on gross returns from various plot types is listed in Table 29. The estimates show that:

- the small compounds produce more than 50% of the total production from the land under cultivation (fallow land excluded).
- the gross return of production per unit area on compounds in Umuokile(M) is higher than in Owerre-Ebeiri(H). Compounds

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(1) 1 kg of cassava roots contain 1490 calories compared with 1140 calories for yams. See: Appendix XIII.

in the medium density village consist of 11% of cultivated area but produce 52% of the output, whereas compounds in the high density village consist of 26% of the land and produce 59% of the crop output.

- the land under fallow is productive both through the regeneration of soil fertility and through the value of tree crops harvested. A substantial proportion of the gross return, although declining from the low to the high density area, is derived from the uncultivated plots.

Table 29: Average Crop Production (in Naira) on Compounds, Outer Fields and Fallow Land in Three Villages in Eastern Nigeria, 1974/75

village	crops	compounds	outer fields	fallow	Total
Okwe (L)	arable	n.a.	265	5	270
	tree	n.a.	4	165	169
	total	n.a.	269	170	439
Umuokile (M)	arable	64	80	2	146
	tree	28	6	103	137
	total	92	86	105	283
Owerre-Ebeiri(H)	arable	70	44	2	116
	tree	29	26	43	98
	total	99	70	45	214

Source: compiled by the author.

2. Family Income from Farming

The farm income available for the household is derived from deducting farm expenses (1) (mainly yam sets and wages for hired labour) from gross re-

(1) Detailed information on farm expenses are provided in Appendix X.

turns. This amount averaged Naira 318.00 in the survey villages in 1974/75. Pronounced differences were found between the villages, between large and small farms, and between farms with different labour capacities.

As with gross returns, the farm family income was found to decline from the low to the high density village (see Table 30). However, due to the fact that Okwe (L) has by far the highest labour capacity, the average income derived from farming per man equivalent is lower than that of Umuokile (M). The small holdings in Owerre-Ebeiri (H) provide an income from farming which amounts only to Naira 90.10 per man equivalent. When comparing the figures per household member we find diminishing incomes from Okwe (L) to Owerre-Ebeiri (H). Umuokile's (M) farm income per person is relatively close to Okwe's (L), which is the result of the smaller household size compared with the other two villages.

Table 30: Average Family Income from Farming in Three Villages in Eastern Nigeria, 1974/75 (in Naira)

	Okwe(L)	Umuokile (M)	Owerre-Ebeiri(H)
Gross return	480	321	272
Purchased inputs	22	3	33
Farm income	458	318	239
Wages for hired labour	37	10	14
Farm family income	421	308	225
Farm family income per ME(a)	108	128	90
Farm family income per household member	48	42	26

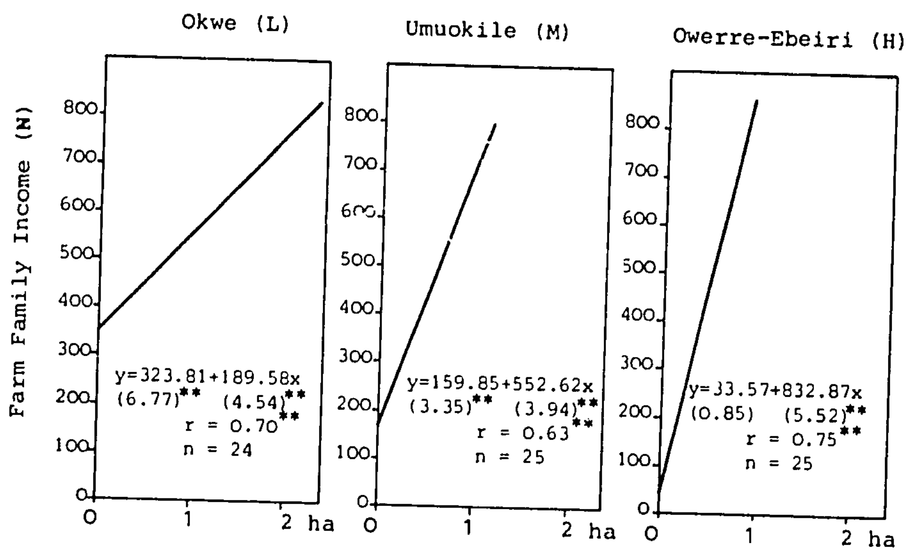
(a) man equivalents (ME) available for farming.

Source: compiled by the author.

a) Farm Family Income and Farm Size

The influence of farm size on farm family income is quite dramatic. Fig.25 indicates that in areas with relatively ample availability of land, the increase in farm size does not increase the farm family income as much as in areas

Fig. 25: Relationship between Farm Family Income and Farm Size in Three Villages in Eastern Nigeria, 1974/75 (cultivated area)



Source: compiled by the author.

where land is more scarce, although soils are more depleted and hence more unproductive. The greater the scarcity of land, the higher the return to additional land. The explanation probably is that farms with larger outer fields have more potential for "milking" land in order to accumulate nutrients in the compounds, and thus for intensification of the compound area. The higher supply of mulching material and organic matter makes it possible to increase the size of the compounds and/or to intensify cultivation on a given compound area.

b) Farm Family Income and Labour Capacity

Significant relationships were found between Farm Family Income and man equivalents available for farm work in the three villages as shown in Table 31.

Table 31: Relationship between Farm Family Income and Man Equivalents available for Farm Work in Three Villages in Eastern Nigeria, 1974/75

Okwe (L)	y = 176.37 + 67.37x (2.94)++	r = 0.53++	n = 24
Umuokile (M)	y = 161.00 + 60.85x (2.57)+	r = 0.47+	n = 25
Owerre-Ebeiri (H)	y = 87.07 + 54.51x (2.35)+	r = 0.44+	n = 25

y = Farm Family Income, x = ME

Source: compiled by the author.

The higher the labour capacity the higher the farm family income (1). As expected, the income due to an additional labourer declines from Okwe (L) (₦ 67) to Umuokile (M) (₦ 61) and to Owerre-Ebeiri (H) (₦ 55). Labour capacity alone can only explain a small amount (between 19 and 28%) of the total variation of the observed farm family income. It would therefore have been more sensible to relate farm family imcome to both quantity and quality of actual work done in the various fields. The performance of the farmers seems to vary widely and this is probably one of the major factors influencing the output.

c) Farm Family Income and Age of Farmer

In Okwe (L) and Umuokile (M) farmers within the age group 51-65 years gain the highest income through farming. Their experience in farming is probably higher than the younger ones, they are not so much engaged in off-farm activi-

(1) The linear function was the most appropriate.

ties (1), and in comparison with their older colleagues their physical strength is in a better state. In Owerre-Ebeiri (H) no distinct relationship was found.

Table 32: Relationship between Farm Family Income and Age of Head of Household in Three Villages in Eastern Nigeria, 1974/75

		Age of Head of Household			
		<35	36 - 50	51 - 65	>65
Okwe (L)	mean	-	325	551	470
	n	-	9	8	7
	CV as %	-	84.5	44.9	54.1
Umuokile (M)	mean	193	326	407	189
	n	6	10	7	2
	CV as %	42.0	60.6	46.3	84.6
Owerre-Ebeiri (H)	mean	133	289	200	252
	n	4	10	7	4
	CV as %	53.5	62.8	34.6	26.8

Source: compiled by the author.

d) Relationships between Farm Family Income and Resource Use

In addition to the factors influencing farm family income which were mentioned before, other factors are included in a multi-variable model of a whole-farm production function. The cost of labour was hypothesized as having a positive effect on farm family income. Education (2) and non-farm income may or

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(1) Okwe (L) $y = 98.01 + 3.66\ x$; $r = 0.11$
Umuokile (M) $y = -47.28 + 8.39\ x$; $r = 0.29$
Owerre-Ebeiri (H) $y = 1131.95 - 8.00\ x$; $r = -0.18$

where y = Non-farm income and x = age of head of household.

(2) Education is measured in years of schooling.

may not result in larger incomes from farming. Farmers with education and/or non-farm income sources have - other things being equal - better resources; however, they could tend to use these advantages more for off-farm activities.

The partial regression coefficients for the linear and Cobb Douglas models estimated for the three villages are listed in Table 33. For Okwe (L) and Owerre-Ebeiri (H) the Cobb Douglas type of function is the most appropriate for the observed data, and explains 69% and 76% respectively of the differences in farm family income for the low and high density villages. In Umuokile (M) the linear function fits the data better and explains 64% of the variations. The F-values show that all three regressions were highly significant.

For a comparison of the partial regression coefficients the same type of function has to be used. The following discussion is based on the linear model, because the R^2 is "satisfactory" for all three villages. The problems of a functional analysis of this type should not be overlooked. Some important factors, such as labour quality, are not included in the functions. Most of the variables are not significant. Some of the variables are intercorrelated. This may explain some of the contradictions between the linear and the CD function. Functional analyses are nevertheless considered of value as a heuristic device.

- Farm size (cultivated area) seems to have the greatest impact on farm family income in the three villages. An additional hectare of cultivated farm land would increase the family income from farming by Naira 153.00 in Okwe (L), by Naira 470.00 in Umuokile (M) and by Naira 884.00 in Owerre-Ebeiri (H). As in the single variable model, the return to land is higher the greater the population density.
- In the multi-variable model, labour capacity, measured in man equivalents (ME) available for farm work, does not significantly influence farm family income.
- In none of the villages is labour cost significantly related to farm family income. With the linear function, the same is true of the relationships between education, age of farmer, non-farm income and farm family income.

In summary, it appears that apart from farm size the other variables are estimates with a relatively low reliability. Furthermore, it seems as if not all important variables are included in the function.

Table 33: Factors Influencing Farm Family Income in Three Villages in Eastern Nigeria, 1974/75

									R^2	F
					Linear Functions					
Okwe (L):	Y =	21.46	+ 152.78x_1	+ 31.66x_2	+ 0.93x_3	− 2.33x_4	+ 3.44x_5	− 0.08x_6	0.61	4.45++
			(2.38)+	(1.37)	(0.68)	(−0.12)	(0.95)	(−0.74)		
Umuokile (M):	Y =	45.36	+ 470.16x_1	+ 31.68x_2	+ 3.60x_3	− 5.41x_4	− 0.51x_5	+ 0.16x_6	0.64	5.28++
			(3.43)++	(1.37)	(1.15)	(−0.49)	(−0.23)	(2.03)		
Owerre-Ebeiri (H):	Y =	35.58	+ 883.80x_1	+ 31.69x_2	− 2.71x_3	− 2.33x_4	− 1.57x_5	+ 0.05x_6	0.68	6.33++
			(5.01)++	(1.64)	(−1.31)	(−0.42)	(−1.06)	(0.93)		
					Cobb Douglas Functions					
Okwe (L):	Y =	25.53	$x_1^{0.47}$	$x_2^{0.36}$	$x_3^{-0.09}$	$x_4^{0.00}$	$x_5^{0.80}$	$x_6^{-0.05}$	0.69	6.36++
			(3.34)++	(1.96)	(−0.97)	(0.08)	(1.89)	(−0.68)		
Umuokile (M):	Y =	26.31	$x_1^{0.42}$	$x_2^{0.00}$	$x_3^{-0.03}$	$x_4^{-0.05}$	$x_5^{0.32}$	$x_6^{0.29}$	0.50	2.98
			(1.56)	(−0.01)	(−0.57)	(−1.39)	(0.61)	(2.60)+		
Owerre-Ebeiri (H):	Y =	3559.94	$x_1^{0.81}$	$x_2^{0.40}$	$x_3^{0.05}$	$x_4^{-0.02}$	$x_5^{-0.42}$	$x_6^{-0.08}$	0.76	9.65++
			(4.75)++	(2.14)+	(1.45)	(−0.95)	(−1.44)	(−0.83)		

y = estimated family income from farming, x_1 = farm size, x_2 = ME, x_3 = labour cost, x_4 = education, x_5 = age of farmer, x_6 = non-farm income;

Number of observations: Okwe: 24; Umuokile: 25; Owerre-Ebeiri: 25.

Source: compiled by the author.

e) Marginal Propensity to Consume Home-produced Food

The small farm sizes and the low yield levels, particularly in the higher population areas, influence the subsistence element, which is very pronounced in Eastern Nigeria. Marginal propensities to consume home-grown food are calculated with a linear regression function and are listed in Table 34. In the low population village an increase of Naira 1.00 in farm family income increases consumption of home-produced food by Naira 0.46. The coefficients for the medium and high population villages are much higher: 0.76 and 0.66 respectively.

The lower value for Owerre-Ebeiri (H) compared with Umuokile (M) is probably due to a higher consumption of purchased food, which is derived mainly through off-farm income.

Table 34: Relationship between Value of Home-produced Food Consumed and Farm Family Income in Three Villages in Eastern Nigeria, 1974/75

Okwe (L)	y = -29.91 + 0.46x (3.97)++	r = 0.65++	F = 15.73++
Umuokile (M)	y = -81.75 + 0.76x (13.79)++	r = 0.94++	F = 190.06++
Owerre-Ebeiri (H)	y = 16.72 + 0.66x (10.51)++	r = 0.91++	F = 110.54++

y = value of home produced food consumed
x = farm family income

Source: compiled by the author.

Nevertheless the coefficients are high compared with other data. For two villages in Yoruba Land with average farm sizes of 1.7 ha, FLINN estimated marginal propensities to consume of 0.09 and 0.20 (1). The information in-

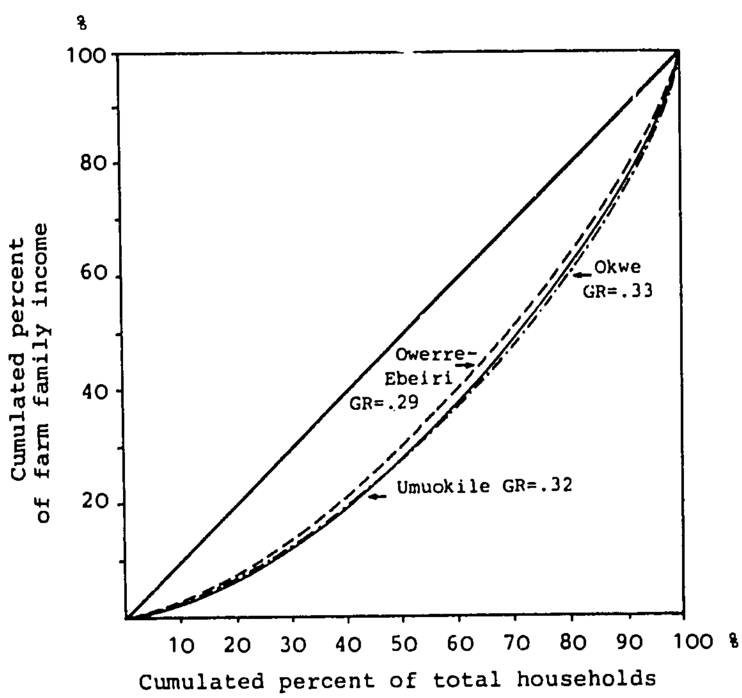
(1) FLINN, J.C.: Resource Use, Income and Expenditure Pattern of Yoruba Smallholders, op.cit., p. 19.

dicates that the marginal propensities to consume tend to be higher when land scarcity is more pronounced.

f) Distribution of Farm Family Income

The distribution of farm family income in the three villages is by no means equal (1). Even under very poor conditions, as in Owerre-Ebeiri (H), 40% of the households earn 60% of the total family income from farming. It is surprising that the differences between the three villages are not pronounced, even though the distribution of land under cultivation in Okwe (L) is much

Fig.26: Relationship between Number of Households and Farm Family Income in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

(1) Similar inequality of farm family income is reported by ROTENHAN,D. von: Bodennutzung und Viehhaltung im Sukumaland/Tanzania. IFO-Institut, München, 1966, p.83.

more unequal (see Fig. 3 on page22). In the low population village 40% of the households own 80% of the cultivated area. Possible explanations for the unequal distribution of farm family income can be found in the differences of family labour capacity, farm sizes and, importantly, in the different management capabilities of the farmers.

3. Total Family Income including Non-farm Income

All 74 farmers in the three villages obtained income from sources other than farming during the survey period. The magnitude of non-farm income increases the lower the income from farming (see Table 35).

Table 35: Average Non-farm Income of Households in Three Villages in Eastern Nigeria, 1974/75

	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
Non-farm income	300	347	721
CV as %	145	117	95
Non-farm income as % of total family income	42	53	76

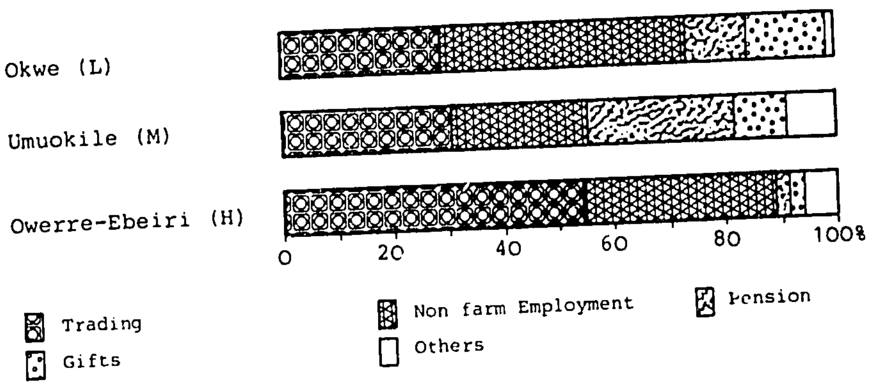
Source: compiled by the author.

Farmers in Okwe (L) acquire 42% of their total family income from off-farm sources, while in Umuokile (M) off-farm income constitutes 53% and in Owerre-Ebeiri (H) it is clearly the main source of livelihood and constitutes 76% of the total family income.

As shown in Fig. 27, trading and employment are the major off-farm activities, accounting for 56-89% of the total non-farm income (1).

(1) More detailed information on non-farm employment in the survey area is provided in Appendix X.

Fig. 27: Relative Importance of Off-farm Income Sources in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

For the educated farmers (1) it is relatively easy to find employment in the non agricultural sector. It is therefore not surprising that the non-farm income of educated farmers is higher than that of the uneducated farmers in the three villages.

Table 36: Average Off-farm Income (in Naira) of Educated and Uneducated Farmers in Three Villages in Eastern Nigeria, 1974/75

	Okwe (L)		Umuokile (M)		Owerre-Ebeiri(H)	
	mean	CV as %	mean	CV as %	mean	CV as %
educated	323	92	561	100	968	87
not educated	287	178	264	117	494	87

Source: compiled by the author.

(1) A farmer who has attended primary school for more than two years is classified as 'educated'.

The inclusion of non-farm income in the total family income changes the income situation of the households significantly. Although there are wide variations within the villages, the average income figures show the highest values for the high density village (see Table 37). The higher the population density the higher the total income per man equivalent, and the better off is each household member.

The results show clearly the great importance of non-farm income, and that the exclusion of the non-agricultural sector would have led to a totally misleading picture.

Table 37: Total Family Income (in Naira) in Three Villages in Eastern Nigeria, 1974/75

village	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
population density	low	medium	high
Total family income (a)	721	655	946
Total family income per ME	180	252	305
Total family income per household member	83	90	108

(a) Total family income = Farm family income + non-farm income

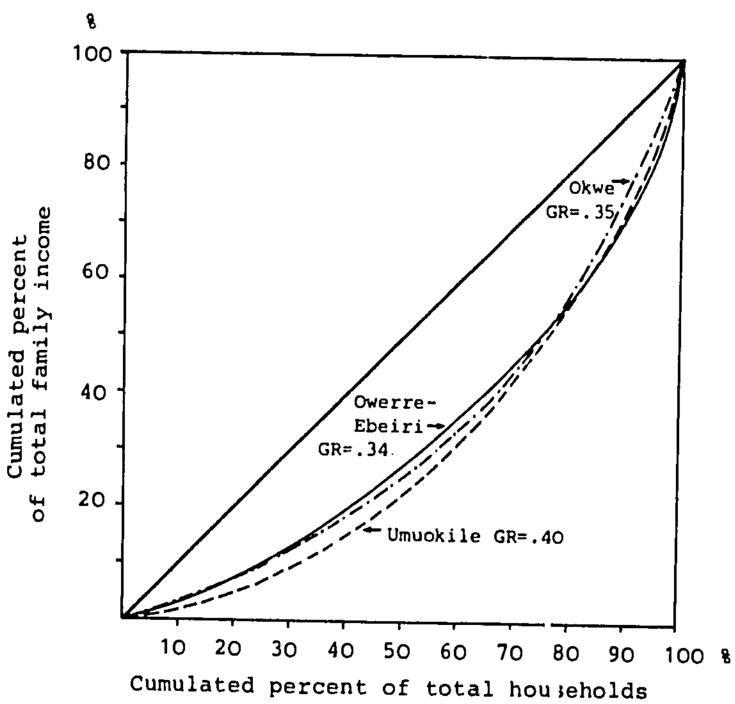
Source: compiled by the author.

This is of crucial importance for the main hypothesis of the study: Boserup's hypothesis, according to which food supply is a function of population growth and not population growth a function of food supply - as expressed by Malthus - is verified only provided off-farm activities are developed. Within a purely agricultural setting Malthus' hypothesis seems to be right. The process of Malthusian impoverishment in an agricultural setting is, however, slowed down by the farmers' efforts to adapt their farming systems to declining soil fertility by an increasing inter-farm differentiation between compounds and the outer fields.

Another important finding is that the distribution of total family income is far more unequal than family income from farming alone (see Fig.28). Non-farm income is therefore more concentrated than income from farming.

The tendency for an increasing differentiation of incomes in the process of economic development, which is normally observed once cash cropping begins to expand, is not pronounced in the study area of Eastern Nigeria. Off-farm employment is the avenue for income differentiation.

Fig. 28: Relationship between Number of Households and Total Family Income in Three Villages in Eastern Nigeria, 1974/75



Source: compiled by the author.

4. Cash Income and Utilisation

Total cash income derives from non-farm sources, and from sales of crops and livestock.

The relative importance of arable crops, tree crops and livestock as sources of cash income changes according to land scarcity (see Table 38). The higher the population density and hence the smaller the farms:

- the less important are arable crops,
- the more important are tree crops, and
- the more important is livestock

as sources of cash income.

Table 38: The Relative Importance of Arable Crops, Trees and Livestock as Sources of Cash Income in Three Villages in Eastern Nigeria, 1974/75

village	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
population density	low	medium	high
average cash income per farm (N)	307	173	76
of which: arable crops (%)	47	21	10
tree crops (%)	49	71	77
livestock (%)	4	8	13

Source: compiled by the author.

Total cash income is used for farm, food and other family expenses (see Table 39) (1).

(1) Detailed information is provided in Appendix X.

Table 39: Average Cash Income, Expenditure and Saving Patterns (in Naira) in Three Villages in Eastern Nigeria, 1974/75

village	Okwe (L)	Umuokile (M)	Owerre-Ebeiri (H)
population density	low	medium	high
a) Cash income			
Cash farm income	307	173	76
Non-farm income	300	347	721
Total cash income	607	520	797
b) Farm expenses			
Labour	37	20	14
Planting material	12	2	29
Others	9	1	8
Total farm expenditure	58	23	51
c) Food expenses			
Fish and meat	74	40	52
Cassava products	6	42	83
Yam	6	6	24
Rice	11	5	27
Others	75	46	75
Total food expenditure	172	139	261
d) Other family expenses			
Trading	60	97	119
School fees	39	38	117
Medical	24	27	50
Clothes	25	18	32
Housing	32	13	27
Others	41	41	153
Total other expenditure	221	234	498
Total cash expenses	451	396	810
Surplus of receipts over outlays	156	124	-13

Source: compiled by the author.

Farm expenses are a minor component (less than 8%) of total expenditure. This is mainly due to the fact that innovations such as fertilizer, pesticides etc. are not regularly available. The major cost item is food expenditure, which is the highest in Owerre-Ebeiri (H), where only a small amount of the total food requirement is produced by the farmers themselves. Compared with total cash income from farming, the food expenses in the high density village are nearly Naira 200.00 higher. Umuokile (M) produces a very small surplus, which means that farmers are only just above the subsistence level. Farmers in Okwe (L) produce a substantial amount for the market. The surplus amounted to Naira 134.00 per farmer during the survey period.

Other important expenses are trading, school fees, medical expenses, clothes and housing. They are usually higher the more cash is available. Particularly pronounced is the difference for school fees between Owerre-Ebeiri (H) and the other two villages. This indicates that farmers in very high population density areas know the great importance of educating their children, who can earn their future income only through activities outside the farm. It is also a type of insurance for the farmers themselves, because well educated and 'well earning' children are in a position to look after their parents when they are not able to take care of themselves.

The surplus of receipts over outlays shows that farmers in Umuokile (M) and in Okwe (L) save a small amount of their total cash income. While one must treat income and expenditure figures with caution, the possibility of generating savings are in general not high. Nevertheless there are better farmers who are in a relatively good liquidity position and are therefore able to put an important part of their incomes into profitable investments (see Gini ratios in Fig. 28, p. 112).

IX. Conclusions

The results of the data collected in the three villages show the tremendous impact of the population density on agricultural production as well as on income derived from non-farm sources. The higher the population density the smaller the farm sizes per household. This pressure on land has the following results in the farming systems of the survey area:

- Reduced fallowing diminishes soil fertility, and consequently results in lower yields and lower labour productivities.
- The internal farm differentiation gains in importance. The outer fields supply fertilizing materials which are accumulated on the compounds. The compounds produce more than 50% of the total production from the land under cultivation.
- The density of trees and arable crops increases. Trees expecially act as nutrient pumps, and seem to slow down the decline in soil fertility.
- Manuring practices gain in importance. The crops are supplied with ashes and organic material.
- The relative importance of livestock as a source of farm-family income increases.
- Although farm sizes decrease with increasing population density, the field work per man equivalent per year increases.

The adaptations were obviously able to slow down the process of diminishing yields, but they are insufficient to stop the process.

Without additional income from off-farm employment, the households in the high population density areas could not provide their daily food requirements.

The importance of non-farm income increases the higher the population density: 42% of the total family income in Okwe (L) is derived from off-farm sources, in Umuokile (M) the figure averages 53%, and in Owerre-Ebeiri (H) 76% of the total family income is derived from off-farm sources. This information indicates that the total family income per household member is higher the higher the population density. Population growth has forced people to work outside the farm, to educate their children, and to migrate to other areas.

These results imply that an increase in food production requires innovations which are so rewarding that the additional income obtained is higher than possible incomes from off-farm sources. Off-farm employment, though not always available, is very often the alternative for the farmers, and especially for the younger generation. Farmers' experience with the multi-storey cropping system suggests it is a type of land use which could well be used as a starting point for the development of the farming system in Eastern Nigeria.

C. AVENUES FOR THE EXPANSION PATH OF THE EASTERN NIGERIAN FARMING SYSTEM

Introduction

The information available on land use development in Eastern Nigeria clearly indicates a tendency towards a farming system at a "low level equilibrium"; cropping on outer fields in highly populated areas has already reached that stage. Counteracting efforts by the farmers has led to the establishment of highly productive multi-storey cropping systems on the compounds. These emerging systems have reduced the speed of the degradation process, but they are insufficient to balance it. The change towards a productive and stable type of land use has to come from innovations, and the question has to be answered as to which avenues for land use development are most likely to succeed in the area (1).

The following five approaches seem to be of particular relevance in the area:

- development of the valley bottoms for wet rice and off-season vegetables,
- establishment of modern tree crop plantations,
- improvement of arable crop production techniques,
- replacement of fallow systems by permanent cultivation systems,
- improvement and expansion of multi-storey cropping in compound farming.

I. Valley Bottom Development

Population growth in the humid tropical lowlands of Asia led to the intensification of land use in valley bottoms, while hillsides and uplands were, and to some extent remain, either vacant, used for extensive types of fallow cultivation, or planted with tree crops (2). One of the most striking aspects of

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(1) The integration of food crop production and forestry (agri-silviculture) seems to be a realistic proposition only in low population density areas and is therefore excluded. See: GRINNEL, H.R.: Agri-Silviculture: A Suggested Research Programme for West and Central Africa, IDRC, Ottawa, and IITA, Ibadan, 1975.

(2) See: BUCK, J.L. Land Utilization in China, Paragon, New York, 1964,p.4.

land use in Eastern Nigeria is the fact that valley bottoms are wasteland, except for some minor development which has begun in recent years. Farmers were extremely skilful in adapting upland farming to the condition of decreasing soil fertility. They have been optimisers within the framework of traditionally known techniques, but they have ignored the high potential of valley bottoms. And valley bottoms lend themselves to development in Eastern Nigeria, because they are usually fertile, floods are rare, and a reliable supply of water can be secured with minor investments.

A significant improvement in the agricultural situation in Eastern Nigeria can be expected from adopting the Asian emphasis on intensive farming of valleys where soils are comparatively fertile, where wet rice can be grown in the wet season and vegetables in the dry season, i.e. where sequential cropping could occur over most of the year. Valley bottom development would also allow the introduction of important innovations in wet rice production which have become available in recent years (high-yielding and disease resistant varieties, effective mineral fertilizer application, (1) multiple cropping techniques).

There is no easy answer to the question why valley bottoms have been ignored, even though food supply was scarce and occasionally people suffered from starvation. The answer probably lies partly in the fact that the Eastern Nigerian farming system developed from shifting cultivation. The principle of meliorating land by drainage is not part of the cultural heritage. The possibilities for increasing material welfare and utility which are outside the cultural heritage are apparently adopted only with the help of strong incentives or in situations of extreme pressure for food. Both situations have occurred in the recent past. Extreme pressure for food existed especially during the civil war and during the following years. Responsive rice varieties are available and great incentives are provided by present food prices. It might therefore be assumed that the ground for valley bottom development is prepared.

1. Wet Rice

Establishing data on the costs and returns of wet rice development in the area was one of the objectives of this survey. In Okwe an area within a valley bottom was opened up and planted with rice. Table 40 shows the costs in comparison with data from Ivory Coast. The initial information indicates that valley

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(1) "With the increasing cost of nitrogenous fertilizers and the increasing use of rice varieties responsive to fertilizers, the possibility of complementing fertilizer treatment with nitrogen fixation in rice culture becomes more important."
See: DART, P.J. and DAY, J.M.: op.cit., p.27.

Table 40: Development Costs of Hydromorphic Valley Bottoms (₦ per ha)

Location	Okwe (L)/ Eastern Nigeria	Forest Zone of Ivory Coast
Construction of a dam	140 (a)	547
Clearing	210 (b)	603
Levelling	112	356
Drains and Field bunds	84	85
Total	546	1591

(a) Only a small dam was necessary to build a water reservoir

(b) Bigger trees were not felled

Source: Eastern Nigeria: compiled by the author.

Ivory Coast: SODERIZ: Project BIRD-CCCE, 1975-78, Annexes, pp. 5,17 et seq.

development with wet rice should be highly profitable. This is confirmed by experience from the Uboma Project, (1) where arable upland development, tree crop planting and valley bottom development were started in 1965 and where wet rice proved to be the most profitable and popular part of the agricultural development project. Table 41 indicates that yields of 3t per hectare can be expected, and that the gross margin is very attractive. It was estimated that the value of rice produced in a five-month period was in excess of that from a traditional system in an 18-month period. (The lower yield in Okwe (L) in 1975 was mainly due to poorer water control over the entire paddy and late transplanting of seedlings).

With the possibility of growing a second crop (rice or vegetables) in the valley in the same year the profitability of developing these hydromorphic bottom lands becomes clear. Prices of rice were high and increased during 1975 more than those of other staple food crops, which provides a further incentive for rice production.

(1) See: Appendix I.

Table 41: Variable Costs and Returns per ha from Wet Rice Produced on Hydromorphic Valley Bottoms in Eastern Nigeria, 1974/75 (one crop season)

Year	Village	No. of farmers	Yield in kg (milled rice)	Price per kg N	Gross return N	Cash cost N	Gross Margin N
1974	Okwe (L)	1	3600 (6000 kg paddy)	0.26	936	140	796
1975	Okwe (L)	4	2688	0.40	1075	186	889
1974	Uboma	1	3096	0.20	619	19 (a)	600
Average Values:			3128	0.29	877	115	762

(a) Costs for threshing and milling are not included.

Source: Okwe: compiled by the author; Uboma: data provided by R.O.M. OFFOR, project manager at Uboma.

2. Vegetables

Elsewhere under similar ecological conditions two rice crops a year are possible. In the three villages, rice in the wet season would normally be followed by dry season vegetables (telferia, okra, tomatoes). Table 42 shows the gross return and the gross margin of vegetables, which indicate that they are a good dry season crop and probably more suitable than wet rice when water supply is not ample.

Within the farm as a system, valley bottom farming will interact with upland farming by offering fuller and more even employment of the available labour capacity and by supplying feed and mulching material for the compound and fields. Nutrients applied with mineral fertilizer to the valley bottom and transported as mulching material to the upland could counteract the general tendency towards decreasing soil fertility.

Eastern Nigeria has large areas of valley bottom which could be developed. It has to be considered, however, that they occupy only a small part of the

Table 42: Costs and Returns of Vegetables Production (a) of Smallholders in Uboma, Eastern Nigeria

Year	No. of farmers	Area in ha	Gross Return N/ha	Cash Costs(b) N/ha	Gross Margin N/ha
1971/72	1	0.24	445	168	277
1972/73	2	0.48	961	273	688
1973/74	4	1.01	918	262	656

(a) Telferia, okra, tomatoes, spinach.
(b) Includes costs of seeds, compost and chemicals.

Source: compiled by the author from Table 5 in Appendix I.

total area, and some villages have no valley bottoms at all. Valley bottom development probably deserves priority, but it is certainly not the only avenue for land use development.

II. Modern Tree Crop Plantations

Asian experience (1) also indicates that food crop production in the valley bottoms could be supplemented by tree crop production on the upland, because erosion and leaching are much more easily reduced by tree crops than by annual or biannual crops. The obvious choice for Eastern Nigeria would be the planting of high-yielding varieties of oil palms:

- New varieties mature earlier (3-4 years instead of 6-7 years).
- New varieties yield more bunches of fruit in kg per tree and the pericarp has a higher fat content (higher extraction rate: up to 22% (2).
- New varieties are earlier to harvest.

(1) See: HARWOOD, R.R.: The Resource Utilization Approach to Cropping Systems Improvement. IRRI, Philippines, 1974.

(2) WASTIE, R.L. and EARP, D.A.: Advances in Oil Palm Cultivation. Kuala Lumpur, Malaysia, Nov. 1972, p.5.

Table 43: Examples of Oil Palm Yields in Tons of Fresh Fruit Bunches ha/year

Country:	-	Ivory Coast	Nigeria	Sumatra
Farm type:	smallholder	smallholder	estate	estate
Variety:	wild palms	n.a.	Tenera	Tenera
Year:	1967	1969	1974 (a)	1975
Age of plantation				
1	-			
2	-	-	-	-
3	-	-	-	-
4	-	-	-	5.0
5	-	-	3.1	11.9
6	0.5	2.5	6.2	19.4
7	0.9	5.0	9.3	22.5
8	1.4	7.0	11.1	25.0
9	1.8	9.5	13.0	25.8
10	2.2	10.5	14.8	26.1
11	2.8	10.5	14.8	26.0
12	2.8	10.5	14.8	26.0
13	2.8	10.5	14.8	26.0
14	2.8	10.5	14.8	n.a.
15	2.8	10.5	14.8	"
16	2.8	10.5	14.2	"
17	2.8	10.5	14.2	"
18	2.8	10.5	14.2	"
19	2.8	10.5	14.2	"
20	2.8	10.5	14.2	"
21	2.8	10.5	13.6	"
22	2.8	10.5	n.a.	"
23	2.8	10.5	"	"
24	2.8	10.5	"	"
				"

(a) Projection of the Commonwealth Development Corporation.

Source: Wild palms and Ivory Coast: RUTHENBERG, H.: Farming Systems, 2nd ed., op.cit.
Nigeria and Sumatra: WALKER, H.: Die wirtschaftliche Bedeutung des technischen Fortschritts im Ölpalmanbau, Universität Hohenheim, unpublished thesis, 1976, p. 17.

- The extraction efficiency is increased through oil palm presses (20-45% more oil in comparison with processing by hand).

Yield data from wild and improved oil palm varieties in different regions show that the yield from new varieties is more than four times higher than from the traditional type.

The very high yield in Sumatra is not only due to high fertilizer inputs and careful husbandry but also to very favourable climatic and edaphic conditions.

Information collected during the survey indicates that modern oil-palms are a competitive crop in the area.

In Table 44 the gross return and labour productivity of a smallholder's plantation (which was established in 1964) are listed. A total yield of 8 tons of fruit bunches per ha per year was realised without mineral fertilizer or a cover crop, but underbrushing was performed twice a year.

Table 44: Economic Return and Productivity from a Smallholder's Oil-palm Plantation in Eastern Nigeria, 1974/75

	Total plantation (3.6 ha)	per ha
Yield of FFB in tons/year	28.8	8.0
Gross return (N) (a)	713	198
Labour input (man-hours)	1260	350
Labour productivity (gross return/man-hour) (N)		0.57

(a) Prices: palm oil N 250 per ton; palm kernels N 100 per ton.

Source: LAGEMANN, J.: Case Study from a smallholding with oil palm in Eastern Nigeria, IITA, Ibadan, Nigeria, 1975.

Gross returns of oil palms in the case study are lower than gross returns of traditional farming in the area (compare Table 14), but it has to be considered that no fertilizer is used and that hand extraction is practised. With modern techniques gross returns should be about two to three times higher. However, the return per hour of work is several times higher. Oil palms in the case study yielded Naira 0.57 per man hour, compared with Naira 0.11-0.23 per man hour in the outer fields of the survey villages (see Table 27). A combination of modern oil palms on the upland and intensive farming in the valley bottoms would allow high labour productivity with tree crops and much employment in the valley bottoms.

The data indicate that improvements in the smallholders situation are possible with the given technology and that a further increase might be expected. However,

> "under traditional conditions the system is leading towards the competition for land between an extending plantation of modern oil palms for cash and the requirements for fallow land to maintain yield levels of food crops". (1)

These observations are very important in high population density areas, where farms are small and only a few farmers are able to grow oil palms without the interculture of cassava, yams, maize and other crops which is practised with the traditional (wild) oil palms. The 75 survey farmers were asked whether they intended to increase the number of oil palms (improved variety). The results show that only in the low density village were most of the farmers (76 %) inclined to establish small plantations, which would be on average 0.7 ha (see Table 45).

More areas could be planted with oil palms if arable crop production could be intensified and cultivated on smaller fields.

A major constraint to implementing small plantations is the fragmentation of farm land. It seems obvious that a land consolidation programme is necessary in the area before modern trees can be introduced on a larger scale. Although it is a difficult undertaking it has been proved in the survey area that land consolidation is possible when integrated with other agricultural programmes (2).

(1) RUTHENBERG, H.: Farming Systems, 2nd edition, p.107.

(2) See: ANTHONIO, Q.B.O. and IJERE, M.O.: op.cit.,p.27. A detailed description of the impact of fragmentation of farm land on agricultural production is given by: JOHNSON, V.C.: Land Tenure and Agricultural Development in Nigeria, op.cit.

Table 45: Farmers' Intentions to Plant Improved Oil Palms in Three Villages in Eastern Nigeria, 1974/75

Village	Yes	No	Total No. of Oil Palms	Average
Okwe (L)	76 %	24 %	1870	98
Umuokile (M)	24 %(a)	76 %	202	34
Owerre-Ebeiri (H)	24 %	76 %	283	47

(a) The large number of women as heads of household decreased this figure. They said: "It is not within the power of women to plant trees". In other words: trees are inherited through the patrilinear system.

Source: compiled by the author.

III. Improvement of Arable Crop Production Techniques

Valley bottom development and the planting of high-yielding tree crops can be based on established procedures, which have shown their effectiveness in a great number of cases with similar natural and economic conditions, as for instance in Ivory Coast. The improvement of arable upland farming in open fields seems to be a much more difficult proposition due to soil fertility problems. Agricultural research is now supplying a number of innovations which may be applicable in the area: (1)

- High-yielding maize varieties (with a taste which is preferred by the local farmers) have been identified and tested during the NAFPP Programme. The yield of improved varieties was about 55% superior to that of the local cultivar.
- Improved clones of cassava are available which ensure high productivity in farmers' fields, even in areas of high disease

(1) Improvements identified by the International Institute of Tropical Agriculture, IITA, Ibadan, Nigeria.

hazard. (Resistance to both cassava mosaic disease (CMO) and cassava bacterial blight (CBB) disease was as stable in an area with high rainfall and sandy soils as in many other environments).

- Although still in the development phase, yams can be produced from seeds instead of using a seed tuber from previous harvests. This improvement decreases the costs of yam production and might reverse the declining cultivation of the traditional staple crop.

The yield increasing capacity of improved maize varieties has been established in a number of cases. An experiment with modern maize production techniques was therefore part of this survey.

Sixty-eight farmers in the three survey villages grew sole crop maize using "improved" production practices. The modal class of maize yields obtained by the farmers diminished from 3-4 tons/ha to under one ton/ha on the most depleted soils. The distributions of the maize yields in the three survey villages are shown in Fig. 29.

The decline of both modal and average yields is consistent with the observations from the traditional system and indicates that mineral fertilizer has little or no effect when the fallow period is very short: (1) modern techniques yield very low returns on land that has been overcropped as in Owerre-Ebeiri (H). To determine the relevance of the technology requires an assessment of how much better off the farmer would be by using the new technology as opposed to his traditional systems. When allowances were made for the production foregone (2) due to the farmer's not following his traditional system of intercropping, it was estimated that 19, 17 and 74 per cent (3) of the farmers in the low, medium and high population villages respectively would have been worse off using the capital intensive technology rather than his current, relatively low-cost system of production. Thus, if the farmers had to pay for all inputs, it is unlikely that the technology would find general adoption in the regions - particularly in the areas with the most impoverished soils.

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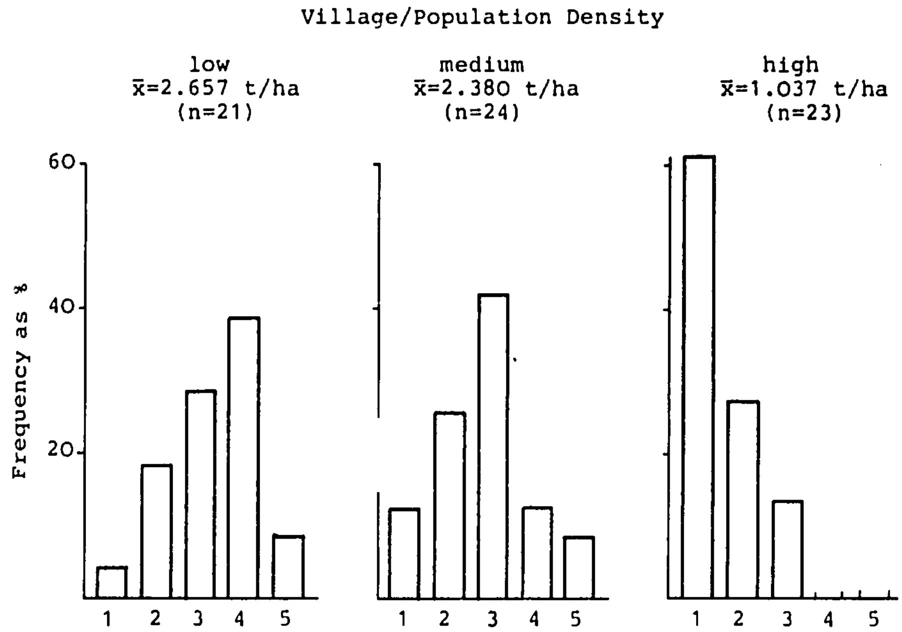
(1) The low base saturation (50%) of soils in Owerre-Ebeiri (H) is probably responsible for the low yield. The added N, P, K fertilizers showed little response as Ca + Mg remained deficient.

(2) The farmers are foregoing the revenue from their traditional maize, eguisi (melon) or groundnut and yams. Cassava could be still planted when the maize was harvested.

(3) FLINN, J.G. and LAGEMANN, J.: ibid. p.11.

Fig. 29: Distributions of Maize Yields in Three Villages in Eastern Nigeria, 1975



Class	Yield range (tons/ha		
1	0	to	0.99
2	1.00	to	1.99
3	2.00	to	2.99
4	3.00	to	3.99
5		≥	4.00

Source: FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize, op.cit., p.6.

In addition it has to be considered that improved crop production with sole stands may not be appropriate under the conditions which prevail in Eastern Nigeria. Table 46 shows that most farmers prefer intercropping to sole cropping.

Table 46: Reasons Advanced by Farmers for Preferring Intercropping as Opposed to Sole Cropping

Reason	Number of responses in each village (a) H	M	L
Varied food supply over time	9	17	10
Limited land	15	13	11
Labour efficiency	9	8	5
Make more money	7	5	9
Risk aversion	3	6	4
Other (b)	6	3	0

(a) Most farmers gave more than one reason.
(b) Conserves the soil, because of tradition, do not know.

Source: FLINN, J.C. and LAGEMANN, J.: ibid. p.20.

A varied food supply throughout the year and a high output from the limited land were the most important reasons given by farmers. (1)

Initial results from experiments carried out at IITA seem to indicate that intercropping is more productive and better adapted to the smallholders' conditions. Table 47 shows that there were significant differences in the calorie values of the different crop combinations, with the highest value observed in maize-melon-cassava crop combinations where the cassava was planted in June.

An increase in arable crop production with new varieties and purchased inputs but still within the bush fallow system may offer some scope for increasing output and productivity, but the evidence so far is not convincing. In areas

(1) The preferences for intercropping are consistent with those reported elsewhere.
See: NORMAN, D.W.: The rationalisation of a crop mixture strategy adopted by farmers under indigenous conditions; the example of Northern Nigeria, in: Journal of Development Studies, 11:1, pp. 3-21, Oct. 1974;
PARKER, N.: Intercropping, B.Sc.Honours Thesis, University of Reading, Reading, May, 1969.

Table 47: Total Dry Weight Yields, Calorie Values of Maize and Melon Relay Cropped with Cassava with Different Crop Combinations and Dates of Cassava Planting in 1974/75

	Treatments Cassava planting: 16th day of each month indicated	Total Yield t/ha	Calorie Maize	10^7 Melon	Cassava	Total
1	Maize alone (April)	4.49	16.03	..	..	16.03
2	Melon alone "	1.02	..	0.53	..	0.53
3	Cassava alone "	14.95	..	..	39.77	39.77
4	Maize/Melon "	4.66	16.60	0.03	..	16.63
5	Maize/Cassava "	15.17	16.42	..	28.12	44.54
6	Maize/Melon/Cassava (April)	16.15	14.96	0.04	31.79	46.79
7	Cassava alone (May)	15.79	..	..	42.00	42.00
8	Maize/Cassava	15.63	17.28	..	28.70	45.98
9	Maize/Melon/Cassava (May)	15.96	15.21	0.10	31.07	46.38
10	Cassava alone (June)	11.84	..	..	31.49	31.49
11	Maize/Cassava	16.59	16.92	..	31.52	48.44
12	Maize/Melon/Cassava (June)	23.73	16.39	0.07	50.89	67.35
13	Cassava alone (July)	10.47	..	..	27.85	27.85
14	Maize/Cassava "	14.15	16.39	..	25.43	41.82
15	Maize/Melon/Cassava (July)	12.99	17.74	0.04	21.12	38.90
16	Cassava alone (August)	7.46	..	..	19.84	19.84
17	Maize/Cassava "	11.73	16.07	..	19.23	35.30
18	Maize/Melon/Cassava (Aug.)	10.30	15.82	0.16	15.53	31.51

Source: IITA, Annual Report, 1975.

with very depleted soils it is unlikely to succeed, and it would require varieties which are particularly suited to acid soils. It is assumed that this avenue of development is unlikely to find a great number of ready adopters.(1) It seems much more likely that the adoption of modern crop production techniques, in particular with mineral fertilizer application, is tied to a change in the system.

(1) It seems to be only a short-term solution, and this only for specific areas.

IV. Replacement of the Fallow System by Permanent Cultivation Systems

Closely related to the question of which innovations would improve arable upland cropping is that of a change from fallow systems to permanent cultivation systems.(1) The survey showed that farmers in high density areas reduced fallowing to such a degree that the fertility restoring capacity of a fallow was severely reduced. The possible answer seems to be to replace the remaining bush fallowing with a soil fertility restoring type of permanent cultivation, which would imply multiple cropping.(2) Past efforts to develop permanent cropping systems in the area failed.

A new effort was made with minimum tillage techniques, which rely on heavy mulching. Experiments at IITA during recent years indicate the importance of mulching under tropical conditions (see Table 48):

> " The continuous maize plot (with residue return) after 2 1/2 years contains considerably less "active matter" compared with the bush and grass fallow plots as indicated by the results for biomass C and primary reserve N. However, the plot of maize with residue return contains three times more "active organic matter" than the maize plot where crop residue was removed. The exchangeable Ca, Mg and K contents follow the same trend. Soil from Guinea grass plots contains the highest amount of exchangeable K. These results clearly demonstrate the necessity of the return of plant residues to tropical soil in order to maintain its productivity."(3)

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(1) REHM, S. argues that high yielding varieties and mineral fertilizer alone are not sufficient to increase agricultural productivity in the humid tropics. He stresses the importance of mulching and the suitability of tree crops under high rainfall conditions. In: Landwirtschaftliche Produktivität in regenreichen Tropenländern, in: Umschau 73, Heft 2, 1973, pp. 44-48.

(2) Permanent cultivation in Taiwan "...is based on an intensive fertilizing with organic and mineral fertilizers, supplemented by measures for erosion control, and careful cultivation. In other densely populated areas, for example in Java and in the West Indies, root-crop systems (manioc, sweet potatoes) have principally developed, and are associated with various tree crops". See: RUTHENBERG, H.: Farming Systems, 1st ed., op.cit., p. 104.

(3) LAL, R.: Role of mulching Techniques in Tropical Soil and Water Management, Technical Bulletin No.1, IITA, Ibadan, Nigeria, 1975, p.31.

Table 48: Biomass and Nutrient Status of Surface Soils (0-15 cm) under Bush Fallow and Continuous Maize after two and a half Years (a)

Treatment	Bio-mass C ppm	PRN (b) %	Organ-ic C %	Exch.bases Ca	me/ Mg	100g K	Bray P ppm	Field moisture %
Bush regrowth	337	3.50	1.46	6.80	2.43	0.53	14	25.8
Panicum maximum	372	3.30	1.68	8.20	2.09	0.96	27	19.8
Maize return residue (a)	184	2.60	1.41	4.80	1.05	0.41	65	16.5
Maize remove residue (a)	58	0.91	1.09	3.10	0.48	0.12	22	13.2

(a) Soil samples were taken in May 1974 for biomass measurements, and only one replication of the plots was sampled as indicated by Plot No. Fertilizers were applied to G and H plots at rates of 150 kg N, 60 kg P_2O_5 and 30 K_2O per hectare per season.
(b) PRN - Primary Reserve N, expressed as % of total N.

Source: ITTA, Annual Report, 1974, p.52.

Experimental results have shown that at present only maize produces enough mulching material to cover the soil and to reduce significantly the leaching of nutrients. The more humid the climate and the more sandy the soil the higher has to be the mulch quantity applied to the fields. The situation is similar on slopes where run-off, soil and nutrient losses are high when the soil is not covered (see Table 49). Mulch rates of 6 tons/ha/year are necessary to minimize the effect of rainfall.

> " The essential factor is the maintenance of the well developed surface aggregation due to the activities of worms and other soil animals, ensuring rapid infiltration of water, and the protection of the soil surface against raindrop impact by the mulch of plant residues." (1)

(1) GREENLAND, D.J.: Bringing the Green Revolution to the Shifting Cultivator, op.cit., p.7.

Table 49: Effect of Rate of Mulch on Run-Off and Soil Loss.
Total rainfall = 64 mm

Mulch rate (tons/ha)	Slope (%) 1	5	10	15	Mean	Percentage of rainfall
			Run-off (mm)			
0	12.0	14.8	10.4	14.3	13.0	20
2	1.3	6.2	6.0	5.7	4.8	8
4	0.4	1.5	3.6	3.3	2.2	3
6	0.0	0.7	1.9	1.8	1.1	2
			Soil loss (tons/ha)			
0	0.48	12.19	27.06	12.25	13.00	
2	0.01	3.49	0.82	0.64	1.24	
4	0.00	0.67	0.11	0.31	0.27	
6	0.00	0.16	0.03	0.08	0.07	

Source: LAL, R.: op.cit., p.11.

Other merits of mulch tillage reported by LAL (1) are:

- soil moisture storage is superior to that of conventionally ploughed soils;
- improvement in soil thermal regime;
- maintenance of soil structure;
- savings in labour and power (expensive machines);
- savings in time due to quick preparing of seed beds;
- minimizing losses due to lodging;
- high fertilizer efficiency.

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(1) LAL, R.: op.cit., p.31.

The combination of minimum tillage and intercropping seems to prevent erosion and to produce yields which are higher than from sole crops (see Table 50).

Table 50: Yields of Cowpea and Intercropped Cowpea and Maize under Different Tillage Methods, IITA, Ibadan, Second Season, 1974

Tillage method	Grain yield, kg/ha			
		Intercropping		
	Sole Cowpea	Cowpea	Maize	Total
Ploughed and ridged	1185	665	1705	2370
Ploughed, flat bed	1274	725	1675	2300
Strip tillage	1538	1022	2337	3359
Zero tillage	1649	941	2809	3750

All plots received 30 kg N/ha, 30 kg P/ha and 30 kg K/ha fertilizers.

Source: Unpublished data of NANGJU, D., IITA, Ibadan.

Despite these promising results it is necessary to bear in mind that the prerequisite for the success of minimum tillage is the application of chemical inputs. High rates of fertilizer are necessary to produce the required mulching material. Insecticides are needed to decrease the risk due to insects, and are usually required to maintain luxurious growth of crops. (1)

Chemical inputs can therefore be a substitute for the use of expensive machinery. The application of inputs is possible even on very small fields, and economies of scale are not pronounced compared with ploughing systems.

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(1) GREENLAND, D.H. points out that pesticides might be avoided through disease resistant material but "...a nutrient requirement is inescapable, because removal of phosphorus, and possibly other nutrients in products sold off the farm must be made good if satisfactory production is to be maintained". In: Bringing the Green Revolution to the Shifting Cultivator, op.cit., p.8.

Even though inductive reasoning and experimental work so far indicates that minimum tillage techniques might produce an operational answer to modern arable cropping in the survey area, it should not be overlooked that they are still in the stage of trial and error. A number of technical questions are open. Nothing is as yet known about costs and returns under the conditions of practical farming. Further, the question of how to combine crop production and mulch production has to be answered. The following alternatives seem to be worthwhile investigating:

- arable crop and mulch production on separate plots but close to each other. Mulch production has to be very high on a relatively small plot compared with the field with arable crops. A production of 30 t mulch/ha requires 25% of the total land available for arable crops for mulch production if 10 t mulch/ha are to be reapplied to the crops,

- trees with a cover crop alternated with narrow but long strips of arable crops, e.g. improved oil palm grown in monoculture with a mulch cover, which serves two purposes: firstly high outputs from oil palms can be expected, and secondly large quantities of mulch will be produced which is applied to nearby fields. Mechanized production would be possible due to the cultivation in long strips.

Firstly, arable crops have to be grown in an intercropping system which covers the soil throughout the rainy season, and secondly crops with a high nitrogen fixing capacity (1) and with large quantities of residues should be included in the mixture.

The two latter points seem to be very difficult to realize because cassava - which has to be included in the mixture as it is the major staple food crop and available throughout the year - cannot supply nitrogen to the soil and provides little or no quantities of mulching material.

Besides the problem of procuring enough mulch, it is obvious that these cultivation systems are labour and capital intensive, and long-term experiments in research stations, as well as under farmers' conditions, have to show

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(1) KRANTZ, B.A. points out that "a non-legume grown in association with a legume would tend to reduce the soil nitrogen level in the root zone of the legume and thus the total nitrogen fixation of the system would be increased". In: <u>Cropping Patterns for increasing and stabilizing agricultural production in the semi-arid tropics</u>. ICRISAT, India, (undated), p.26.

whether these possibilities provide a high productivity of land and labour. Research is still facing the task of finding:

> " continuous cropping systems, which make the best use of the environmental potential, which can be realized with the technology available and which either are adapted to the farmers and the existing infrastructure or which are so rewarding that a change of the behavioural functions and of infrastructures can be expected". (1)

V. Improvement and Expansion of Multi-storey Cropping in Compound Farming

Continuous cultivation throughout the year has proved its value in the survey area when tree and arable crops are combined in a multi-storey system and the land receives large quantities of organic material. The land use system of compound farming resembles the ecological conditions of a tropical forest and has therefore the following advantages:

- Leaves of tree and arable crops can assimilate throughout the year. Solar energy is used at various levels of the storey. "Intercropping combinations generally develop a higher leaf area index and cover the ground more rapidly than do plants in monoculture." (2) Soil temperature is therefore optimal and the subsoil has a good moisture content.
- Growth of weeds is suppressed by the close cover of the leaf canopy.
- Negative effects of heavy rainfall are minimized in a multi-storey system. The roots of tree and arable crops at various depths can absorb moisture and nutrients effectively.
- Crops, fruits and fibre are produced throughout the year and serve the requirements of the households.

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(1) RUTHENBERG, H.: Some Consideration about the Design of Experimental Work with Farming Systems at IITA, Ibadan, Nigeria, 1973, p.9.

(2) HERRERA, W.T. and HARWOOD, R.R.: Crop Interrelationships in Intensive Cropping Systems, IRRI, Philippines, 1973, p.7.

- Nutrients supplied by fertilizers are used efficiently due to the dense root system.

An example of how to increase production on land around the homestead is given by the Wahaya farmers in the region of Bukoba in Tanzania:

> "Year by year, the new homestead is gradually extended, domestic refuse and mulch contribute to the soil's fertility which slowly improves. Eventually the bananas grow more strongly, producing increasing yields. If the owner of the new homestead has got any cattle, their dung is used as manure for the bananas, so as to accelerate the growth of fertility. In this way, in the course of a decade, a new grove is built up, with clearly noticeable zones of soil fertility which decreases towards the periphery. Bordering this grove, one usually finds some land the fertility of which needs building up first before it can be expected to produce any yields. The expansion of the new homestead comes to an end when it reaches the limit of other new plots in the neighbourhood or stretches of land of such low fertility that their inclusion would serve no purpose. In this manner, spread out in the grassland landscape around Bukoba, whole blocks of banana-groves have come into existence." (1)

Improvements and expansion of compounds are possibly avenues for the development of the Eastern Nigerian farming system which would find interested adopters, in particular in part-time farming areas. The provision of nutrients seems to be of crucial importance, and the following approaches could help:

Mineral fertilizer

Mineral fertilizer is seldom used by small-scale farmers in the survey area. High yields require high rates of fertilizer, since the crops removed from the plots contain in themselves large quantities of nutrients. Fertilizer will be used effectively, since the soil is not open to rainfall and sunshine and the deep rooting system can reactivate nutrients which otherwise would be lost. Trees especially serve as "nutrient pumps" under high rainfall conditions. Some information is needed about the compounds' output response to fertilizer. With mineral fertilizer the compounds would also produce more mulching material.

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(1) FRIEDRICH, K.H.: Coffee-Banana Holdings at Bukoba, in: RUTHENBERG, H.: Smallholder Farming and Smallholder Development in Tanzania, Afrika Studien Nr.24, München, 1968, pp.188 et seq.

Animal manure

Livestock production is an important source of manure and could be extended. The prevailing input-output prices for chickens makes egg production very profitable (1), and this when feed was purchased. Similar conditions seem to exist with goat production(2), but no data are available for this type of livestock. The proposition of extending livestock relying on purchased feed creates the possibility of purchasing fertility from other areas where it is ample and/or cheaper to produce.

Experience in densely populated areas in Asia indicates that the fertility status of compounds can be significantly improved by importing feeds for livestock and by fertilizing with the nutrients made available with the manure.

Household refuse

Instead of applying the refuse directly to the plot, it would be better to prepare compost heaps to which lime is added at regular intervals.

The concentration of production on a small area leads therefore to a vigorous growth of all plants which cover the soil and prevent erosion and leaching of available nutrients. Weed growth is reduced and minimises the use of herbicides.(3) The potential effect of insects and pests is relatively low when different crops are grown on one field. Thus, small quantities of chemical inputs are sufficient, which indicates that the multi-storey system could be an efficient user of these modern inputs. In respect of the labour input, it has been shown that continuous cropping on a small area is well suited to the requirements of part-time agriculture:

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(1) See Appendix I.

(2) Further research in goat production under smallholder conditions seems to be a relevant proposition. See also: OBI, J.K. and TULEY, P.: op. cit., p.11.

(3) Experiments at IRRI showed that "Imperata cylindrica, which is common throughout the tropics, is highly sensitive to shading". See: HARWOOD, R.R.: The Concepts of Multiple Cropping: An introduction to the principles of cropping systems design, IRRI, Philippines, 1973, pp.9 and 13.

- Labour productivity on established compounds is high (1). Data collected from 88 compound plots in two villages prove that the opposite is the case and this without improved technology (see p.93). A reasonable explanation of the high labour productivity is that once the compounds have been established and fertility of the soil is improved, they provide very high and steady yields with relatively little and easy work.
- The labour input is distributed over the whole year; labour peaks are not as pronounced as in more extensive systems.
- The crops needed daily (e.g. vegetables) are produced close to the house, which saves a lot of time.
- Minor operations can be conducted when the farmers return from off-farm employment, and these activities might not be regarded as tedious work but as an agreeable change in the daily activities. It is worth mentioning that work under the shade of trees is more comfortable than in the open fields.

Most of the agricultural research up to now has focused on sole stands and open fields. The idea of developing varieties which fit into the crop combination of a multi-storey physiognomy is relatively recent. There is reason to assume that compound output could be significantly improved by varieties which are especially developed to fit into the system with regard to light, shade tolerance, vegetation cycle and nutrient requirements. The potential of multi-storey physiognomies is very high, and the environmental benefits of this type of land use for the humid tropics are obvious.

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(1) Similar information is reported for the banana-coffee groves at Bukoba/ Tanzania. See: FRIEDRICH, K.H.: Coffee-Banana Holdings at Bukoba, op.cit., p.203.

VI. Conclusions

From innovations which are ready for adoption and even more from recent improvements made by research stations, a significant increase in agricultural production appears to be possible. The discrepancy between potential production and reality is wider than ever before. New varieties are available which produce two to three times as much as traditional species (e.g. oil palms, rice). Even higher yielding are intercropping or multi-storey systems, which make the best use of the solar energy throughout the year. Tree crops are particularly suited to upland soils under humid conditions. They conserve soil fertility and in terms of calories per ha and year produce much more than annual crops. Yield variations are lower than in the case of arable crops, because their deeper rooting system uses water and nutrients more efficiently.

Permanent cultivation with arable crops is only possible when large quantities of organic material are applied to those crops. High yields are required to arrive at balanced farming systems, and without mineral fertilizer it does not seem possible to procure enough mulch to increase the yield of arable crops. Most of the "improved practices" are, at present, the results of agricultural research stations, and it seems necessary to start a realistic testing and modification of technology under farmers' conditions to ensure that the new methods have a good chance of being adopted.

Problems with the proposed "high input" system compared with the traditional "low cost" system may be encountered from the economic point of view. The labour and capital inputs are high, and it is difficult to assess at this stage whether the return per hour of work is attractive enough to the farmers. Other problems lie in the transfer of technology, in the timely supply of the necessary inputs, marketing and processing of products and in the poor infrastructure of the area. Tackling these problems has to be combined with high prices for agricultural products and low prices for the inputs. (1)

The essence of these arguments is that technical solutions are very important prerequisites for a change in the farming system but their implementation requires institutions and policies which make it attractive to small farmers to increase their production.

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(1) This implies a policy which is in contrast to the (short-term) interests of citizens in urban areas, who are interested in low prices. The importation of large quantities of agricultural products holds down the prices artificially, encourages migration from rural to urban areas and increases the slums in the cities.

D. APPENDICES

APPENDIX I: A Case Study: Uboma(1)

1. Introduction

The Uboma Rural Development Project(2) (URDP) was selected for a case study for three main reasons:

- An evaluation of the project was possible as detailed information was available related to the traditional system of cultivation in the same agro-ecological zone.
- The project improved the welfare of smallholders living in a typical rural environment.
- The project with its organisation, development programmes and monetary costs may be duplicated elsewhere in the country.

2. Description of the Project

a) Objectives

The objectives of the URDP were directed to the needs and capabilities of the people in the project area. These foci were identified during a socio-economic and nutritional survey (3) conducted prior to the start of the technical assistance programme in 1965. The general objectives of the Uboma project can be summarised as follows:

- to achieve an adequate supply of food;
- to increase the income from cash crops;

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(1) This case study draws heavily on the paper: "Increasing Production through Rural Development Projects: Uboma" by LAGEMANN, J., IITA, Jan.1976 (quoted in the following as LAGEMANN, J.: Uboma).

(2) Uboma is situated about 19 km north-east of Umuahia (E.C.S. of Nigeria) on the east side of the main Umuahia-Okigwe road. The physical environment of the project area is described by OLUWASANMI, H.A., DEMA, I. S. and others: Uboma - A Socio-Economic and Nutritional Survey in a rural Community in Eastern Nigeria. The world land use survey, occasional papers, No.6, 1966.

(3) See: OLUWASANMI, H.A., DEMA, I.S. and others: ibid.

- the conservation of the natural resources;
- the achievement of economic stability and adequate social services (1).

The project had and has the goal of fulfilling the objectives by identifying the appropriate technology, by technical advice and by organising the supply of needed inputs. "It is hoped (by the project management) to teach people living in rural areas how to raise their standard of living by their own efforts using their own resources of manpower and material" (2).

b) Organisation

The project team, viz an agronomist (project leader), an agricultural assistant, a cooperative inspector (junior staff), a driver and a clerk, is responsible for some 45,000 people living in an area of about 65 square km (3). The agronomist who lives in the project area is responsible for all activities, and hence in a large way for the success of the project. His salary and promotion is based on project performance.

The project team seeks the cooperation of research organisations (4) from which they get improved practices that are tested and modified to identify appropriate technology for the local conditions before the farmers are advised to adopt them. The implementation of the programme is mainly done through the traditional social organisations. Fig.1 shows the information flow in the project.

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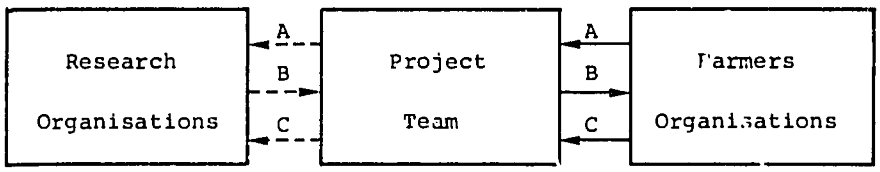
(1) See: EZEILO, W.N.O. in: OLUWASANMI, H.A., DEMA, I.S. and others, ibid., p.105.

(2) OFFOR, R.O.M. (Project manager at Uboma): An Address Presented on the Occasion of Uboma Farmers' Day held on the 22nd of March, 1975.

(3) The estimated population density is about 700 persons/per square km.

(4) E.g. with F.A.R.T.S. at Umudike, IITA at Ibadan and various universities.

Fig. 1: Information Flow in the Uboma Project



A = collection of information (What are the needs?)
B = technical advice through improved practices
C = feedback

Source: LAGEMANN, J.: Uboma, op.cit., p.4.

3. Economics of Major Activities

Two kinds of crops out of the whole range of activities (see Table 1) play the most important roles in the project: Oil palm and wet rice. During the past years, the wet rice production has been combined with dry season vegetables production (rainy season: wet rice; dry season: vegetables). The technology employed to produce these crops is simple and feasible for the small scale farmers, and - just as important - there were no difficulties in marketing the output at remunerative prices. Furthermore, declining soil fertility (due to continuous cultivation) is not a problem in valley bottoms.

Pineapple production and poultry keeping also seem to be promising enterprises. Production costs and benefits are listed on pages 159-160 for these two latter activities.

a) Oil Palm Production

Most of the improved oil palm seedlings were planted in 1965-1967 prior to the Civil War. The major constraints in increasing oil palm production was the supply of improved varieties from the Nigerian Institute for Oil Palm Research (NIFOR).

Table 1: List of Activities: Uboma, East Central State Projects

Year	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Wet rice(hectarage)	-	0.8	3.2	15.4	275.3	295.5	325.9	643.7	643.8	647.8	657.9	657.9
Dry season vegetables (valley bottoms)(hectarage)	-	-	0.8	1.2	1.4	10.1	12.1	13.0	32.4	35.6	40.5	40.5
Pineapples(stands) suckers distributed each year	500	12000	14540	14540	227	1000	3000	3500	3890	17228	15200	-
Budded orange (stands)(cumulative)	29	479	1050	1508	1735	1735	1735	1735	1735	1935	2068	-
Modern oil palms (hectarage) (cumulative)	15.4	85.0	221.9	315	315	315	344.2	344.2	346.2	349.8	364.4	421.1
Fish ponds(hectarage)		3.2	3.2	11.7	11.7	11.7	11.7	11.7	11.9	12.0	12.1	-
Fertilizer use (tons)	0.4	1.35	2.6	3.8	2.5	0.6	0.1	5.8	7.3	10.93	14.7	-
Pesticide use (kg)	-	44.1	81.8	109.1	58.2	-	77.7	121.4	181.4	250.9	415.9	-
Total share capital of Co-operative Societies (₦)	-	120	1636	3450	3450	3450	7600	10524	17450	18880	18338	-
Poultry (birds)	200	200	200	200	200	200	200	975	450	1500	2850	2850
Pigs	-	12	27	35	63	79	93	108	42	48	54	-

Source: OFFOR, R.O.M., Project Manager at Uboma.

Returns from Oil Palm Production

Up to now there have been no yield data available from plantations in Uboma itself (1). Hence data from other studies close to the Uboma area were used to estimate the output of oil palms. The increase in total gross return (Table 2) during a period of four years is quite substantial. There are two factors involved:

- The production of oil and kernels increases rapidly from the 5th to the 10th year after planting.
- Prices, mainly for oil palm, more than doubled during the period under consideration.

Costs of Producing Oil Palm (2)

The costs of labour for production and processing of the crop are the dominant costs involved in producing palm oil. The increase in labour costs over the years is mainly due to the higher wages paid to the labourers (3).

Net Return and Increase through Project

Although the net return was positive in all years and increased from year to year, the opportunity costs of the land under oil palms were higher than the net return in 1972 and 1973 (see Table 2). From there onwards farmers obtained a net return through the project activities.

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(1) A detailed survey is being conducted at the moment by NIFOR to provide such information. Data are expected to be available at the end of 1977.

(2) All costs before 1972, establishment costs of plantings, etc., are excluded from the calculation. These costs were taken into account during the evaluation of the period 1965-1971 by ANTHONIO, G.E.O. and IJERE, M.O.: Uboma Development Project 1964-1972, published by Shell International Petrol Ltd., Whitefriars Press, London, 1973.

(3) The labour costs include family and hired labour.

Table 2: Increase of Net Return through Improved Oil Palm Varieties in the Uboma project

	1972	1973	1974	1975
Area under oil palms (ha)	346.2	349.8	364.4	421.1
1. Returns				
yield of bunches in t(1)	1130	1989	2703	3081
yield of palm oil in t	132	233	316	352
price per t of palm oil in N	115	155	230	280
gross return from oil in N	15204	36078	72747	98543
yield of kernels in t	50.9	89.5	121.7	138.6
gross return from kernels in N	3560	7160	10949	13860
Total gross return	18754	43238	83696	112403
2. Costs				
total man-days (2)	17300	17500	18200	21050
labour cost p. man-day in N	0.60	0.70	0.80	1.00
total labour cost in N	10380	12250	14560	21050
processing costs (3)	3560	7160	10949	13860
fertilizer (N 5.40 p.ha)	1868	1890	1966	2273
Total costs	15808	21300	27475	37183
3. Net return in N	2956	21930	56221	75220
4. Increase in Net Return through Project				
opportunity costs in N/ha (4)	80	90	100	110
Total opportunity costs in N	27680	31500	36400	46310
Increase/decrease through project	-24724	-9562	19821	28910

Source: LAGEMANN, J.: Uboma, op.cit., p.7.

(1) Yields are estimated at 0.45 t in 5th year, 1.0 t in 6th year, 2.8 t in 7th year, 5.6 t in 8th year, 7.3 t in 9th year and from 10th year onwards 8 t/ha. See: Western State of Nigeria: Production, Production Requirements, Costs and Returns of Crops: Southern Rain Forest Zone, Agr. Project Planning and Marketing Division.
A yield of 8 t/ha was also recorded from a smallholder's plantation in Okwe (L). See: LAGEMANN, J.: Case Study from a Smallholding with Oil Palm in Eastern Nigeria. IITA, 1975.

(2) 50 days per ha are estimated. See: Western State of Nigeria, op.cit., p.76; NWACHUKWO, S.O.: A Multi-period Linear Programming Model for an Economic Evaluation of Cocoa/Oil Palm Settlement Holding in Nigeria. University of Guelph.

(3) No data on processing costs are available. It is estimated that the value of the kernels will cover all processing costs.

(4) Opportunity costs are annual net returns from the traditional bush fallow system.

b) Rice Production (wet rice)

The significant increase in rice production is clearly shown by the rapid increase of land under rice cultivation. Rice was almost unknown in Uboma prior to the project. The project started in 1965 with an area of 0.8 ha of rice. Ten years later the area under rice reached about 640 ha.

In 1974 detailed input-output data were collected by OFFOR from a 1.21 ha rice field. The resulting costs and returns are listed in Table 3. The net return was N 413.00 from the field or N 341.00 per ha. If family labour costs were deducted, the profit was reduced to (about) N 250.00 per ha (1).

Table 3: Input-Output Data of Wet Rice Production in Uboma

Operation	Cost (N)	Area(ha)	Cost/ha (N)
Clearing	54.00	1.21	44.63
Raking	16.00	1.21	13.22
Tilling	55.80	1.21	46.12
Transplanting	63.60	1.21	52.56
Weeding	16.90	1.21	13.97
Harvesting	101.60	1.21	83.97
Seed	12.60	1.21	10.41
Fertilizer (kg/ha)	10.00	1.21	8.26
Total (approx.)	330.00		273.00

Yield kg	Yield/ha kg	Value of yield N	Value of yield/ha N	Net return N	Net return p.ha N
3745.5	3095.5	743.00	614.00	413.00	341.00

Notes: a) Cost of family labour and meals given to hired labour were not included.
b) Labour rate was 60 k/man and 30 k/woman plus two meals/day.

Source: OFFOR, R.M.C., Project Manager at Uboma.

(1) The net return is very similar to the data collected at a rice experiment in Okwe (L), some 40 km away from Uboma.

The irrigation system allows (on an area of 100 ha) two rice crops to be grown per year, which increases the net return per ha/year to ₦ 682.00 or, if the cost of family labour is considered, to ₦ 500.00 per ha/year.

The production of rice within an irrigation system, in addition to the tremendous profit from rice, brought the following advantages to the smallholders:

- possibility of continuous cultivation throughout the year on the valley bottoms (without a decline in soil fertility);
- reduction in yield fluctuations due to water control;
- concentration of production on a small area, which saves a lot of time spent walking to and from various fields;
- employment throughout the year for the farmers themselves and creation of employment for other people who are either unemployed or under-employed (see Table 4 "Total labour costs" is income for a large number of people);
- generated additional employment for millers, transporters, etc.

c) <u>Vegetable Production</u>

Farmers in Uboma became the main suppliers of off-season vegetables for the surrounding local markets and - even more important - for the urban market in Umuahia. The high prices of off-season vegetables created the incentive for the farmers to produce vegetables instead of rice in the off-season on their irrigated fields. In 1973/74 about 40 ha were grown with vegetables.

The data on vegetable production (see Table 5) were collected by OFFOR during the period 1971-1974. In assessing the increase in net return from vegetables, it is assumed that the net return per ha does not change over the period.

Table 6 shows the increase in net return through vegetable production.

Table 4: Total Return of Rice Production in the Uboma Project

	1972	1973	1974	1975
1. Returns				
rice area in ha (a)	644	648	658	658
total yield in t (b)	2,073	2,084	2,112	2,112
price in ₦ per t	160	180	200	250
Total gross return in ₦	331,680	375,120	422,400	528,000
2. Costs				
total man-days (c)	338,520	340,340	344,890	344,890
labour cost per man-day in ₦	0.60	0.70	0.80	1.00
total labour cost in ₦	203,112	238,238	275,912	344,890
seed	6,704	6,746	6,850	6,850
fertilizer	5,319	5,352	5,435	5,435
total costs	215,135	250,336	288,197	357,175
3. Net Return	116,545	124,784	134,203	170,825
4. Increase in Net Return through project				
opportunity costs in ₦/ha	80	90	100	110
total opportunity costs (d)	52,480	59,400	67,000	73,700
increase through project	64,065	65,384	67,203	97,125

(a) An area of 100 ha is irrigated throughout the year and two crops of rice are harvested.

(b) An average yield of 2786 kg milled rice/ha is used for the calculation, which is 10% below the figures from Table 3.

(c) An average labour input of 440 man-days/ha is used.

(d) Total opportunity costs include - besides the foregone production of the rice production area - those from the lake, which has a size of 12 ha.

Source: LAGEMANN, J.: Uboma, op.cit., p.9.

Table 5: Costs and Returns of Vegetable Production in Uboma

Year	1971/72	1972/73	1972/73	1973/74	1973/74	1973/74	1973/74
Farm No.	1	2	3	4	5	6	7
Costs (N)							
seeds	29.20	31.00	48.20	70.00	26.30	45.00	51.70
compost	11.00	13.00	17.00	54.92	4.50	-	6.00
agro chem.	-	-	7.05	11.00	7.38	7.20	14.30
hired labour	13.00	12.00	32.00	141.00	47.00	45.30	54.00
total costs (N)	53.20	56.00	104.25	276.92	85.18	97.30	126.00
Returns							
fluted pumpkin (Telferia)	45.80	65.40	-	305.80	58.65	122.30	170.00
okro	50.00	80.70	-	100.00	42.40	-	17.00
tomatoes	11.00	10.00	-	80.00	29.05	-	19.00
spinach	-	15.00	-	-	-	-	-
total return (N)	106.80	171.10	222.00	485.80	130.10	122.30	206.00
Net Return (N)	53.60	115.10	117.75	208.88	44.92	25.00	80.00
Hectarage	0.24	0.32	0.16	0.45	0.24	0.16	0.16
Net/ha (N)	224.00	360.00	736.00	464.00	187.00	156.00	500.00

Note: 1) The lower net return in 1973/74 as compared with previous years was due to the fact that fluted pumpkin bought from Owerri area was from an inferior strain unsuitable to Uboma conditions, which thus performed poorly.

2) Cost of family labour is not reflected here, as this is off-set by crops consumed by the family.

Source: OFFOR, R.M.O., Project Manager at Uboma.

Table 6: Increase in Total Net Return from Vegetable Production

	1972	1973	1974	1975
₦	12,000	13,500	15,000	15,000

Source: LAGEMANN, J.: Uboma, op.cit., p.12.

Future increase in vegetable production depends mainly on two factors:

- availability of compost, and
- availability of Telferia seed. Telferia is the main vegetable, and seed cannot be produced in large quantities.

4. Project Inputs versus Outputs

a) Costs

Investment Costs

The dam and sluices were the only infrastructural investment costs incurred in the project. The total cost of ₦ 25,024.00 was paid by the Ministry of Agriculture and Natural Resources.

Operating Costs

The annual budget provided by Shell-BP includes the salary of the agronomist and his staff, the maintenance of a vehicle and the costs involved in running the office and operating the vehicle. No heavy machines like tractors, etc., were provided for the project. The operating costs of the project are listed in Table 7.

Table 7: Operating Costs of the Uboma Project

Year	Costs in Naira
1965	10,000
1966	16,00C
1967	17,000
1968	12,800
1969	13,200
1970	10,000
1971	10,400
1972	20,000
1973	40,300
1974	48,360
1975	61,100
Total	259,160

Source: Data from 1965-1971 are collected by ANTHONIO and IJERE, op. cit., data from 1972-1975 are provided by OFFOR, R.O.M.

b) Increase in Farmers' Net Income

Returns from the five major activities (1) are included:

- oil palm production;
- rice production ;
- vegetable production ;
- citrus production ;
- poultry keeping.

Table 8 indicates the rapid increase in farmers' net income due to the project activities. Most of the oil palms came into full maturity in the last two years, and boosted the output significantly.

(1) Measurement of the net return through poultry keeping is provided on page 158. The inclusion of other project activities would not change the picture significantly.

Table 8: Increase in Farmers' Net Income

Year	Net Income in Naira
1965	1,400
1966	4,200
1967	4,000
1968	26,800
1969	23,400
1970	35,000
1971	58,300
1972	63,995
1973	87,530
1974	128,015
1975	171,500
Total	604,140

Source: Data from 1965-1971 are collected by ANTHONIO and IJERE, op. cit.; data from 1972-1975 are compiled by the author.

The project development can be judged by the changes in costs and the increase in income during the project period (1) (see Fig.2). The actual costs and returns (I curves) have been deflated (2) (D curves) in order to show the real improvement of the farmers' situation in comparison with the start of the project in 1965.

The net present value of the project with a discount rate of 10% (which is regarded as the opportunity costs for the invested capital) is ₦ 114,461.50. The internal rate of return is approximately 32.0%. Both discounted profitability measures show the extremely high return of each Naira invested into a well organised project.

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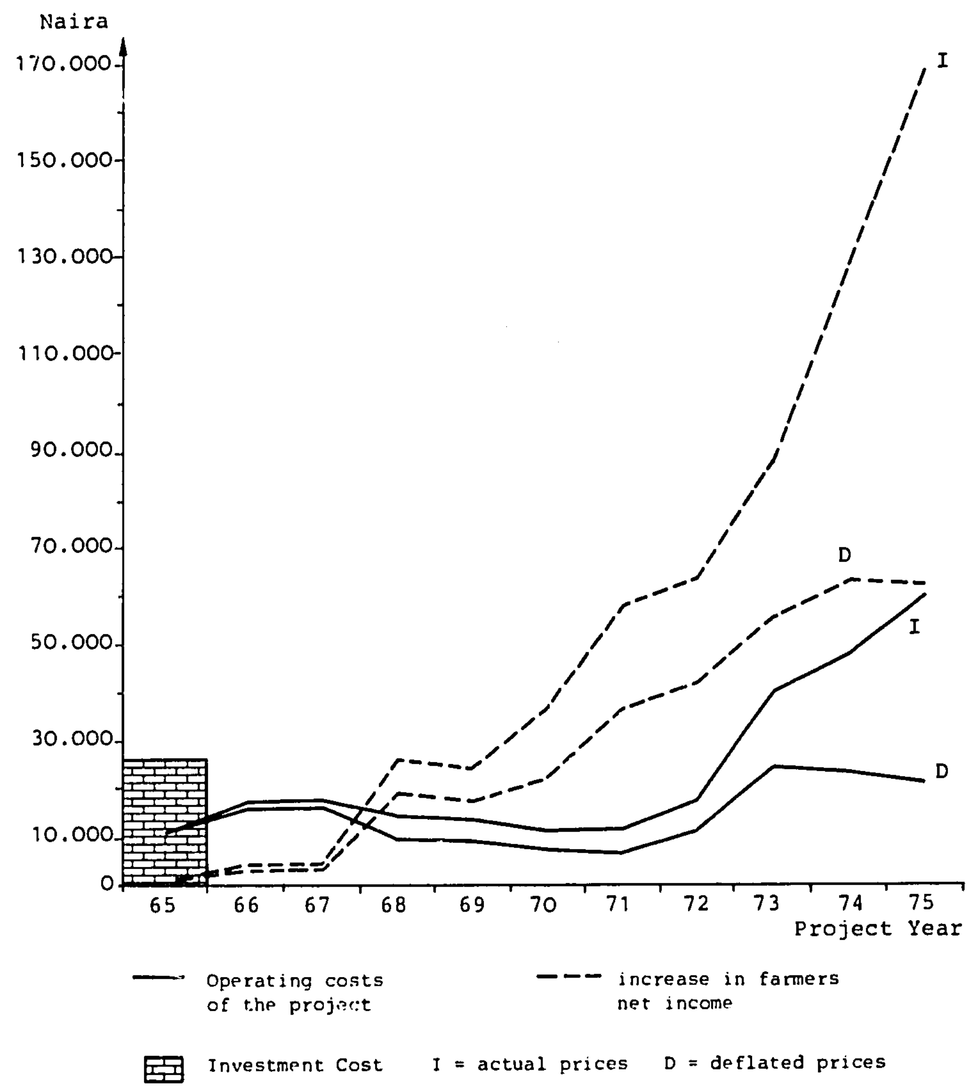
(1) Other direct and indirect benefits which are not quantifiable, e.g. improvement in nutrition or improved roads, are not considered here.

(2) The deflated curves show the cost and return stream without the influence of inflation. The consumer price indices for lower income groups from Enugu, E.C.S. of Nigeria were used in the calculation. For 1974 and 1975 an inflation rate of 25% and 40% was estimated. Federal Office of Statistics: Economic Indicator, Vol.6, No.2, 1970 and Vol.9, No.3,1973, Lagos, Nigeria.

Fig. 2: Increase in Income Compared with the Costs of the Project (in Naira)



Source: LAGEMANN, J.: Uboma, op.cit., p.15.

5. Conclusions

The analysis indicates that the technical assistance project has made a positive impact on the economic situation of the smallholders in Uboma. This was possible for two major reasons:

- The major activities (oil palm and wet rice) allow a soil conserving type of land use which is the prerequisite for continuous cultivation without a decline in yields. High yielding varieties and the necessary inputs (fertilizer and chemicals) were made available to the farmers at the right time. Furthermore, the prices for these products created an incentive for increased production.
- A small team with practical experience in agriculture received the logistic and financial support from Shell-BP and were free in their choice of activities, but also responsible for the project's performance.
- Right from the beginning of the project farmers saw that the team could tackle simple but urgent problems (e.g. combatting diseases), which increased the confidence between farmers and the project management. Later on this relationship allowed more complex problems to be solved, like the land consolidation which was required in the irrigation area.

GRIFFITH-JONES (1), while indicating the philosophy of Shell-BP projects, gives some further criteria for the success:

- identification of problems and resources of the project area through a comprehensive economic and social survey;
- project team having to live in the project area;
- well qualified staff;
- few or no constraints on strategy;
- authorities and responsibility of the extension worker having to be clearly defined;
- field work being most important, and
- carefully worked out programme with regular evaluations.

Uboma, with wet rice production in the valley bottoms and oil palm production on the upland soils, has shown possible development paths which are suitable also for larger areas in the humid regions of Nigeria.

(1) GRIFFITH-JONES, T.: Promoting Agricultural Change. In: Span, Vol. 18, No.2, 1975, pp.54-56.

Additional calculations:

Table 9: Production Costs and Returns of a Poultry Farm

Egg Production		
Fixed Costs		
building (cement, zinc roof)		634.00
equipment: 10 drinking troughs		10.00
10 feeding troughs		10.00
4 lanterns		7.20
feed distribution cups		0.60
	Total N	661.80
Variable Costs		
a) costs up to laying stage		
220 chickens (2 days old)	N	96.00
5 gal. of kerosene at 0.45 each		2.25
16 bags chick mash at N 4.50 each		72.00
31 bags growers chick mash at N 4.00		124.00
54 bags growers chick mash at N 4.30		232.00
paper bags		1.20
medicine		12.00
	Total N	539.45
cost per unit: N 2.59 (207 chicks)		
b) costs during laying period (12 month)		
feed	N	1197.25
medicine		47.05
water cost (a)		200.95
	Total N	1445.25
Total variable costs:	N	1984.70
depreciation of building (20 years)		31.70
depreciation of equipment (3 years)		9.27
	Total N	2025.67
Returns		
eggs (b)	N	2407.15
chickens		667.90
	Total N	3075.05
Net return (c)	N	1049.38

(a) Fetching water from a stream. (b) Prices varied from N 0.63 to N 0.93 per dozen. (c) Labour costs are not included; work is done by family labour. Non-quantifiable return: chicken dung, mainly used for yam cultivation.

Source: compiled by the author from data collected from Umunna Poultry Farms, Etiti.

Table 10: Assessment of the Increase in Net Return through Poultry Keeping in Uboma (in Naira)

Year	1972	1973	1974	1975
net return per bird	3.00	3.50	4.00	5.00
no. of birds kept	450	1500	2850	2850
Total net return	1,350.00	5,250.00	11,400.00	14,250.00

Table 11: Assessment of the Increase in Net Return through Citrus Production in Uboma (in ₦)

Year				
net return per tree (estimated)	7.00	8.00	9.00	10.00
Total net return	12,145.00	13,880.00	15,615.00	17,350.00
Total opportunity costs (10 ha)	800.00	900.00	1,000.00	1,100.00
Total net return	11,345.00	12,980.00	14,516.00	16,250.00

Sources: LAGEMANN, J.: Uboma, op.cit., p.19.

Table 12: Economics of Pineapple Production in Uboma

Experiment started	- September, 1973
Completed	- October, 1975
Plot size	- 0.13 ha

Costs (N)	
clearing & raking	7.50
bed making	12.30
suckers	32.30
planting	2.64
weeding 3 times	18.30
fertilizer & application	8.60
Total	81.64
Returns	
fruits	104.83
suckers	62.08
Total	166.91
Net	85.27
Net/ha	655.92

Notes:

1. Fruit harvesting and marketing costs are not included.
2. Returns made over a period of 2 years, unlike rice and vegetables, which give returns in 3-4 months.
3. Future depends on market. As with rice and vegetables, not much can be marketed locally. Umuahia market cannot absorb too much.
4. Transportation from the farm and to even local markets is a problem, as not many fruits can be carried by a farmer.
5. Land is tied for 2 years.
6. Yield was 19.3 tonnes/ha.-- approximately.
7. Fruit size averaged 2 kg.

Source: OFFOR, R.M.O., Project Manager at Uboma.

APPENDIX II: Methodology (1)

1. Introduction

The choice of the problem which is dealt with in this study was made by a multi-disciplinary team of Agronomists, Pedologists and Economists. Having agreed on the problem, the next concern of the group was to formulate testable hypotheses and to agree on the data which had to be collected and analysed to test these hypotheses.

2. Area and Village Selection

Eastern Nigeria is known as an area with one of the highest population densities in Africa, and it was therefore selected as the study area. Having identified a number of regions within Eastern Nigeria as suitable for the survey, the State Ministry of Agriculture (the Chief Agriculture Officer) and the senior hereditary rulers in the regions were approached and their cooperation sought to undertake the survey in their domain. Various villages within the proposed study areas were visited with the help of an officer from local sub-stations of the Ministry of Agriculture to identify villages which appeared to meet the selection criteria.

For administrative purposes villages were chosen which:

- could be reached within half a day's drive of a central point where the supervisor resided, and
- are accessible by 4-wheel drive vehicles throughout the year.

Published and unpublished data, and knowledge of the local area by personnel from the International Institute of Tropical Agriculture, Ministry and Universities, enabled identification of three villages suitable for in-depth study.

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(1) This section has drawn freely on FLINN, J.C. and LAGEMANN, J.: Procedures for Collecting Socio-Economic Data at the International Institute of Tropical Agriculture, Ibadan, Nigeria. Paper prepared for the ADC/CIMMYT/Ford Foundation Seminar on field collection of socio-economic data in Developing Countries. Beirut, Dec. 1974.

During the first stage of selecting the villages, all cooperating researchers visited potentially suitable sites to ensure that the proposed villages met the selection criteria from each researcher's own disciplinary viewpoint.

Once the required number of survey villages had been tentatively identified, the village chiefs, elders and councillors were approached, the objectives and nature of the survey discussed, and its benefits to the villages explained, and their cooperation was sought to have the village included in the survey.

The final selection of survey villages was done after conducting a pilot survey (1) which verified that the villages met the required first stage selection criteria (2).

3. Selection of Survey Farmers

The pilot survey provided a complete enumeration in Okwe and in Umuokile, but in Owerre-Ebeiri of about 20% of the households (see Table 13), which was roughly each 5th house in the village.

Table 13: Number of Households Enumerated in the Pilot Survey

Village	No. of households	% of enumeration
Okwe	101	approx. 100
Umuokile	93	approx. 100
Owerre-Ebeiri	135	approx. 20

Source: FLINN, J.C. and LAGEMANN, J.: Farm Management, Utilization Study, East Central State, Nigeria, Pilot Survey. IITA, Ibadan, 1974.

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(1) See: FLINN, J.C. and LAGEMANN, J.: Farm Management, Land Utilization Study, East Central State, Nigeria, Pilot Survey. IITA, Ibadan, 1974 (mimeo).

(2) See: APPENDIX III: Justification of the village selection.

Several households were excluded from the sampling frame because they did not meet preconditions (e.g. farmer planned to be absent from the village for extended periods). The remaining farmers provided the sampling frame from which the respondents were chosen.

4. Data Collection

The majority of farmers interviewed in the survey were illiterate, and none kept written records of their farming activities or financial transactions. Thus weekly visits were made by the enumerators and supervisor to the farmers, in order to collect the required information either by memory recall or by direct measurements (1).

The data collected from the farmers can be divided into three groups:

- situational data collection;
- weekly data collection ;
- bi-monthly data collection.

The questionnaires and survey forms, which were pre-tested and modified several times, are provided in APPENDIX V.

Situational data collection

- field sizes, soils and land tenure;
- cropping pattern and cropping history;
- labour capacity and labour input;
- livestock;
- yield cross checks for major arable crops ;
- farmers' views of growing crops and their envisaged constraints;
- farmers' attitude towards "improved" practices.

Weekly collected data

- yield measurement of arable and tree crops;
- cash income;
- expenditure;
- credit operations.

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(1) Detailed information of problems involved in data collection is given by YANG, W.Y.: Methods of Farm Management Investigations; FAO Agricultural Developme Paper No.80. Rome, 1965.

Bi-monthly collected data

- market prices for arable and tree crops.

a) Measurement of Fields and Soil Survey

At the start of the survey, and as new fields were opened up, the fields worked by the respondents were identified by the land surveyor visiting each of the fields with the farmer. Each field was given a numeric code for analytical and reference purpose and marked with a label in the field in order to identify specific plots (1) later on.

On the field data sheet a sketch map was made showing the shape and location of the field, the time taken to walk to it and the approximate distance from the field to the farmer's home (see Form L 7). The fields were measured by the land surveyor using a tape and compass. To ensure that the correct plot boundaries were identified for this exercise, the farmer accompanied the land surveyor to identify the exact boundaries of his fields which were often not distinguishable from his neighbours' plots and were irregular in shape (2). The field was then drawn to scale in the field office and the area measured with a planimeter. If the closing error was too large (more than 10% of the circumference) the field was remeasured. The main problem which occurred when estimating farm sizes was the occasional farmer's unwillingness or forgetfulness to divulge all the fields he farmed. As the survey progressed and the farmers became less suspicious of the interviewers, they disclosed the location of such plots.

During the field survey, a composite soil sample was taken for laboratory analysis from all farmers' plots. The final information sought on the soil data sheet (see: Questionnaire in APPENDIX V) was related to soil texture, slope, relief, drainage and evidence of erosion. The farmer was asked when he was on the specific plot for the type of acquisition of the field and the approximate price (see: Form L 12).

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(1) It would have been better to mark the plot with different colours, because the labels were sometimes destroyed by heavy rains and had to be replaced.

(2) This was very time consuming due to the fact that farmers were not always available, although appointments were made several days before the measurements took place.

b) Cropping Pattern and Cropping History

The cropping pattern on all fields was identified in May/June when nearly all crops were planted. On the small compounds all arable and tree crops were counted. A different method for the near and distant fields was adopted. A square plot of 100 m^2 was marked out and at the four ends pegs with white tops were set in position. A rope linked the four ends which ensured that analysing was effected on crops within the roped zone. All arable crops were counted in the square plot and recorded on Form CP. Fruit and non-fruit trees were counted on the whole plot and recorded.

The quadrants were not measured randomly for of the following reasons:

- The fields were in general very small (on average 400 - 500 m^2).
- When the cropping pattern differed markedly within a field, it was divided into several plots (sometimes up to eight plots).
- The time needed for randomly measuring a square plot exceeds one hour and this would have delayed the beginning of other parts of the survey.

c) Labour

Data on the labour capacity of the households and initial information of hired labour were collected at the beginning of the survey (see: Forms L1 and L2). Labour input data were collected separately for arable and tree crops three times in the cropping season (see: Forms L3, L4, L8, L9, L13, L14). The number of persons and hours worked for all activities and crops by men, women and children from within and outside the household was recorded. Farmers had to recall this information for a period of three months, which was very difficult. This method provided only rough information. A higher accuracy requires labour data collection at least once a week (1).

d) Livestock

All kinds of livestock kept, sold, purchased and consumed by household members were recorded once during the survey period. Usually farmers were conscious of the number of goats and sheep kept by the household mem-

(1) See also: LUNING, H.A. op.cit., p.61; and UPTON, M.: Farm Management in Africa, op.cit., p.225.

bers, whereas in most cases the number of chickens had to be estimated by the heads of household.

e) Yield Measurement

Following NORMAN (1) three methods were used in estimating yields of arable crops:

1) yield plot method,
2) five unit method, and
3) year-end method.

Due to the fact that usually a large number of crops were grown, methods 2 and 3 were used only as cross-checks.

The yield plot method was the standard method of estimating the yields of all arable crops and the 100 square meter quadrant - measured when recording the cropping pattern - was used for this purpose. Farmers were requested to notify the enumerators when they planned to harvest the quadrant, so that arrangements could be made for the enumerators to be present to harvest and weigh the crop(s) taken from the ground. The small compounds did not contain square plots, hence yield data were recorded from the whole plots on a weekly basis. Whenever possible, enumerators were present when crops were harvested from the compounds. Otherwise the household members were questioned about the quantity of their harvests.

The yield plot method was extremely time-consuming (more than 300 plots with several harvest periods for different crops) and farmers sometimes harvested without informing the enumerators. In this case the head of household was asked and the estimated figure recorded.

The statistical problem resulting from the enormous heterogeneity of farmers' fields should not be overlooked. The attempt was made to reduce this problem by:

- dividing a field into several plots when the cropping pattern was different in the field, and

(1) NORMAN, D.W.: Methodology and Problems of Farm Management Investigations: Experiences from Northern Nigeria. African Rural Employment Study, Zaria, Nigeria, 1973, pp. 22 et seq.

- including a large part of the total area in the quadrant (on average one fourth to one fifth of the total plot size).

Yields from tree crops were requested from the household members on a weekly basis. Whenever possible, enumerators weighed samples of the harvest and estimated the total size of the weekly harvest.

f) Farmers' Attitude towards Traditional and "Improved" Practices

Such qualitative information was largely sought through a series of situational questionnaires (see: Forms L11, L15 and Maize Questionnaire). The Questionnaire on farmers' attitude towards "improved" practices was completed after the new methods were demonstrated and conducted with all farmers (1). This information provided insight for subsequent investigations related to more specific topics, e.g. problems and strategies for farming under conditions of increasing land and labour scarcity, and strategies of farmers for reducing the variability of food supply caused by natural hazards (disease, insects, rainfall). The information on "what and why" was sought through a blend of open-ended and closed questions.

g) Financial Transactions

With frequent interviews, a reasonably accurate profile seemed to be obtained from respondents of expenditure items, such as capital invested in the farm (e.g. costs of hoes, cutlasses, extension of land for farming), variable farm costs (principally hired labour), major non-farm variable costs (e.g. school fees), and investment (e.g. bicycles, building materials). However, the same did not seem to hold true for petty trading and other personal expenditures (food, clothes, gifts, etc.). This lack of repeatability in response is no doubt partly due to the farmer's unwillingness to divulge what he regards as highly personal information, partly also because other members of the household are responsible for these expenditures (particularly the wives), and he is not really aware of their magnitude.

Similar problems were also observed when establishing the income and credit operations of the farm family.

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(1) Experiments on farmers' fields were also used as checks on the reliability of the data obtained from the farmers.

h) Market Prices

Prices for major arable and tree crops were collected bi-monthly by obtaining prices from wholesalers at the local markets (see: Form MP). Further, while the prices per unit varied between markets and over time, so did the volume of the basic units (agricultural produce typically being sold on a per unit volume/bunch/tuber as opposed to on a weight basis). In consequence, in addition to collecting agricultural prices, the enumerators weighed five local measures of crop to enable prices per kilogram of product to be derived.

5. Field Supervision

The villages and enumerators were visited twice a week to check completed questionnaires and field recordings, and to sort out any problems or misunderstandings which had emerged either in completing the questionnaires or between the enumerators and villagers. Much time was given to discussions with the survey farmers in order to collect direct information from them about their farming practices and to demonstrate the continuing interest in the survey (1). The interest in the project was further shown by frequent visits of the cooperating researchers.

A number of cross-checks were carried out in an attempt to reduce recall and experimental error in the data:

- Recorded information was checked against activities of enumerators with the selected farmers.
- Consistency checks were built into the questionnaires.
- Enumerators completed daily field diaries. The information was checked with the field records.
- Questionnaires were checked for missing information and data falling outside what experience suggests to be reasonable upper and lower limits.
- Information collected from the farmers by the supervisor was checked against the field records.

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(1) MORIS, J.R. explains how to gain and keep farmers' cooperation during intensive field survey. In: Multisubject Farm Surveys reconsidered: Some methodological lessons. Institute of Public Administration, Dar-es-Salaam, 1970, pp. 15 et seq.

6. Data Analysis

After these field checks the data were punched on computer cards and numerical codes and values of parameters were checked for consistency.

For the weekly collected data and the data on labour input, computer programmes were written for analysing the data. Arithmetic means (1), frequency distributions and variations were calculated for a large number of groups of data and the differences between the groups were tested for significance with the students' t-test and chi-square test.

Regression analysis was used to establish relationships between major variables (2).

When using the production function approach, the following problems prevail, especially when dealing with traditional tropical agriculture, and they are more pronounced the more complex the system is:

- firstly, the analysis explains only the allocation of resources at the mean level. The practical application for the individual farmer is rather low (3), and
- secondly, a more practical problem, the measurement of major inputs in traditional agricultural systems is very difficult due to
  - the variability of soil fertility, even within a small field,
  - root crops (with relatively low yields) not responding very much to available nutrients in the soil, and

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(1) Detailed information on the use of measures of central tendency is provided by UPTON, M. in: Farm Management in Africa. London, 19[illegible],pp. 209 et seq.

(2) With respect to studying relationships, PENNY points out: "Since the data are from socio-economic systems, the relationship between an aspect of the system and any other aspect should be both consistent with all that is already known about that particular system and meaningful". PENNY, D.H.: Hints for Research Workers in the Social Sciences. Cornell University, Department of Agricultural Economics, 1973, p.49.

(3) LUNING, H.A.: op.cit., p.75; NAGEL, F.W.: Die Ökonomik der Beregnung bei Weizen in semi-ariden Regionen Nordafrikas und des Nahen Ostens - untersucht für die Negev Israels. Zeitschrift für ausländische Landwirtschaft, Sonderheft 4, DLG-Verlag, Frankfurt, 1975, p.20.

- the variability of labour input being very high and the fact that important parameters (care, motivation) cannot be measured.

When comparing labour input and crop output between field types and villages, common denominators are required for the different types of labour and crops

a) Estimating Man Equivalents

Following NORMAN (1), two simplifying assumptions were employed in assigning weights:

1) Physical labour productivity is correlated first positively and then negatively with increases in age.
2) The physical labour productivity of women is lower than that of men.

Table 14: Man Equivalents Used in the Study for Quantification of Labour Capacity and Input per Household and per Field

Labour class	Age	Male adult equivalents
small child	≤ 7	0.0
large child	8 - 15	0.3
female adult	16 - 60	0.8
male adult	16 - 60	1.0
female adult	≥ 61	0.5
male adult	≥ 61	0.5
male adult (part-time farmer)		0.5

Source: compiled by the author.

(1) NORMAN, D.W.: Zaria Study, op.cit., p.17.

The chosen male adult equivalents for "large child" and "female adult" differ from those which NORMAN used in his Zaria study. Nearly 95% of the children in the three survey villages in Eastern Nigeria go to schcol, so that their chances of working on the farms are limited. The older children, while they are no longer at school, remain at home due to their inability to find employment in the region or elsewhere in the State. However, the farmers do not regard these members as a component of their farm labour force.

The Ibo women are known as hard field workers; their man equivalent is therefore higher than those used by NORMAN.

The estimates of man equivalents do not include the quality of the farm workers, nor do they differentiate between activities undertaken in urgent or slack farm periods. Further, according to RUTHENBERG (1), "the estimate of available labour in terms of man equivalent (ME) must be regarded as artificial, since the information it offers reflects the point of view of western observers and not that of the local social order".

Nevertheless, with the limited time available, a comparison of labour input with estimated man equivalents seems to be an appropriate method. A survey with more emphasis on labour utilisation should use the work study approach for establishing the weights of man equivalents (2).

b) Estimating Gross Return from Crop Production

The comparison of crop output is made in physical (t/ha calories/ha and dry matter / ha (3)) and monetary (Naira) units. The physical output (4) from all crops per plot were measured in kilograms, and the weekly harvests multiplied with the prevailing market prices during the month of harvest.

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(1) RUTHENBERG, H.: Smallholder Farming and Smallholder Development in Tanzania. Weltforum Verlag, München, 1968, p.328.

(2) A good description of the "work study" approach is given by: FARRINGTON, J.: Farm Surveys in Malawi. The Collection and Analysis of Labour Data, Development Study No.16, University of Reading, 1975.

(3) See: Tables with calories and dry matter content of all crops in APPENDIX XIII.

(4) An allowance was made for yam sets planted.

The estimation of gross return from crops is made at local market prices which were collected during the survey period (see APPENDIX VI).

For comparisons of gross returns between the villages the prices from one of the major markets (Onitsha) in Eastern Nigeria were used (see APPENDIX VI).

The data from 1973 were taken because they were similar to the local market prices which prevailed during 1974/75.

APPENDIX III: The Physical Environment of the Study Area (1)

The survey was conducted in the Ibo-dominated area of concentrated settlement of the former East Central State of Nigeria (2). This area, known as the Igbo-heartland, has a size of about 5,000 square kilometres which contains between three and five million inhabitants (3).

1. Climate

The climate of the study area

> " is conditioned by the properties of two airmasses, both of tropical origin. These are (i) the equatorial maritime (mT) airmass originating from the south-west, warm and moist; (ii) the tropical continental (cT) airmass originating from the east or north-east, warm and very dry" (4).

The rainy season starts in March and lasts up to November, when the continental airmass accompanied with "Harmattan" weather introduces the dry period with low minimum temperature.

As shown in Figure 3 the study area is located in the region with an annual rainfall between 2,000 and 2,250 mm (80" - 90").

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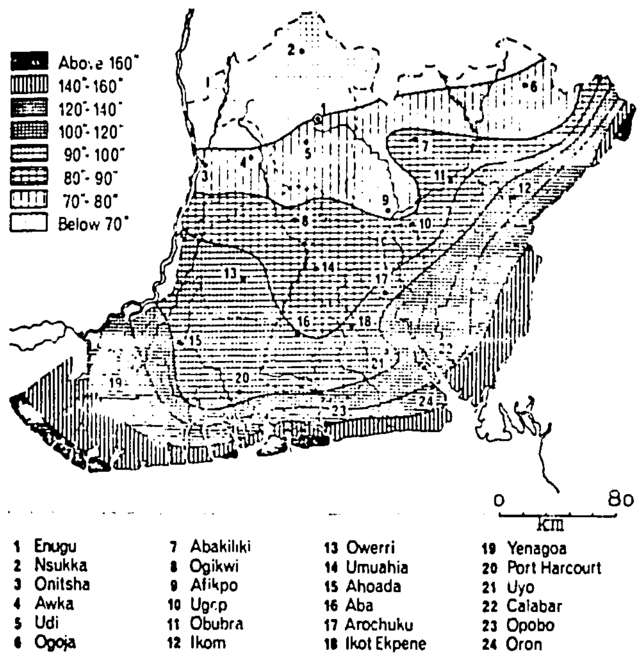
(1) This section draws heavily on a paper by LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: Root Crop Oil Palm Farming Systems: A Case Study from Eastern Nigeria. IITA, Ibadan, 1975.

(2) The E.C.S. was divided into two states in early 1976: Imo and Anambra State. The survey area was located in what is now Imo State.

(3) See: CORVINUS, F. and GRENZEBACH, K.: Afrika-Kartenwerk Serie W: West Afrika, Nigeria, Kamerun, Blatt 9: Bevölkerungsgeographie, Berlin, New York, (forthcoming).

(4) OLUWASANMI, H.A., DEMA, I.S. and others: UBOMA, op.cit. p.115.

Fig. 3: Mean Annual Rainfall



Source: FLOYD, B.: op.cit., p.145.

Weather records are not available for the three survey villages. The climatic data reported in Fig.4 and 5 are those for Umudike, some five to 50 km away from the survey villages. The mean annual rainfall in the survey area was estimated to be in the order of 2,200 mm, with peaks in July and September and the so-called "August break" in between. Mean daily maximum temperatures determined in the same manner would be highest in January-February (33° C to 34° C) and lowest in July (28° C), and mean daily minimum temperatures would be lowest in January-February (20° C to 21° C) and highest in March-April (22° C). The relatively high maximum daily temperatures in January-February coupled with relatively low minimum daily temperatures in the same period result from the clear weather prevailing during the dry season, when both day and night radiation are unhampered by cloud cover.

Fig. 4: Temperature and Rainfall in the Survey Area

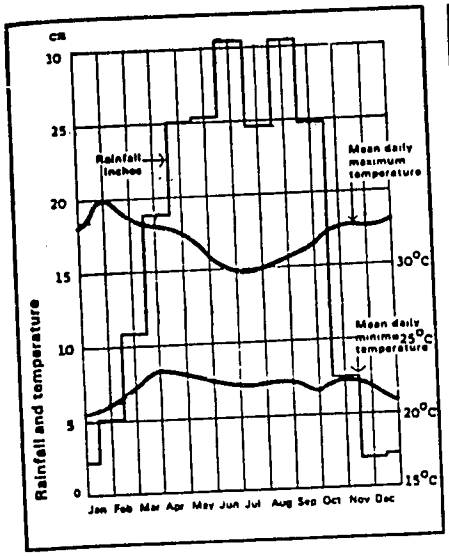
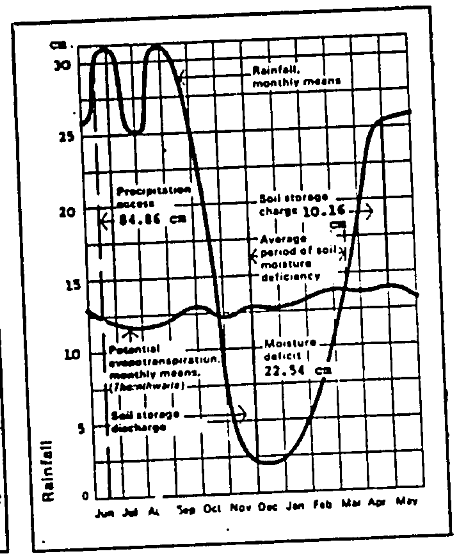


Fig. 5: Potential Evapotranspiration and Water Budget



Source: OLUWASANMI, H.A., DEMA, I.S. and others: op.cit., p.15.

Estimated potential evapotranspiration figures for Umudike (derived by using the Thornthwaite method) indicate that on average precipitation falls below potential evapotranspiration early in November. Assuming a 10 cm buffer of soil moisture between field capacity and wilting point, moisture levels do not normally limit crop growth until late November to early December. Nevertheless, the low water holding capacity of the soils may cause drought stress and yield loss due to occasional rainless periods of 10 or more days, especially during the August period of lower rainfall. The dry season then lasts four to five months, with rainfall exceeding evapotranspiration again in April.

2. Soils

Soils in the study area are formed on deeply weathered areneceous sediments of Plio-Pleistocene age (1). These soils are remarkably homogeneous throughout the area both in relation to their physical and chemical characteristics and to their distribution in a very gently undulating plateau (terrace landscape).

The soils are classified as Oxic Paleudults (USDA Soil Taxonomy) or as Dystric Nitosols (FAO/UNESCO legend of the World Soil Map). The depth of the soil is generally more than two metres, and profiles may reach well over 10 metres in depth. Colours are uniformly red below the surface soil. The textural profiles show a sandy loam surface soil and a gradual increase in clay content in the sub-soil which is usually a sandy clay loam and rarely a sandy clay (25% to 40% clay). Structure is weak crumb in the surface layer and weak subangular blocky in the sub-soil. The surface structure is relatively stable, and the soils are not very erodable. On bare land, the effect of heavy rains is moderate, with some separation of the clay-humus fraction from the sandy matrix under the impact of rain drops. Most lands in the area do not show appreciable erosion, but gullying takes place on the field roads and in unprotected road ditches (2).

3. Vegetation

According to KEAY (3), the natural vegetation in the study area falls within the "Lowland Rain Forest Zone in the Moist Forest at the Low to Medium Altitude Zone". In this vegetation zone, the larger trees are decidous, while others, which are mostly under-storey plants, are evergreen. When undisturbed, the forest attains a stratified structure consisting of three strata. The topmost structure consists of a few tree species usually over 36 m in height, such as Iroko (*Chlorophora exelsa*) and Obeche (*Triplochyton scleroxylon*), which are located at wide-spread intervals with the crowns isolated. They are often designated as "emergents". The middle structure consists of a great variety of species varying in height from 16m to 36m with small laterally spreading crowns in contact with each other, thus forming the upper

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(1) FORBES, T.R.: *A West African Soil Climosequence and Some Aspects of Foodcrop Potential*. Unpublished MSc.thesis, Cornell University, 1975.

(2) Badly eroded and gullied areas can be found in the Awka-Orlu uplands and in the Nsukka Udi Plateau. See:FLOYD, B.:op.cit., pp.119-121.

(3) KEAY, R.W.J., ONOCHIE, C.F.A. and STANFIELD, D.P.: *Nigerian Trees*. Federal Government Printers, Lagos, 1965.

canopy of the mature forest. The third or lowest stratum, often designated as under-storey, consists of trees usually less than 16m in height, with spreading crowns frequently bound together by lianas such as Landolphia spp. and Combretum spp., which with the many shrubs form a dense canopy.

While oil palms are the dominant species of cultivated lands, there are few found in the forest, and where they do exist they are often in the form of forest outliners or occupy gaps in the forest canopy. Under these conditions, the climax vegetation consists of the following families:

a) Leguminosae, e.g. Cylicodiscus spp. and Gossweillerodendron spp.;

b) Meliaceae-Khaya irorensis and Entandrophragma spp.;

c) Sterculaceae, e.g. Cola spp., Triplochyton spp. and Sterculia spp.;

d) Moraceae-Fig family, e.g. Clorophora spp., Ficus spp., Treculia spp.;

e) Ulmaceae-Celtis spp. and Heloptelea spp.

Farming, bush clearing, firing and other human activities have reduced the forest to mainly oil palm bush with a few isolated patches of woodland and secondary forest. The large trees consist of specially preserved or protected plants such as Clorophora exelsa and Triplochyton scleroxylon. There are numerous medium-sized trees such as African breadfruit (Treculia africana), the oil bean (Pentaclethra macrophylla) and kolas (Cola spp.). Under prolonged periods of cultivation, the oil palms persist and attain prominence, with some woodland developing in areas of fallow made up of shrubs and small trees such as Dialum guineensis and Phyllanthus discoides, which are sometimes entangled with several combretaceous and other climbers. Some shrubs which grow from stumps remaining after the clearing of the forest in fallows include: Newbouldia leavis, Berlinia spp., etc.

Acioa barteris and Anthonatha macrophylla may be purposely planted in fallows, while Ficus, Dialum guineensis and other shrubs are mainly grown or protected as browse plants. In some areas, prolonged periods of cultivation with very short fallows result in soils being invaded by certain grasses such as Pennisetum purpurcum, Adropogon spp. and Panicum maximum, while on extremely poor soils spear grass (Imperata cylindricum) is common. Recently, the noxious Eupatorium odoratum has become the major climax vegetation in fallows on constantly cropped land. Around compound farms where perennial crops grow in mixtures with annual crops, perennial weeds such as Icacina spp., with underground rootstocks, gradually attain dominance over annual weeds, and in many cases are the only weeds found during the dry season.

APPENDIX IV: Justification of the Village Selection

1. Different Population Densities

Detailed information on population densities is available from the survey area (see Map 1).

The data are derived from the population census in 1963 and show the following densities for the three survey villages:

- Okwe (L) (100 - 200 persons/km^2)
- Umuokile (M) (350 - 500 persons/km^2)
- Owerre-Ebeiri (H) (750 - 1000 persons/km^2)

Since 1963 the population has increased, although the civil war reduced the number of people living in the survey area. GRENZEBACH (1) mentioned that the highest population density is in the area around Orlu (Owerre-Ebeiri (H) is located near Orlu) where two million people are living with an average density of 1000 persons/km^2 in 1974. For the Orlu division itself he found a density of up to 1200 persons/km^2.

This information seems to be realistic and is verified through the survey data. The farm sizes in the three villages studied indicate population densities of 250 persons/km^2 for Okwe (L), 500 persons/km^2 for Umuokile (M) and 1200 persons/km^2 for Owerre-Ebeiri (M) (see page 23). No other rural areas in Africa south of the Sahara are under such a population pressure, and the differences between the villages are very pronounced. Both factors show that the villages were carefully selected and well suited to test the hypothesis of the study.

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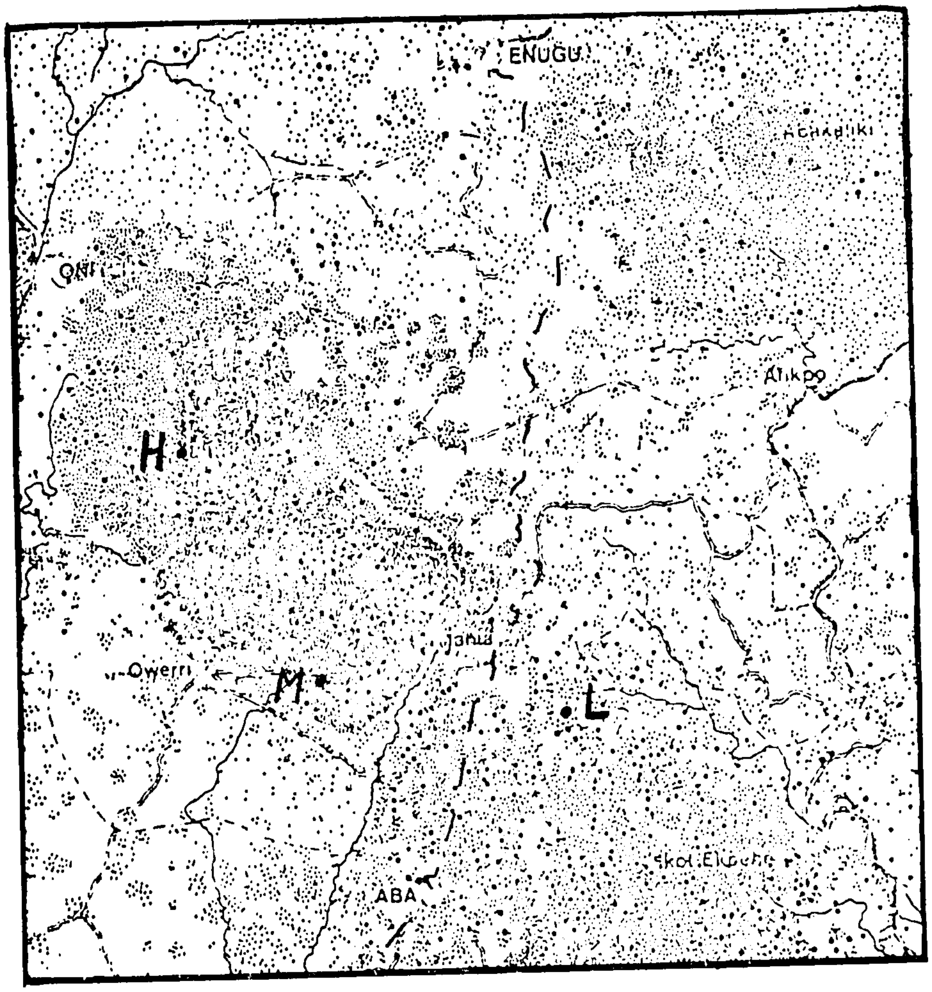
(1) GRENZEBACH, K.: Luftbilder: Indikatoren für regionale Komplexanalyse - Orba (E.C.S., Nigeria) - Strukturwandel in einem dichtbesiedelten Agrarraum Ostnigerias. In: Die Erde, Zeitschrift der Gesellschaft für Erdkunde zu Berlin, 1974, 105. Jahrg., Heft 2.

Map 1: Absolute Population Distribution in Eastern Nigeria, 1963



. : 250 Persons
• :1000 Persons

0 10 20 30 40 50 60 70 80 km

L = Okwe M = Umuokile H = Owerre-Ebeiri

Source: CORVINUS, F. and GRENZEBACH, K. In: Afrika-Kartenwerk der deutschen Forschungsgemeinschaft, Serie W, Blatt 9.

2. Different Fallow Periods

Population densities influence the length of the fallow period. Fig.7 on page 42 demonstrates marked differences in the bush fallow period in the three villages. The modal values are six years in the low density village, four years in the medium and one year in the high density village. The figures for Owerre-Ebeiri (H) are more varied than for the other two villages.

3. Ceteris Paribus Conditions

a) Soils

For comparison of the soils in the three villages, two profiles are described, one representing Owerre-Ebeiri (Village H) and Umuokile (Village M) and the other representing Okwe (Village L). Both soils are derived from the same parent material and have the same time of deposition. This is reflected in similar soil characteristics of the sub-soil. But there are some differences in the characteristics of the top-soil. Compared with profile A, profile B has a sandier surface soil with a less stable structure (so it is more erodible), a higher pH and a higher organic matter content (see Tables 15 and 16).

Apart from the generally sandier surface texture at Okwe, soils in the three villages are similar. However, the sandy surface texture and related physico-chemical characteristics of the Okwe soil is significant, if intensity of cultivation in Okwe is to increase. As found in the general area, such soils are susceptible to a more rapid degradation and, with a land use similar to that in the two other villages, a rapid decrease in yield potential will occur on the sandy soils at Okwe.

In the opinion of the pedologist, the soil uniformity of the three survey villages was not a restrictive assumption.

Soil Profile Description

Profile A, Orlu Series (Owerre-Ebeiri and Umuokile)

- Classification:	Typic Paleudult (USDA) Dystric Nitosol (FAO) Sol ferralitique mayennement désaturé appauvri
- Family:	Clayey; Kaolinitric, Isohyperthermic
- Date description:	15 August 1975
- Location:	5 47'N 7 OI'E East Central State, Orlu Division, Owerre-Ebeiri, 1 km of Orlu on Orlu-Owerri road, 1.6 km inside, W of road on Chief Benjamin's Land
- Elevation:	170 m
- Land form:	Very gently undulating plateau, long slopes, not incised (coastal terrace, little micro-relief)
- Slope:	4% south, middle of a long slope, flat across and along
- Land use:	Oil palm-farm land combination, 1st year of re-growth after one year of cowpea. Ground cover in-complete, grasses and scattered regrowth of shrubs. Ridged land.
- Climate:	See figures of Orlu

Data on the profile:

- Parent materials:	Plio-pleistocene coastal sediments (Benin sands or sands of the Geologic map) clayey material
- Drainage:	Well drained
- Moisture:	Moist throughout, to depths over 350 cm
- Groundwater:	Very deep, no ground water even temporarily stag-nating.

General aspect of profile: Deep uniform reddish soil, loamy in surface, clayey at depth. Concentration of medium roots, mainly oil palm, approx. from 60-100 cm depth, possibly indicating depth of wetting point conditions in dry season. Also deeper and shallower roots.

Profile description:

Ap:	0 - 18 cm	Dark reddish brown (5 YR 3/3 moist), sandy loam, moderate coarse and medium platy, composed of weak angular blocky units in lower part of the horizon; very friable, slightly plastic, non-sticky, many fine interstitial pores in upper 5 cm, common fine tubular random pores throughout; many fine, few medium roots; clear, smooth boundary; pH 4.6.
B_1	18 - 35 cm	Dark reddish brown (2.5 YR 3/4 moist), sandy loam, weak fine subangular blocky; friable, sl. plastic; few broken thin cutans; some thin films of clay-humus infiltration, mainly vertical; many fine tubular random inped pores, few medium pores; common fine and medium roots; diffuse smooth boundary; pH 4.6.
B_{21}	35 - 100 cm	Dark reddish brown (2.5 YR 3/4 - 4/4 moist), sandy clay loam, weak to moderate fine subangular blocky; friable, sl. sticky, sl. plastic, clay bridges, common thin broken cutans, many tubular random inped pores; common fine and medium roots; but many medium roots mainly from oil palm between 65 and 90 cm; diffuse smooth boundary; pH 4.8.
$B_{22}t$	100 - 130 cm	Dark red (2.5 YR 3/6 - 4/6), sandy clay, moderate fine subangular blocky; friable, sl.sticky, sl.plastic; clay bridges and cutans as in previous horizon, but somewhat clearer visible; many fine, few medium tubular random inped pores; common medium, few fine roots diminishing with depth; diffuse smooth boundary; pH 5.0.
$B_{23}t$	130 - 160 cm	Dark red (2.5 YR 4/6), sandy clay, moderate fine subangular blocky; friable, sl.sticky, sl.plastic; cutans as in previous horizon; many fine tubular random inped pores, somewhat diminishing with depth; fine roots.

Table 15: Soil Profile Data Sheet, Profile A

Location: Orlu E.C.S.
Vegetation/Land use: Fallow with Oil Palm

Horizon No.	1	2	3	4	5	6	7	8	9
Depth	0 - 18	18-35	35-100	100-130	130-150	190-210	240-260	290-310	340-360
Text class	SCL	SCL	SCL	SC	SC	SC	SC	SC	SC
0 - 2 u %	25.0	30.4	33.2	37.2	37.2	37.2	39.2	37.2	39.2
2 - 50 u %	4.8	3.6	0.8	0.8	0.8	0.8	0.8	2.8	0.8
50 - 2000 u %	70.0	66.0	66.0	62.0	62.0	62.0	60.0	60.0	60.0
pH-H_2O (1:1)	5.0	5.0	4.9	5.1	5.2	5.1	5.1	5.2	5.2
pH-KCl (1:1)	3.9	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.0
Org. C%	1.0	0.72	0.46	0.28	0.24	0.16	0.2	0.12	0.08
Total N %	0.14	0.08	0.06	0.05	0.04	0.04	0.04	0.03	0.03
C/N ratio	7	9	8	6	6	4	5	4	3
Extract.) Ca	0.24	0.16	0.14	0.12	0.12	0.14	0.15	0.14	0.12
cations) Mg	0.05	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02
me/100g) K	0.04	0.01	0.01	NIL	NIL	0.01	0.01	NIL	0.01
) Na	0.15	0.14	0.13	0.13	0.13	0.16	0.14	0.14	0.14
) Mn	NIL	NIL	NIL	NIL	NIL	0.01	0.02	0.01	0.01
) Fe									
Exch.ac.) Al	1.60	1.52	1.52	1.20	0.96	0.96	0.96	0.96	0.88
me/100g H	0.16	0.12	0.12	NIL	0.08	0.04	0.20	NIL	0.16
Cec.SU of cat.	2.24	1.97	1.94	1.47	1.31	1.34	1.35	1.28	1.34
Base saturation %	21	17	15	18	21	25	26	25	22

Source: MOORMANN, F.R., Pedologist at IITA,
Analysis conducted by Analytical Services Laboratory, IITA.

Soil Profile Description

Profile B (Okwe)

- Location:	Umudike east extension of F.A.R.T.S. experimental farm
- Classification:	Typic Paleudult (USDA) Dystric Nitosol (FAO) Sol ferralitique moyennement dêsaturê
- Land form:	Plateau or peneplain, flattish higher part
- Slope:	1 - 2% NW convex
- Vegetation:	Sec. bush, mainly Eupatorium odoratum

Data on the Profile:

- Parent materials:	Plio-pleistocene coastal sediments, sandy in upper layers
- Drainage:	Well drained
- Moisture:	Dry surface, moist sub-soil
- General aspect of profile:	Deep profile with grey sandy surface and red clayey sub-soil

Profile description:

A_1 0 - 15 cm	Very dark grey (10 YR 3/1 moist) sandy loam, weak fine and medium crumb to single grained, loose, many fine and medium roots, many interstitial, few tubular pores, wavy, abrupt and gradual boundary.
A_2 15 - 25 cm	Dark reddish brown (5 YR 3/3 moist) sandy loam, very weak subangular blocky to structureless single grained; loose, common, locally many fine and medium roots, some coarse roots; many interstitial, common tubular pores; irregular, gradual boundary.

B 25 - 80/95 cm — Yellowish red (5 YR 4/6, moist) sandy loam, with patches of more clayey material, moderate fine subangular blocky; structure hard; common fine roots, many fine tubular pores; patchy clay coatings, distinct in root channels; irreg.lar, gradual boundary.

$B_{22}t$ 80/95 - 230 cm — Yellowish red (2.5 YR 4/6, moist) sandy, clay, moderately fine subangular blocky; firm, slightly sticky, slightly plastic; common patchy clay coatings on peds, distinct coatings in root channels; few fine roots; many fine tubular pores.

Table 16: Soil Profile Data Sheet, Profile B

Horizon No. Depth	1 0 - 15	2 15 - 25	3 25/70-80/95	4 80/95-230	5 230 +
Text class	Sa L	Sa loam	Sa loam	Sa clay	Sa clay
0 - 2 u %	13	17	20	40	49
2 - 50 u %	9	7	2	1	5
50 - 2000 u %	78	76	77	58	46
pH-H_2O (1:1)	5.7	4.9	5.1	5.2	5.5
Org. C %	2.48	0.38	0.34	0.26	0.14
Extract.) Ca	3.24	0.16	0.26	0.46	0.50
cations) Mg	0.75	0.04	0.06	0.03	0.05
me/100g) K	0.08	0.02	0.02	0.02	0.02
)Mn	0.02	n.d.	n.d.	n.d.	n.d.
)Fe	n.d.	n.d.	n.d.	n.d.	n.d.
Exch.)Al	n.d.	0.42	0.49	0.75	0.38
acidity)H	0.54	0.51	0.44	0.80	0.48
me/100g)					

Source: MOORMANN, F.R., Pedologist at IITA. Analysis conducted by Analytical Services Laboratory, IITA.

b) Rainfall

Rainfall data are not available from the three survey villages themselves, but from two locations within the survey area:

Table 17: Rainfall data from two locations in the survey area in Eastern Nigeria

	Umudike 1929 - 1973	Umudike 1974	Uboma 1974
Jan.	21.8	1.8	0.0
Feb.	48.6	10.7	20.3
Mar.	115.1	155.7	86.7
Apr.	208.4	203.7	322.6
May	266.5	223.8	325.6
June	273.2	349.0	199.4
July	297.9	202.7	347.5
Aug.	271.9	224.4	329.2
Sep.	331.4	411.5	297.7
Oct.	254.0	234.7	295.9
Nov.	76.6	19.3	17.8
Dec.	18.1	1.0	0.0
Total	2183.5 (mm)	2038.3 (mm)	2242.7(mm)
		Umudike 1975	Uboma 1975
Jan.		0.0	0.0
Feb.		54.3	21.6
Mar.		64.0	142.7
Apr.		330.1	231.9
May		310.8	456.2
June		239.5	172.9

Source: Umudike: Mr.A.O. UBBOR, Agromet. Section, F.A.R.T.S.,
Uboma: Mr. R.O.M. OFFOR, Project Manager at Uboma.

Umudike is about five km away from Okwe, and Uboma about 20 km from Umuokile and 35 km from Owerre-Ebeiri (all distances are bee-lines).

Rainfall in 1974 was in both stations very close to the 42 years' average data from Umudike, and amounted to 2038.3 mm in Umudike and 2242.7 mm in Uboma, which gives an average figure of 2140.5 mm.

The distribution of rainfall, although there are some differences between Umudike and Uboma, were not significantly different from the 42 years' average rainfall data (tested with chi-square test). The data verify information collected from farmers in all three survey villages that rainfall was "average" during the survey period.

c) Landscape (topography)

The landscape in Umuokile and Owerre-Ebeiri is very uniform. Both villages are situated on a very gently undulating plateau. The slopes of the fields are within a range from 0 to 5%, the modal value is 2 - 3%. 75% of the fields in Okwe are similar to those in the other villages: they are situated on a gently undulating plateau with slopes from 0 - 7%. The remaining 25% of the fields are located in sloping areas with slopes from 10 to 25%. Due to the fact that the bush fallow is the longest in Okwe, the effect of run-off and soil erosion was not very severe.

It is therefore assumed that the fields on slopes do not significantly affect the result of the data from Okwe.

d) Land Tenure

Farmers were asked for all plots (370) how they acquired the land cultivated during the survey period. 70% to 78% of all field were inherited, and leased plots accounted for from 8% to 19% of all fields. Communal land played a role only in Owerre-Ebeiri and accounted for 20% of the fields (see Table 18).

e) Infrastructure

All villages are accessible by two-wheel drive vehicles throughout the year and are situated close to tarred roads. Owerre-Ebeiri is - with respect to transport availability - in a comparatively bad situation. The roads to the nearest

Table 18: Types of Acquisition of Land in Three Villages in Eastern Nigeria (as a percentage)

village	inherited	leased	communal	other (a)	total
Okwe	78	19	0	3	100
Umuokile	71	8	1	20	100
Owerre-Ebeiri	70	9	20	1	100

(a) includes: purchased, gift, exchanged and pledged.

Source: compiled by the author.

sizable townships (Owerri and Umuahia) are in a poor condition. Costs for transport by taxi are shown in Table 19.

Table 19: Taxi Costs for One Person from the Survey Villages to the Two Nearest Sizable Towns. Prices in Kobo.

From	to	1973/74	1974/75
Okwe	Umuahia	30	40
Okwe	Ikot Ekpene	50	60
Umuokile	Owerri	20	30
Umuokile	Umuahia	50	70
Owerre-Ebeiri	Owerri	40	80
Owerre-Ebeiri	Umuahia	70	150

Source: compiled by the author.

The differences in transport costs between 1973/74 and 1974/75 are mainly due to fuel scarcity.

The local markets which farmers attend every four or eight days are located either directly in the village, as in Owerre-Ebeiri, or very close to it. Enyioguguu, the market for Umuokile, is 0.5 km away, and the Ndoro market is 2 km away from Okwe. Farmers transport their products either by headload or by bicycle. Cyclists transport products from the medium and high density villages to the local markets for a fare of about 10 Kobo.

f) Influence of Towns

The next sizable township to the three villages can be reached within half an hour's taxi drive. Owerri-Ebeiri is located one km away from a town (Orlu) with about 5000 inhabitants. This fact is probably a weak point in the survey. On the other hand extremely high population densities can usually only be found close to townships.

g) Physical Availability of Production Factors

Farmers obtain their inputs, like yam sets, cassava cuttings and seeds either from their previous harvest or from the local markets. Mineral fertilizer was not used at all during the survey period - mainly due to non-availability to the farmers - though insecticides (Alderin dust) were used by five farmers in Owerre-Ebeiri, since they were available from the Ministry of Agriculture and in the market of Orlu.

Credit is not available from banks, but farmers obtain credit mainly from friends, relatives and traders. It is concluded that traditional production factors are available in the three survey villages, but mineral fertilizer and chemical inputs are not generally available due to a poorly organized distribution system for these "new inputs".

APPENDIX V: QUESTIONNAIRES

Root Crop/Oil Palm Systems Survey   Questionnaire 1   Form L1

Name of Head of Household ______________________________

Village: ______________ Enumerator: ______________   Case No: __________

Date: __________

1. The household (Labour stock)

Note: All questions are directed to the head of the household. List all members of the household starting with the head of the household, his wives and children followed by relatives.

List of Household members normally living with the Head of the Household

No.	Relationship to Household head	Sex M or F	Age	No. of years Schooling	Non-farm work			
					Type	No.of days per week	Wage per week	Only Sparingly
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

Household members away from home

No.	Relationship	Sex	Age	Occupation	Education	Farm Support
1						
2						
3						
4						
5						

ROOT CROP/OIL PALM SYSTEMS SURVEY Questionnaire 2 Form L2

Name of Head of Household: ______________________ Case No. __________

Village: ______________ Enumerator: ______________ Date: __________

2. Non-family labour

Did you hire any labour this year? __________

If the answer is yes, ask the following

Crop activity	Month	Class of labour	No. of persons hired	No. of days	Wage rate per day*	Office use

* If farmer [illegible] meal [illegible] labourers, [illegible] with an [illegible]

In which month do you normally hire the most labour? __________

Did you employ paid labourers on your farm [illegible] years ago? __________

[illegible] __________

[illegible] labourers [illegible] __________

[illegible] __________ [illegible] __________

[illegible] __________ [illegible] __________

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 2 — **HUSBANDRY PRACTICES – CROPS** — *FORM TYPE:* L3

1 [Q] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] PLOT No 5 6 [ ][ ] 7 [ ] DATE ________ ENUMERATOR ______________

NOTE Complete for each plot Form L3

Ask what is done on the plot from January 1974 up to the time of questioning.

TYPE		WHICH CROP(S)		MONTH			FAMILY LABOUR			NON FAMILY LABOUR		
					P	No	PERSON(S)	NO	HOURS	KIND 2	NO	HOURS
	8 – 9		10–11		12	13 14	15	16 – 17	18 – 20	21	22 – 23	24 – 26
CLEARING	A1											
BURNING	A2											
RIDGING	A3											
MOUNDING	A4											
PLANTING 1 CROP	A5											
2 CROP	A5											
3 CROP	A5											
4 CROP	A5											
5 CROP	A5											
6 CROP	A5											
7 CROP	A5											
STAKING	A6											
THINNING	A											
1st WEEDING	A8											
APP OF FERTILIZER	A9											
2nd WEEDING	A8											
HARVESTING	B2											
	B2											
CARRYING TO	B3											
THE HOUSE	B3											
PROCESSING	B4											
	B4											

(1) A – HEAD OF HOUSEHOLD
B – WIFE(S)
C CHILDREN
D – OTHERS

(2) E – HIRED
F – EXCHANGE
G – COMMUNUAL
H – OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 2 — **HUSBANDRY PRACTICES – TREES** — *FORM TYPE:* L 4

1 [P] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] PLOT No. 5 6 [ ][ ] 7 [ ] DATE ________ ENUMERATOR ____________________

NOTE: Complete for each plot Form L 4

Ask what is done with the trees from January 1974 up to the time of questionning

TYPE	8 – 9	WHICH TREES	10 - 11	MONTH	12	13 - 14	HOURS 16 – 17	HARVEST QUANTITY IN LOCAL UNITS
TRIMMING	B1							
	B1							
	B1							
	B1							
	B1							
HARVESTING	B2							
	B2							
	B2							
	B2							
	B2							
CARRYING TO THE HOUSE, MARKET OR FACTORY	B3							
	B3							
	B3							
	B3							
	B3							
PROCESSING WITHIN THE HOUSE HOLD	B4							
	B4							
	B4							
	B4							
	B4							

What are you doing with the branches and leaves of these trees?

- -

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 2

CROPPING HISTORY

FORM TYPE: L 6

1 [R] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] PLOT No. 5 6 7 [ ][ ] [ ] DATE ______ ENUMERATOR ______

NOTE: Complete for each plot Form L 5
Place yourself in the middle of the plot and ask:

1. *What has been grown on the plot you are standing, disregarding the history of neighbouring areas*
2. *Crops plan to grow from now until returned to bush*

	8 9	2 YEARS AGO	10 11	LAST YEAR	12-13	PRESENT	14 15	NEXT YEAR
CROPS GROWN								

1. Why do you use this crop mixture which we have just discussed, on this piece of land?
   (a) because of tradition [ ]
   (b) scarcity of land [ ]
   (c) other reasons (which) ______
2. Does this plot grow some crops better than others?
   Which crops better? [ ] ______ Why? Soil fertility [ ] No shade [ ] Shade [ ] Other reasons ______
   Which crops worse? [ ] ______ Why? Soil fertility [ ] No shade [ ] Shade [ ] Other reasons ______
3. Why do you cultivate this plot in this manner?
   in mounds ______
   or ridges ______
   or zero tillage ______
4. How long was the previous bush fallow on this plot? [ ] years
5. How long do you think you will leave this plot in bush before it is cropped again? [ ] years

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE   ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 3   **HUSBANDRY PRACTICES – CROPS**   *FORM TYPE :* L8

1 [G]   2 VILLAGE [ ]   3 4 CASE No. [ ][ ]   5 6 7 PLOT No. [ ][ ] [ ]

DATE__________   ENUMERATOR:____________________

NOTE: Complete for each plot Form L8

Ask what is done on the plot from July 1974 (Questionnaire 2) up to the tim) of questioning

TYPE		WHICH CROP(S)		MONTH			FAMILY LABOUR			NON FAMILY LABOUR			
					P	No	PERSON(S) 1	No.	HOURS	KIND 2	No.	HOURS	TOTAL COST
	8 - 9		10-11		12	13 14	15	16 – 17	18 – 20	21	22 – 23	24 – 26	27 – 30
CLEARING	A1												
BURNING	A2												
RIDGING	A3												
MOUNDING	A4												
PLANTING 1. CROP	A5												
2. CROP	A5												
3. CROP	A5												
4. CROP	A5												
5. CROP	A5												
STAKING	A6												
THINNING	A7												
WEEDING	A8												
FERTILIZER	A9												
HARVESTING 1. CROP	B2												
2. CROP	B2												
3. CROP	B2												
4. CROP	B2												
CARRYING TO THE HOUSE	B3												
	B3												
PROCESSING	B4												
	B4												

(1) A – HEAD OF HOUSEHOLD
B – WIFE
C – CHILDREN
D – OTHERS

(2) E – HIRED
F – EXCHANGE
G – COMMUNUAL
H – OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 3

HUSBANDRY PRACTICES – TREES

FORM TYPE: L 9

1 N — VILLAGE 2 ☐ — CASE No. 3 4 ☐☐ — PLOT No. 5 6 7 ☐☐ ☐ — DATE ______ ENUMERATOR ______

NOTE Complete for each plot Form L 9

Ask what is done with the trees from July 1974 (QUESTIONNAIRE 2) up to the time of questionning

TYPE		WHICH TREES		MONTH	P	No.	FAMILY LABOUR PERSON(S) 1	FAMILY LABOUR No.	FAMILY LABOUR HOURS	NON FAMILY LABOUR KIND 2	NON FAMILY LABOUR No.	NON FAMILY LABOUR HOURS	NON FAMILY LABOUR TOTAL COST
	8 – 9		10–11		12	13 14	15	16–17	18 – 20	21	22 – 23	24 – 26	27 – 30
TRIMMING	B1												
	B1												
	B1												
	B1												
	B1												
HARVESTING	B2												
	B2												
	B2												
	B2												
	B2												
CARRYING TO THE HOUSE, MARKET OR FACTORY	B3												
	B3												
	B3												
	B3												
	B3												
PROCESSING WITHIN THE HOUSE HOLD	B4												
	B4												
	B4												
	B4												
	B4												

1: A – HEAD OF HOUSEHOLD
B – WIFE
C – CHILDREN
D – OTHERS

2: E – HIRED
F – EXCHANGE
G – COMMUNUAL
H – OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP -- OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 3

LIVESTOCK INQUIRY

FORM TYPE L 10

H VILLAGE [ ] CASE No [ ][ ] DATE ____ ENUMERATOR ____

LIVESTOCK OWNED

TYPE *	AGE		TOTAL No.	OWNERSHIP*	NUMBER OF MALES	NUMBER OF FEMALES	VALUE	AGE		TOTAL No.	OWNERSHIP*	NUMBER OF MALES	NUMBER OF FEMALES	VALUE
		[illegible]	7–9	10-11	12-13	14-15	16-20		[illegible]	23-26	[illegible]	[illegible]	[illegible]	[illegible]
GOATS	UNDER 1 YR.	AA						OVER 1 YR.	AB					
SHEEP	UNDER 1 YR.	AC						OVER 1 YR.	AD					
PIGS	UNDER 1 YR.	AE						OVER 1 YR.	AF					
CHICKEN	UNDER 6 MTHS	AG						OVER 6 MTHS	AH					
DUCKS		64												
OTHERS														

LIVESTOCK PURCHASED IN 1974

	GOATS			SHEEP			PIGS			CHICKEN			DUCKS			OTHERS	
	NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23-24	[illegible]	[illegible]	32-33	34-35	36-40	41-42	43-44	46-49	50-51	52-53	54-56
60			61			62			63			64					

*A – HEAD OF HOUSEHOLD
B – WIFE(S)
C – CHILDREN
D – OTHERS

LIVESTOCK SOLD IN 1974

	GOATS			SHEEP			PIGS			CHICKEN			DUCKS			OTHERS	
	NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE
[illegible]	[illegible]	[illegible]	14-15	[illegible]	[illegible]	23-24	[illegible]	[illegible]	32-33	34-35	36-40	41-42	43-44	46-49	50-51	52-53	54-56
60			61			62			63			64					

LIVESTOCK CONSUMED IN 1974

	GOATS			SHEEP			PIGS			CHICKEN			DUCKS			OTHERS	
	NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE		NO	VALUE
[illegible]	[illegible]	[illegible]	14-18	[illegible]	[illegible]	23-24	[illegible]	[illegible]	32-33	34-35	36-40	41-42	43-44	45-49	50-51	52-53	54-56
64			51			52			53			54					

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP/OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 3 | OIL PALMS | FORM TYPE L11

Village__________ Case No.____________ Enumerator:____________

---

1. Do you have now more or less oil palms on your land than 20 years ago?__
   If not the same, why?______________________________
2. Did you plant any new oil palm in the last 10 years?______________
   If yes, how many?____________ 1. Wild oil palms......................
   2. Improved oil palms..................
3. When do you consider it worthwhile to fell an old oil palm tree and plant another one?______________________________
4. Do you have any plots where you recently cleared the oil palms in order to grow more arable crops?____________________
5. Do you have any plots where you intend to increase the number of oil palms?________
   No.of Plots.........No.of oil palms..........
6. Could you plant oil palms on your distant fields?______________
   Would they yield?..................if not, why?........................
7. Do you feel it would be better to have improved oil palms in pure stands or intercropped with arable crops?______________
   Pure stands................. Why?.....................
   Intercropped................ Why?.....................
8. Have you heard about the Oil Palm Rehabilitation Scheme?__________
   Have you participated?______________
   If not why?______________________________
9. Under which conditions would you participate in such a scheme?________
   ____
   ____
10. How do you process the oil bunches?______________________
    ____
    ____
11. Who is responsible for processing the oil bunches?__________
    ____
12. Ask the responsible person: What should be done to make the processing work easier and quicker?
    ____
    ____
    ____

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ROOT CROP/OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 3 LAND TENURE FORM TYPE: L12

Village_________ Case No. ___________ Enumerator___________

Plot No.	Type of acquisition+	Year	Price

+Distinguish between the following types of acquisition: Inheritance, gift, purchase, lease, share cropping, communal, other (specify)

If you want to crop more land, can you get it?___________
From whom?___________ Price?___________
How far away from your house?___________

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP/OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 4 CROPS FORM TYPE L15

Village_________ Case No.___________ Enumerator ___________

1. Do you now grow more or less
   Cassava ___________ Why? ___________
   Yam ___________ Why? ___________
   Cocoyam ___________ Why? ___________
   Maize ___________ Why? ___________
   than 10 years ago?

2. What are the major problems which prevent you increasing your yields of
   Cassava ___________
   Yam ___________
   Cocoyam ___________
   Maize ___________

3. If planting materials were not scarce, what would you grow and in what proportions?

Crops	Proportion (as %)

4. What are you doing to increase the yields of your crops?
Cassava ______
Yam ______
Cocoyam ______
Maize ______

5. What farming practices do you use now that you did not 10 years ago?
______
______
______

6. Why have you changed your farming practices? ______
______
______

7. Why do you prefer intercropping to sole cropping? ______
______
______

8. Which crops need most manuring?

	High	Medium	Low
Cassava	______	______	______
Yam	______	______	______
Cocoyam	______	______	______
Maize	______	______	______

9. From where do you get manuring and mulching materials?
1. ______ 2. ______
3. ______ 4. ______

10. Do you have enough manuring and mulching materials? ______

11. Do you bring such materials to the crops on your distant fields? ______
If not, why? ______

12. Are there yield-increasing methods you know about but don't use? ______

Practice	Why does not use
______	______
______	______
______	______

13. Do you know the price of 1 bag of min. fertilizer? ______

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ROOT CROP/OIL PALM SYSTEM SURVEY

FORM TYPE L16

TREES ENQUIRY ON FALLOW PLOTS

Village ____________ Case No. ____________ Date ____________ Enumerator ____________

Fallow Plot No	Distance[1]	Oil palm	Raffia palm	Coco nut	Pear	Citrus	Cocoa	Banana	Plan tain	Paw paw	Mango	Bread fruit	Oil bean	Guava	Others[2]	Non-Fruit Trees
Total																

Ask the farmer whether he has collected from any fallow plot one of the following items:

Firewood ____________ Crops ____________ (which?) ....

Mulching material ____________ Leaves ____________ Others ....

1. Estimate No. of minutes to walk from the house to the plot
2. Identify kind of tree(s)

Comments:

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP – OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 4 **HUSBANDRY PRACTICES – CROPS** *FORM TYPE* L 13

1 [S] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] PLOT No. 5 6 [ ][ ] 7 [ ]

DATE ________ ENUMERATOR ________

NOTE Complete for each plot Form L 13

Ask what is done on the plot from September 1974 (QUESTIONNAIRE 3) up to the time of questioning

TYPE	8-9	WHICH CROP(S)	10-11	MONTH P 12	MONTH No. 13-14	FAMILY LABOUR PERSON(S) (1) 15	No. 16-17	HOURS 18-20	NON FAMILY LABOUR KIND (2) 21	No. 22-23	HOURS 24-26	TOTAL COST 27-[illegible]
CLEARING	A1											
BURNING	A2											
RIDGING	A3											
MOUNDING	A4											
PLANTING 1 CROP	A5											
PLANTING 2 CROP	A5											
STAKING	A6											
THINNING	A7											
WEEDING	A8											
FERTILIZER	A9											
HARVESTING 1 CROP	B2											
HARVESTING 2 CROP	B2											
HARVESTING 3 CROP	B2											
HARVESTING 4 CROP	B2											
CARRYING TO THE HOUSE	B3											
	B3											
	B3											
	B3											
PROCESSING	B4											
	B4											
	B4											
	B4											

(1) A – HEAD OF HOUSEHOLD
B – WIFE
C – CHILDREN
D – OTHERS

(2) E – HIRED
F – EXCHANGE
G – COMMUNUAL
H – OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE — ROOT CROP - OIL PALM SYSTEM SURVEY

QUESTIONNAIRE 4 — **HUSBANDRY PRACTICES - TREES** — *FORM TYPE* L 14

1 [T] VILLAGE 2 [ ] CASE No 3 4 [ ][ ] PLOT No. 5 6 [ ][ ] 7 [ ] DATE ________ ENUMERATOR ________________

NOTE Complete for each plot Form L 14

Ask what is done with the trees from September 1974 (QUESTIONNAIRE 3) up to the time of questionning.

[illegible]		WHICH TREES		MONTH	FAMILY LABOUR					NON FAMILY LABOUR			
					P.	No.	PERSON(S) (1)	Hrs.	HOURS	[illegible] (2)	No.	NAIRA	TOTAL COST
	8 – 9		10–11		12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27 – 30
TRIMMING	B1												
	B1												
	B1												
	B1												
	B1												
HARVESTING	B2												
	B2												
	B2												
	B2												
	B2												
CARRYING TO THE HOUSE, MARKET OR FACTORY	B3												
	B3												
	B3												
	B3												
	B3												
PROCESSING WITHIN THE HOUSE HOLD	B4												
	B4												
	B4												
	B4												
	B4												

(1) A – HEAD OF HOUSEHOLD
B – WIFE
C – CHILDREN
D – OTHERS

(2) E – HIRED
F – EXCHANGE
G – COMMUNUAL
H – OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

WEEKLY YIELD MEASUREMENTS – CROPS

FORM TYPE YM-C

1 [D] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] WEEK 5 6 [ ][ ] ENUMERATOR ____________

		PLOT	1	No.	KG UNIT	2		PLOT	1	No.	KG UNIT	2		PLOT	1	No.	KG UNIT	2		PLOT	1	No.	KG UNIT	2
YAM	[illegible]						[illegible]						[illegible]						[illegible]					
CASSAVA	[illegible]						[illegible]						[illegible]						[illegible]					
COCOYAM	[illegible]						[illegible]						[illegible]						[illegible]					
MAIZE	[illegible]						[illegible]						[illegible]						[illegible]					
OKRA	[illegible]						[illegible]						[illegible]						[illegible]					
GROUNDNUT	[illegible]						[illegible]						[illegible]						[illegible]					
VEGETABLES	[illegible]						[illegible]						[illegible]						[illegible]					
TELFERIA	[illegible]						[illegible]						[illegible]						[illegible]					
MELON	[illegible]						[illegible]						[illegible]						[illegible]					
PUMPKIN	[illegible]						[illegible]						[illegible]						[illegible]					
TOMATO	[illegible]						[illegible]						[illegible]						[illegible]					
BEANS	[illegible]						[illegible]						[illegible]						[illegible]					
PINE APPLE	[illegible]						[illegible]						[illegible]						[illegible]					
PEPPER	[illegible]						[illegible]						[illegible]						[illegible]					
FLUTED PUMPKIN	[illegible]						[illegible]						[illegible]						[illegible]					
ONIONS	[illegible]						[illegible]						[illegible]						[illegible]					

1)

A – BASKETS
B – BASINS
C – TUBERS
D – CIGARETTE CUPS
E – BUNCHES
F – BUNDLES
G – OTHERS

2)

P – YIELD FROM WHOLE PLOT
S – YIELD FROM SQUARE PLOT

COMMENTS:

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

WEEKLY YIELD MEASUREMENTS – TREES

FORM TYPE YM - T

1 E   VILLAGE 2 [ ]   CASE No 3 4 [ ][ ]   WEEK 5 6 [ ][ ]   ENUMERATOR ______________

CROPS		PLOT	*	NO	KG UNIT		PLOT	*	NO	KG UNIT		PLOT	*	NO	KG UNIT		PLOT	*	NO	KG UNIT		PLOT	*	NO	KG UNIT
OIL PALM	01					01					01					01					01				
RAFIA	04					04					04					04					04				
KOLANUT	05					05					05					05					05				
COCONUT	06					06					06					06					06				
PEAR	07					07					07					07					07				
CITRUS	08					08					08					08					08				
COCOA	09					09					09					09					09				
BANANA	10					10					10					10					10				
PLANTAIN	11					11					11					11					11				
PAW PAW	12					12					12					12					12				
MANGO	13					13					13					13					13				
BREAD FRUIT	14					14					14					14					14				
OIL BEANS	15					15					15					15					15				
GUAVA	16					16					16					16					16				
FIRE WOOD	17					17					17					17					17				

* A BASKETS   D BUNCHES
B BASINS   E BUNDLES
C FRUITS   F OTHERS

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

WEEKLY SUMMARY EXPENDITURE

FORM TYPE: E

1 C VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] WEEK 5 6 [ ][ ] ENUMERATOR ____________

FARM EXPENSES	
LABOUR	
FERTILIZER	
PESTICIDES	
CUTLASS, AXE	
HOES, SHOVELS	
LAND RENT	
PLANTING MATERIAL	
LIVESTOCK FEED	
ANIMAL ( )	

NON FARM EXPENSES	
CLOTHING	
MEDICAL	
SCHOOL FEES	
TRANSPORT	
BICYCLE	
PETTY TRADING	
HOUSING	
HARDWARE	
TAXES	
FESTIVALS	
ENTERTAINMENTS	
GIFTS	
CONTRIBUTIONS	
KEROSINE	
MATCHES	
SOAP	
TOBACCO/SNUFF	
LOAN RETURNED	

FOOD EXPENSES	
YAMS	
GARI	
CASSAVA ROOTS	
COCOYAM	
MAIZE	
OKRA	
GROUNDNUTS	
VEGETABLES	
TELFERIA	
MELON	
PUMPKIN	
TOMATO	
BEANS	
PINE APPLE	
PEPPER	
FLUTED PUMPKIN	
ONIONS	
MILK	
BREAD	
RICE	
MEAT	
FISH	
EGGS	
SALT	
SUGAR	
BEVERAGES	
PALM OIL	
PALM WINE	
KOLA NUT	
OIL BEANS	

COMMENTS

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

WEEKLY SUMMARY OF INCOME

FORM TYPE: 1

1 [A] VILLAGE 2 [ ] CASE No. 3 4 [ ][ ] WEEK 5 6 [ ][ ] ENUMERATOR. ______________

FARM	TREES	OIL PALM: BUNCHES 01	OIL 02	KERNELS 03	PALM WINE 04	KOLANUT 05	COCONUT 06	PEAR 07	CITRUS 08	COCOA 09	BANANA 10
		PLANTAIN 11	PAW PAW 12	MANGO 13	BREAD FRUIT 14	OIL BEANS 15	[illegible] 16	FIRE WOOD 17			
	CROPS	YAMS 20	GARI 21	CASSAVA 22	COCOYAM 23	MAIZE 24	RICE 25	GROUNDNUT 26	VEGETABLES 27	TELFERIA 28	MELON 29
		PUMPKIN 30	TOMATO 31	BEANS 32	PINE APPLE 33	PEPPER 34	FLUTED PUMPK. 35	ONIONS 36			
	STOCK	GOATS 50	SHEEP 51	PIGS 52	CHICKEN 53	DUCKS 54	BUSH MEAT 55	DOGS 56			

1 [B]

NON FARM	PERSON	7 8	9	10 – 14	15	16 – 20	21	22 – 26	27	28 – 32	33	34 – 38	39	40 – 44	45	46 – 50	51	52 – 56
			*	AMOUNT	*	AMOUNT	*	AMOUNT	*	AMOUNT	*	AMOUNT	*	AMOUNT	*	AMOUNT	*	AMOUNT
	HEAD OF HOUSEHOLD	60																
	[illegible]	61																
	[illegible]	62																

* A – OFF FARM EMPLOYMENT
B – GIFTS
C – ESUSU / CREDIT
D – PETTY TRADING / TRADING
E – PENSION
F – OTHER
G – CREDIT REPAYMENT

COMMENTS:

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP – OIL PALM SYSTEM SURVEY

WEEKLY CREDIT OPERATIONS

FORM TYPE: CO

1 F | 2 VILLAGE | 3 4 CASE No | 5 6 WEEK | ENUMERATOR ____________

LOANS GIVEN

CASH

AMOUNT	DATE REPAYMENT DUE	AMOUNT DUE	PURPOSE OF LOAN
7 – 15	16 – 18	14 – 19	19 20

KIND

AMOUNT	DATE REPAYMENT DUE	AMOUNT DUE	PURPOSE OF LOAN	TYPE OF ITEM LOANED
20 – 28	29 30	30 – 32	33 34	35 36

LOANS RECEIVED

CASH

AMOUNT	DATE REPAYMENT DUE	AMOUNT DUE	PURPOSE OF LOAN
37 – 41	42 43	44 – 48	49 50

KIND

AMOUNT	DATE REPAYMENT DUE	AMOUNT DUE	PURPOSE OF LOAN	TYPE OF ITEM LOANED
51 – 55	56 57	58 – 62	63 64	65 66

*70 – LABOUR
71 – FERTILIZER
72 – PESTICIDES
75 – LAND RENT and EXTENSION
65 – FOOD
66 – TOOLS
81 – MEDICAL
82 – SCHOOL FEES
85 – PETTY TRADING/ TRADING

COMMENTS:

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

ROOT CROP - OIL PALM SYSTEM SURVEY SOIL DATA SHEET (Field)

Plot No. ....Date:............. Surveyed by ....

Depth	Texture	Colour	Others

Soil Unit ______

% Slope ______ Form ______ Position ______

Land Form ______

Relief ______ Micro Relief ______

Land Use ______

Weeds ______

Trees ______

Drainage ______ Ground Water (cm) ______

Evidence of Erosion ______

Human Influence ______

FORM CP

Name of Head of Household:......................... Case No:................

Village:................................. Date:..................

Kindred:................................. Enumerator:.................

Name of Field:.......................... Size of whole plot:.............

Plot No:............... Size of square plot:............

Type of Crop	No/m²	Type of fruit tree	Age	No	Non-fruit tree	No

ROOT CROP/OIL PALM SYSTEM SURVEY — IITA

Record of Local Market Prices — Form: MP

Village:________________________ Date__________

Enumerator:________________________

Crops	Local Unit	Price per Local Unit	Weight in kg/gr	Price per kg
Yam	3 Tubers			
Cocoyam	Basket or basin			
Maize	1 c.c.			
Cassava roots	Basket			
Gari	1 c.c.			
Melon	1 c.c.			
Telferia	1 bundle			
Pumpkin	5 fruits; seeds 1 c.c.			
Fluted Pumpkin	1 fruit			
Pepper	1 c.c.			
Okra	10 fruits			
Tomato	10 fruits			
Vegetables	1 bundle			
Pineapple	1 fruit			
Beans	1 c.c.			
Cowpeas	1 c.c.			
Groundnuts	1 c.c.			
Rice	1 c.c.			
Trees				
Oil palm bunches	1 bunch* or 1 basket			
Palm oil	1 beer bottle			
Palm wine	1 jar* or 1 calabash			
Kolanut	10 pods			
Coconut	1 nut			
Cocoa	10 pods			
Pear	10 fruits			
Orange	10 fruits			
Grapefruit	10 fruits			
Lemon	20 fruits			
Banana	1 bunch			
Plantain	1 bunch			
Pawpaw	1 fruit			
Mango	10 fruits			
Breadfruit	1 c.c.			
Oil Bean	1 basket			

* identify which unit.

MAIZE QUESTIONNAIRE

Farmer's Name ______________ Village ______________

Case No. ______________ Date ______________

Good day, now that your maize plot has been harvested we would appreciate very much your opinion on the maize and the way we asked you to grow it. Your suggestions and ideas will help us develop better maize varieties, and better ways of growing the maize.

1. Were you satisfied with the yield from your maize plot?

   YES (   ) to Q5   NO (   ) to Q2

2. Why were you dissatisfied with your maize yield?

3. What do you think were the major reasons for your poor yields?

4. What do you think could have been done about these problems?

   To Q6

5. What factors do you think contributed to the good yields?

6. Fertilizer costs [illegible] a bag. Do you think the extra yield from using the fertilizer makes it worthwhile? YES(   ) NO (   )

7. Do you plan to use fertilizer on your maize crop in 1976

   YES (   ) to Q9   NO (   ) to Q8

8. Why won't you use fertilizer on your 1976 maize crop?

   To Q10

9. How many bags will you buy?

10. Many farmers had problems with white ants this year, Do you think the Alderin dust effectively controlled the white ants?

    YES (   )   NO (   )

11. Alderin dust costs 45 [illegible] a packet,

    a) do you intend to buy some next year? YES (   ) NO (   )

    b) where could you buy it?

    c) on which crops will you use it?

12. If you grow our maize again next year which of the practices we suggested would you follow, which would you change to suit your needs?

	Change*	How practice modified
plot preparation		
spacing of stands		
date of planting		
no. plants stand		
sole crop maize		
fertilizer at planting		
fertilizer at 4-5 weeks		
early weeding		
later weeding		
insect control		

* yes or no, if yes, fill in right side column.

13. Which of the management practices we have just been talking about do you think most importantly influenced your maize yields?

14. What factors do you think mainly limited the yield of your maize?

15. Would you plant this variety of maize next year using our recommendations if you had to pay for the fertilizer and aldrin dust?

YES ( ) No ( )

16. If you had $ 1- to spend on your maize crop, how would you spend it to get the highest return from the $ 1-?

17. Do you prefer to grow maize as a sole crop or as an intercrop?

Sole crop ( ) Intercrop ( )

18. Why do most people prefer to grow maize as an intercrop?
("Because of tradition" is not an accepted answer....probe on this one: there may be several reasons)

19. If you had grown our maize as an intercrop on the same plot size as used this year, how much do you think your maize yields would have been reduced?
not at all ( ) by 1/4( ) by 1/2( ) by 3/4 ( )

20. What are you going to do with the white maize you grew this year?

% consumed as green cobs	% consumed as dry cobs	% sold	% kept for seed
( )	( )	( )	( )

21. How will you store your maize?

22. If you were to sell 1 cigarette cup of our white maize (dry) in the market, based on your past experiences, how much do you think you would receive for it?
now
after christmas
just after planting time next year

23. You have just told me the price of maize is ________ kobo a cigarette cup higher in February-March than it is now. What prevents you storing more maize and so making more money when the prices are higher?

24. In what ways is our maize better than your varieties?

25. In what ways is your maize variety better than our maize?

26. How does the taste of our maize compare with your maize?
better ( ) about the same ( ) worse ( )

27. Thank you for your help, but before I go, would you please tell me how you think we all could have done a better job in growing the maize?

APPENDIX VI: PRICES AND PRICE VARIATIONS OF MAJOR CROPS IN EASTERN NIGERIA

Table 20: Monthly Prices of Major Arable Crops in the Local Market of Ndoro (Umuahia Division), E.C.S. of Nigeria. Period: August 1974-July 1975.

Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1. Cowpeas	25	45	30	30	25	25	25	25	25	25	25	25
2. Yam	15	13	15	14	18	20	12	23	15	18	18	26
3. Cassava	3	2	3	3	3	4	4	4	5	4	5	5
4. Cocoyam	10	10	10	10	10	10	10	10	10	10	10	10*
5. Maize	6	7	10	20	13	25	27	45	35	35	20	35
6. Okra	20	15	15	30	50	25	30	50	50	25	20	25
7. Groundnut	16	16	18	16	16	20	20	18	20	20	20	20
8. Vegetables	25	25	25	25	25	25	25	25	25	25	25	25*
9. Telferia	25	25	25	25	25	25	25	25	25	25	25	25*
10. Melon(with shells)	30	30	30	60	90	45	53	53	63	75	75	88
11. Pumpkin	10	10	10	10	10	10	10	10	10	10	10	10*
12. Tomatoes	30	20	20	30	40	30	40	40	30	40	40	40
13. Beans	35	50	40	30	25	30	30	40	35	35	35	35
14. Pineapple	6	6	7	4	6	10	10	6	10	6	10	5
15. Pepper	35	40	35	35	35	40	45	60	75	60	75	80
16. Fluted pumpkin	3	3	3	3	4	6	7	7	9	7	6	4
17. Onions	15	15	15	15	15	15	15	15	15	15	15	15*

Notes: Prices were collected bimonthly. * Prices are estimated.

Source: compiled by the author.

Table 21: Monthly Prices of Major Arable Crops in the Local Market of Enyiogugu (Mbaise Division), E.C.S. of Nigeria. Period: August 1974-July 1975.

Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1. Cowpeas	16	18	[illegible]	[illegible]	[illegible]	24	22	[illegible]	20	20	20	16
2. Yam	13	15	[illegible]	12	12	12	17	17	23	22	16	16
3. Cassava	3	4	4	5	5	6	6	10	6	15	6	5
4. Cocoyam	8	5	10	11	12	13	16	17	19	29	21	9
5. Maize	4	5	15	[illegible]	22	[illegible]	26	31	31	48	26	15
6. Okra	25	35	25	20	25	[illegible]	[illegible]	[illegible]	[illegible]	40	20	15
7. Groundnut	13	12	13	[illegible]	[illegible]	17	15	25	[illegible]	35	32	15
8. Vegetables	25	25	25	25	25	25	25	25	25	25	25	25*
9. Telferia	25	25	25	25	25	25	25	25	25	25	25	25*
10. Melon(with shells)	25	25	25	25	25	33	33	55	55	55	80	100
11. Pumpkin	10	10	10	10	10	10	10	10	10	10	10	10*
12. Tomatoes	[illegible]	30	20	20	40	40	40	50	30	30	30	25
13. Beans	40	40	40	40	[illegible]	32	32	36	36	36	32	28
14. Pineapple	8	8	15	5	15	4	8	8	8	8	7	8
15. Pepper	30	20	20	25	[illegible]	30	25	60	35	45	35	40
16. Fluted pumpkin	5	5	5	7	11	5	7	10	11	7	7	5
17. Onions	15	15	15	15	15	15	15	15	15	15	15	15*

Notes: Prices were collected bimonthly. * Prices are estimated.

Source: compiled by the author.

Table 22: Monthly Prices of Major Arable Crops in the Local Market of Owerre-Ebeiri (Orlu Division), E.C.S.of Nigeria. Period: August 1974-July 1975. Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1. Cowpeas	18	16	15	20	24	25	23	20	21	23	25	20
2. Yam	13	11	10	10	13	10	13	17	23	21	21	20
3. Cassava	4	4	3	3	3	3	5	8	8	9	10	8
4. Cocoyam	7	6	5	6	11	10	13	17	15	14	15	20
5. Maize	6	9	9	9	13	13	24	24	20	20	8	6
6. Okra	30	30	10	16	40	36	44	30	30	40	40	40
7. Groundnut	20	15	15	15	17	17	17	17	17	17	25	25
8. Vegetables	25	25	25	25	25	25	25	25	25	25	25	25*
9. Telferia	25	25	25	25	25	25	25	25	25	25	25	25*
10. Melon(with shells)	38	38	43	38	38	60	60	55	60	50	75	64
11. Pumpkin	10	10	10	10	10	10	10	10	10	10	10	10*
12. Tomatoes	30	30	10	10	40	32	54	30	30	40	40	40
13. Beans	35	40	40	25	25	32	32	32	35	35	35	35
14. Pineapple	5	4	3	5	2	4	6	6	5	6	7	6
15. Pepper	25	25	30	30	30	40	45	50	50	50	50	40
16. Fluted pumpkin	4	5	4	3	5	5	6	5	6	5	4	3
17. Onions	15	15	15	15	15	15	15	15	15	15	15	15*

Notes: Prices were collected bimonthly. * Prices are estimated.

Source: compiled by the author

Table 23: Monthly Prices of Major Arable Crops in the Market of Onitsha, E.C.S.of Nigeria. Period: Jan.-Dec.1973. Prices in Kobo per kg

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Cowpea	20	20	20	20	20	20	20	20	20	20	20	20
2. Yam	11	12	13	15	15	16	16	17	14	12	12	12
3. Cassava	03	03	03	03	04	04	04	04	04	04	03	03
4. Cocoyam	10	10	10	10	10	10	10	10	10	10	10	10(1)
5. Maize	08	08	08	12	13	13	10	10	10	10	10	08
6. Okra	21	22	30	29	29	19	15	14	17	16	17	24
7. Groundnut	21	18	19	17	18	20	21	21	22	25	25	25
8. Vegetables	25	25	25	25	25	25	25	25	25	25	25	25(2)
9. Telferia	25	25	25	25	25	25	25	25	25	25	25	25(2)
10. Melon(with shells)	31	30	29	25	25	25	27	28	29	30	30	30
11. Pumpkin	10	10	10	10	10	10	10	10	10	10	10	10(3)
12. Tomatoes	28	31	24	30	30	34	37	37	39	27	26	25
13. Beans	22	24	27	25	21	24	27	28	28	41	50	37
14. Pineapple	11	10	11	9	11	11	11	11	8	9	9	9
15. Pepper	37	38	37	36	32	30	32	37	34	36	38	43
16. Fluted pumpkin	6	7	7	9	7	6	4	3	3	3	3	4(3)
17. Onions	20	20	21	16	13	14	15	18	18	17	17	23

Notes: 1) average price in 1973, 2) estimated prices for the 3 survey villages, 3) prices from Ndoro market.
These prices are used to compare the monetary output between the 3 villages.

Source: MINISTRY OF ECONOMIC DEVELOPMENT: Retail Market Prices of Foodstuffs in East Central State of Nigeria, Enugo, E.C.S.of Nigeria, 1974.

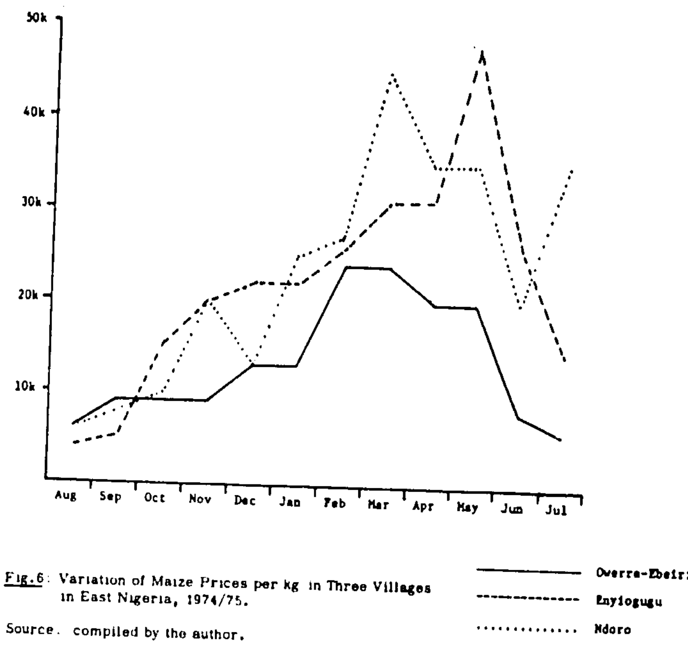


Fig.6: Variation of Maize Prices per kg in Three Villages in East Nigeria, 1974/75.

Source. compiled by the author.

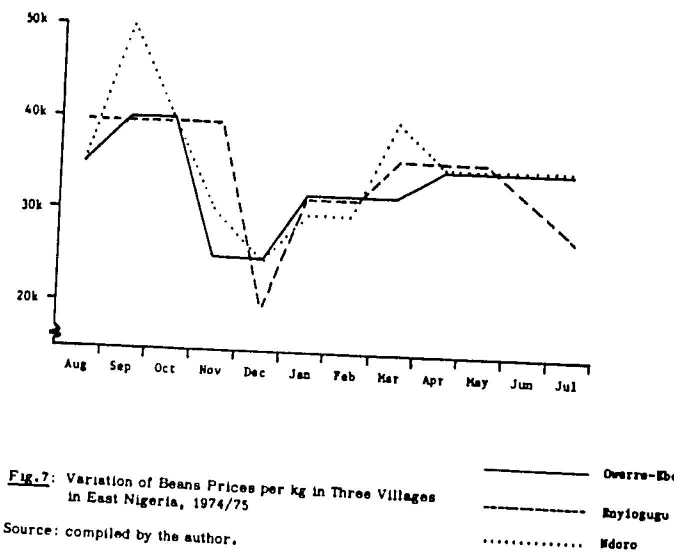


Fig.7: Variation of Beans Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

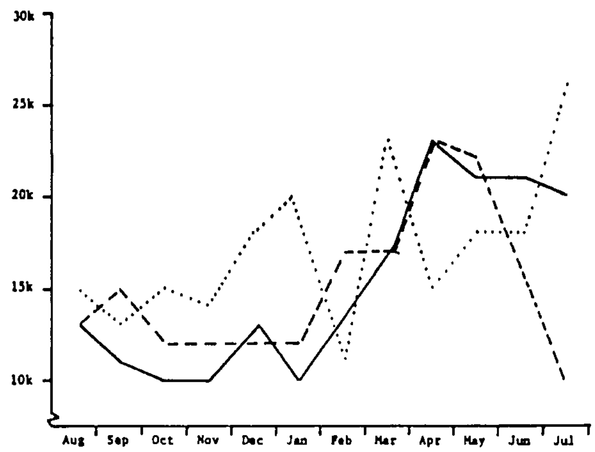
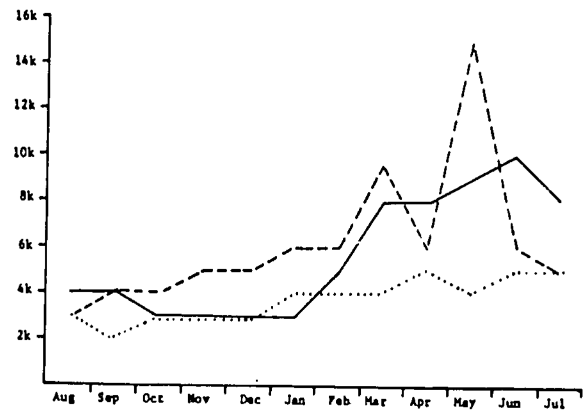


Fig.8: Variation of Yam Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

———— Owerre-Ebeiri
------------ Enyiogugu
.... Ndoro



———— Owerre-Ebeiri
------------ Enyiogugu
.... Ndoro

Fig.9: Variation of Cassava Roots Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

Fig. 10: Variation of Groundnut Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

———— Owerre-Ebeiri
- - - - - Enyiogugu
. . . . . . Ndoro

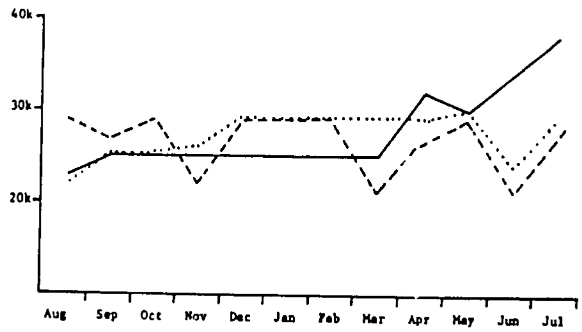


Fig. 11: Variation of Palm Oil Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

———— Owerre-Ebeiri
- - - - - Enyiogugu
. . . . . . Ndoro

Table 24: Monthly Prices of Major Tree Crops in the Local Market of Ndoro (Umuahia Division), E.C.S. of Nigeria. Period: August 1974-July 1975
Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Oil palm	2	2	2	2	2	2	2	2	2	2	2	3
Palm oil	22	25	25	26	29	29	29	29	29	23	24	29
Raffia palm wine	3	3	3	3	7	8	9	5	11	12	3	5
Kolanut	25	30	30	25	40	15	25	30	40	40	25	20
Coconut	6	5	4	5	4	[illegible]	7	14	20	12	10	14
Pear	12	14							10	10	8	10
Orange	4	5	10	9	10	5	9	10	12	20	10	8
Cocoa	5	4	6	8	5	10	10	7	6	5	5	4
Banana	5	6	6	5	6	5	8	9	10	9	8	10
Plantain	6	7	6	6	7	10	11	9	12	11	13	11
Paw paw	1	3	5	2	2	6	6	3	5	3	2	5
Mango								5	5	7	10	
Breadfruit	3	4	4	5	5	4	4	4	4	4	3	6
Oilbeans	30	30	30	30	30	30	30	30	30	30	30	30*
Guava	5	5	5	5							5	5*

Notes: Prices were collected bimonthly. *Prices are estimated.

Source: compiled by the author.

Table 25: Monthly Prices of Major Tree Crops in the Local Market of Enyiogugu (Mbaise Division), E.C.S.of Nigeria. Period: August 1974-July 1975.
Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Oil palm	2	3	3	2	3	3	3	2	3	[illegible]	2	[illegible]
Palm oil	29	27	29	22	29	29	29	21	26	29	21	[illegible]
Raffia palm wine	4	6	4	2	7	3	3	10	12	12	1	[illegible]
Kolanut	14	16	17	18	24	23	23	24	30	42	16	[illegible]
Coconut	6	7	10	20	10	10	8	8	[illegible]	11	8	7
Pear	6	12	14	15						10	[illegible]	4
Orange	4	6	7	6	5	10	10	3	4	25	[illegible]	[illegible]
Cocoa	2	1	2	8	5	7	5	4	4	4	6	[illegible]
Banana	8	8	5	8	8	7	8	10	15	13	12	13
Plantain	8	9	8	11	9	9	9	15	10	16	14	9
Paw paw	1	4	3	2	2	2	1	2	1	2	1	1
Mango								4	4	10	10	
Breadfruit	4	5	4	5	4	6	6	1	2	6	5	6
Oil beans	25	30	34	28	23	24	24	26	29	55	47	22
Guava	5	5	5	5							5	5*

Notes: Prices were collected bimonthly. * Prices are estimated.

Source: compiled by the author.

Table 26: Monthly Prices of Major Tree Crops in the Local Market of Owerre/ Ebeiri (Orlu Division), E.C.S.of Nigeria. Period: August 1974-July 1975. Prices in Kobo per kg

Crop	1974					1975						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Oil palm	2	2	2	2	2	2	2	2	2	3	3	3
Palm oil	23	25	25	25	25	25	25	25	32	30	34	38
Raffia Palm wine	4	4	3	6	9	8	6	12	14	12	10	10
Kolanut	22	25	28	35	33	40	50	38	60	60	30	40
Coconut	3	3	4	5	3	5	5	5	9	6	5	5
Pear	8	8	8							30	22	8
Orange	2	2	4	5	3	5	10	7	6	8	5	4
Cocoa		4	3	3	3							
Banana	5	6	6	7	6	7	7	7	8	15	10	6
Plantain	6	6	8	5	7	8	10	12	13	10	11	8
Pawpaw	1	2	1	1	1	2	3	3	3	2	3	3
Mango								10	11	9	12	
Breadfruit	4	6	8	7	7	6	5	4	7	2	6	5
Oilbeans	17	19	22	20	33	33	30	38	36	40	38	34
Guava	5	5	5	5							5	5*

Notes: Prices were collected bimonthly. * Prices are estimated.

Source: compiled by the author.

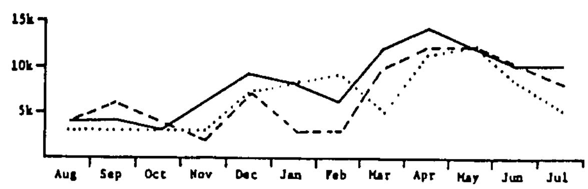
Table 27: Monthly Prices of Major Tree Crops in the Market of Onitsha, E.C.S. of Nigeria. Period: Jan - Dec 1973. Prices in Kobo per kg

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Oil palm	1	2	2	1	1	1	2	2	2	3	3	3(1)
Palm oil	18	21	21	16	16	19	21	21	24	28	28	29
Palm wine	6	6	9	12	12	9	8	4	4	3	4	8(3)
Kolanut	26	33	31	43	47	24	30	20	24	25	26	32(3)
Coconut	8	9	9	9	8	9	9	9	9	9	10	9
Pear				10	17	12	7	9	11	11	15	(3)
Orange	9	10	14	14	11	12	14	12	10	8	17	7
Cocoa	8	7	6	5	5	6	4	4	3	4	6	4(3)
Banana	10	11	20	12	13	12	12	11	10	9	8	9
Plantain	11	12	21	13	14	13	13	12	11	10	9	10(2)
Pawpaw	3	3	3	3	2	2	3	1	3	3	2	2(3)
Mango			6	7	7	11						(3)
Breadfruit	5	5	3	4	4	5	6	4	5	5	6	5(3)
Oilbeans	29	28	31	32	42	43	28	21	25	28	24	28(3)
Guava						5	5	5	5	5	5	*

Notes: 1) Prices derived from Palm oil prices. 2) Prices derived from Banana prices. 3) Prices from Onitsha market are not available for these products; figures are average prices from Ndoro, Enyiogugu and Owerre-Ebeiri markets. * Prices are estimated

These prices are used to compare the monetary output between the 3 villages.

Source: MINISTRY OF ECONOMIC DEVELOPMENT: Retail Market Prices of Foodstuffs in East Central State of Nigeria, Enugo, E.C.S. of Nigeria, 1974.



Overre-Ebeiri
Enyiogugu
Ndoro

Fig.12: Variation of Raffia Palm Wine Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

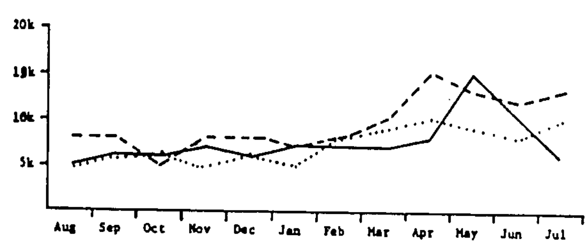


Fig.13: Variation of Banana Prices per kg in Three Villages in East Nigeria, 1974/75

Source: compiled by the author.

Overre-Ebeiri
Enyiogugu
Ndoro

APPENDIX VII: DETAILS ON LABOUR INPUT

1. Seasonal Distribution of Field Work

Table 28: Seasonal Distribution of Field Work in Okwe(L), 1974/75

Activity		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Clearing	A	833.7	2977.8	817.6	35.0		42.0						119.0	4825.1
	B	3.93	14.04	3.85	.16		.20						.56	22.74
Burning	A	38.5	63.0	532.7	69.3	14.0								717.5
	B	.18	.30	2.51	.33	.07								3.39
Ridging +	A			7.0	21.0									28.0
Mounding	B			.03	.10									.13
Planting	A		273.0	2177.0	3433.5	154.7	420.0							6458.2
	B		1.29	10.26	16.19	.73	1.98							30.41
Staking	A			115.5	178.5	339.5	42.0							675.5
	B			.54	.84	1.60	.20							3.18
Thinning	A							61.6						61.6
	B							.29						.29
Weeding	A				401.8	1138.9	2153.9	699.3	1004.5	1196.3	588.8	238.7	205.8	1627.2
	B				1.89	5.37	10.15	3.30	4.74	5.64	2.78	1.13	.97	35.97
Fertilizing	A				70.0								10.5	80.5
	B				.33								.04	.37
Harvesting	A						.7	11.9	36.4	65.1	151.2	420.7	53.9	739.9
	B							.06	.17	.31	.71	1.98	.25	3.48
Total	A	872.2	3313.8	3649.8	4209.1	1647.1	2658.6	772.8	1040.9	1261.4	739.2	659.4	389.2	21,213.5
	B	4.11	15.63	17.19	19.84	7.77	12.53	3.65	4.91	5.95	3.49	3.11	1.82	100.00

Figures are total man-hours of 24 households; time spent on tree crops is not included.
A = man-hours per month. B = % of annual work on the land.

Source: compiled by the author.

Table 29: Seasonal Distribution of Field Work in Umuokile (M), 1974/75

Activity		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Clearing	A	1189.3	1036.0	268.8							.7	42.0		2536.8
	B	12.34	10.75	2.79								.44		26.32
Burning	A	67.9	92.4	32.9										193.2
	B	.70	.96	.34										2.00
Ridging +	A				14.0	5.6					.7	6.3		26.6
Mounding	B				.15	.06						.07		.28
Planting	A	82.6	541.1	2331.7	521.5	143.5		2.8		6.3	7.0	6.3	2.1	3644.9
	B	.86	.56	24.20	5.41	1.49		.3		.07	.07	.07	.2	37.84
Staking	A		131.6	82.6	61.6	11.9								287.7
	B		1.37	.86	.64	.12								2.99
Thinning	A													
	B													
Weeding	A			12.6	296.1	1031.8	635.6	501.9	44.8	50.4	11.2	.7		2585.1
	B			.13	3.07	10.71	6.60	5.21	.46	.52	.12			26.82
Fertilizing	A													
	B													
Harvesting	A					3.5	117.6	77.0	58.8	56.0	9.1	5.6	33.6	361.2
	B					.04	1.22	.80	.61	.58	.09	.06	.35	3.75
Total	A	1339.8	1801.1	2728.6	893.2	1196.3	753.2	581.7	103.6	112.7	28.7	60.9	35.7	9635.5
	B	13.90	18.70	28.32	9.27	12.42	7.82	6.04	1.07	1.17	.28	.64	.37	100.00

Figures are total man-hours of 25 households; time spent on tree crops is not included.

A = man-hours per month.
B = % of annual work on the land.

Source: compiled by the author.

Table 30: Seasonal Distribution of Field Work in Owerre-Ebeiri (H), 1974/75

Activity		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Clearing	A	28.0	576.8	1031.1	1039.5	170.8	25.2	45.5	196.0	105.7			2.8	3221.4
	B	.16	3.24	5.79	5.84	.96	.14	.26	1.10	.59			.01	18.09
Burning	A	14.0	77.0	375.9	591.5	62.2	2.8							1128.4
	B	.78	.43	2.11	3.32	.38	.01							6.33
Ridging + Mounding	A	18.2	13.3	633.5	1227.1	504.0	33.5	57.4	108.5	202.3	20.3			2818.1
	B	.10	.07	3.56	6.89	2.83	.19	.32	.61	1.14	.11			15.82
Planting	A	6.3	17.5	817.6	1444.8	786.8	178.5	79.8	79.1	116.2	15.4			3542.0
	B	.04	.10	4.59	8.11	4.42	1.00	.45	.44	.65	.09			19.89
Staking	A		14.0	94.5	324.8	518.7	348.6	1.4	2.8	.7				1305.5
	B		.08	.53	1.82	2.91	1.96		.01					7.31
Thinning	A							2.1	38.5	14.7	6.3		5.6	67.2
	B							.01	.22	.08	.04		.03	.38
Weeding	A			9.1	119.0	660.8	1148.7	457.8	522.9	529.9	158.9	197.4	296.8	4101.3
	B			.05	.67	3.71	6.45	2.57	2.94	2.97	.89	1.11	1.67	3.03
Fertilizing	A				3.5	7.0		16.8	7.0					34.3
	B				.02	.04		.09	.04					.19
Harvesting	A	50.4			11.2		21.0	133.7	207.2	243.6	67.9	324.1	537.6	1596.7
	B	.28			.06		.12	.75	1.16	1.37	.38	1.82	3.02	8.96
Total	A	116.9	698.6	2961.7	4761.4	2715.3	1758.3	794.5	1162.0	1213.1	268.8	521.5	842.8	17814.9
	B	.66	3.92	16.63	26.73	15.25	9.87	4.45	6.52	6.80	1.51	2.93	4.73	100.00

Figures are total man-hours of 25 households; time spent on tree crops is not included.

A = man-hours per month.
B = % of annual work on the land.

Source: compiled by the author.

2. Seasonal Distribution of Family and Non-family Labour

Table 31: Seasonal Distribution of Family and Non-family Labour for Major Acticities in Three Villages in Eastern Nigeria, 1974/75

Activity														
Clearing	A	949.9	1813.7	1222.9	518.7	170.8	46.2	25.9	187.6	64.4	.7	42.0	2.6	5045.6
	B	1101.1	2776.9	894.6	555.8		27.0	19.6	8.4	41.3			119.0	5543.7
Burning	A	92.4	197.4	51[illegible].4	490.0	67.2	2.8							136[illegible].2
	B	28.0	35.0	429.1	170.8	14.0								676.9
Ridging +	A	18.2	13.3	472.5	701.4	105.7	9.8	34.3	77.0	141.4	21.0	6.3		1600.9
Mounding	B			168.0	560.7	403.9	23.8	23.1	31.5	60.9				1271.9
Planting	A	88.9	740.6	4006.8	3378.9	887.6	325.5	82.6	59.5	91.0	22.4	6.3	2.7	9692.8
	B		91.0	1319.5	2020.9	197.4	273.0		19.6	31.5				3952.9
Staking	A		145.6	254.1	480.9	709.1	208.6	1.4	2.8	.7				1803.2
	B			38.5	84.0	161.0	182.0							465.5
Thinning	A							63.7	26.6	14.7	6.3			111.3
	B								11.9				5.6	17.5
Weeding	A			21.7	438.9	1795.5	2276.4	871.5	852.6	798.0	436.1	296.1	410.9	8197.7
	B				378.0	1036.0	1661.8	787.5	719.6	978.6	322.0	140.7	93.1	6117.3
Fertilizing	A				3.5	7.0		11.2	7.0				10.5	39.2
	B				70.0			5.6						75.6
Harvesting	A	50.4			11.2	3.5	139.3	222.6	302.4	364.0	222.6	749.0	539.0	2604.0
	B									.7	5.6	1.4	86.1	93.8
Total	A	1199.8	2910.6	6490.4	6023.5	3746.4	3008.6	1313.2	1515.5	1474.2	709.1	1099.7	965.3	30,456.3
	B	1129.1	2902.0	2849.7	3840.2	1812.3	2161.6	835.8	791.0	1113.0	327.6	142.1	303.8	18,209.1

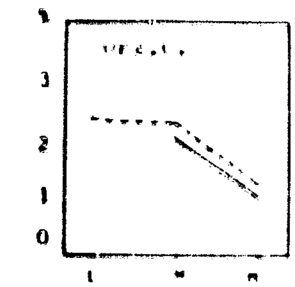
Figures are total man-hours of 74 households; time spent on tree crops is not included.

A = Family Labour in man-hours. B = Non-family Labour in man-hours.

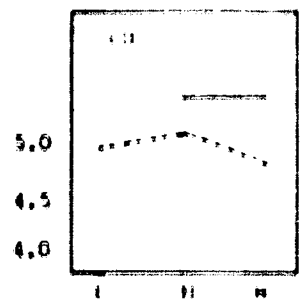
Source: compiled by the author.

APPENDIX VIII: DETAILS ON SOIL FERTILITY INDICATORS

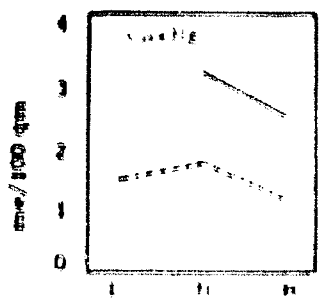
Fig. 14: Comparison of Soil Fertility Indicators between Villages and Plot Types



Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C N	M - H	N.S.	L	N - D	N.S.
	L - M	N.S.	M	C - N	N.S.
	L - H	H.S.		C - D	N.S.
	M - H	H.S.		N - D	S.
D	L - M	H.S.	H	C - N	N.S.
	L - H	H.S.		C - D	N.S.
	M - H	H.S.		N - D	N.S.

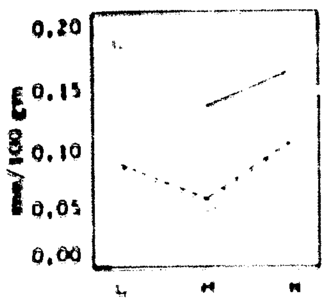


Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C N	M - H	N.S.	L	N - D	N.S.
	L - M	N.S.	M	C - N	H.S.
	L - H	N.S.		C - D	H.S.
	M - H	H.S.		N - D	N.S.
D	L - M	S.	H	C - N	N.S.
	L - H	S.		C - D	H.S.
	M - H	H.S.		N - D	S.

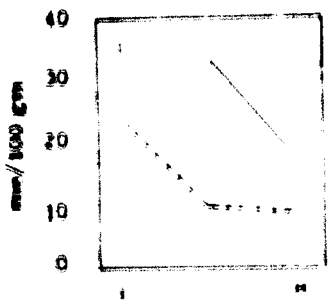


Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C N	M - H	S.	L	N - D	S.
	L - M	N.S.	M	C - N	H.S.
	L - H	N.S.		C - D	H.S.
	M - H	N.S.		N - D	N.S.
D	L - M	N.S.	H	C - N	N.S.
	L - H	N.S.		C - D	H.S.
	M - H	H.S.		N - D	N.S.

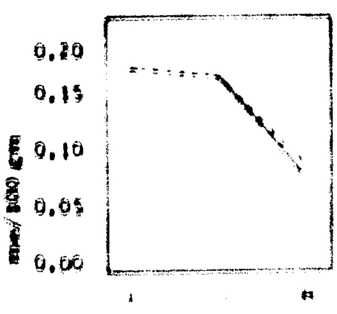
Plot Type ____ Compounds (C), -------Near fields (N), ...Distant fields



Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C	M - H	N.S.	L	N - D	N.S.
N	L - M	N.S.	M	C - N	H.S.
	L - H	N.S.		C - D	H.S.
	M - H	H.S.		N - D	N.S.
D	L - M	N.S.	H	C - N	H.S.
	L - H	N.S.		C - D	H.S.
	M - H	N.S.		N - D	N.S.



Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C	M - H	H.S.	L	N - D	H.S.
N	L - M	H.S.	M	C - N	H.S.
	L - H	H.S.		C - D	H.S.
	M - H	N.S.		N - D	N.S.
D	L - M	N.S.	H	C - N	H.S.
	L - H	N.S.		C - D	H.S.
	M - H	N.S.		N - D	N.S.



Plot Type	Village	Signif.1)	Village	Plot Type	Signif.
C	M - H	H.S.	L	N - D	N.S.
N	L - M	N.S.	M	C - N	N.S.
	L - H	H.S.		C - D	N.S.
	M - H	H.S.		N - D	N.S.
D	L - M	N.S.	H	C - N	N.S.
	L - H	H.S.		C - D	[illegible]
	M - H	H.S.		N - D	N.S.

1) These are the results of tests of statistical significance of the difference between the two means. 'Not significant' implies that the difference is small in relation to the remaining variation within the groups.

Source: Soil sampling under the direction of F. H. MÖCKELMANN, Field guest at IITA. Analysis conducted by Analytical Services Laboratory, IITA.

APPENDIX IX: DETAILS ON GROSS RETURNS FROM CROP PRODUCTION

Table 32: Average Gross Returns from Major Arable Crops in Three Villages in Eastern Nigeria, 1974/75

Local Market Prices (1974/75)

	Okwe			Umuokile			Owerre-Ebeiri		
	mean	n	CV as %	mean	n	CV as %	mean	n	CV as %
Cowpeas	-	-	-	-	-	-	0.65	16	77
Yam	67.89	21	134	51.97	25	110	46.69	25	65
Cassava	132.69	24	87	49.36	25	131	19.33	25	63
Cocoyam	37.28	4	153	19.94	22	109	36.21	25	59
Maize	21.24	17	149	7.52	25	119	7.52	25	106
Okra	1.59	6	90	1.8	20	81	4.13	23	120
Groundnut	0.11	1	-	11.25	19	150	-	-	-
Vegetables	2.65	24	172	3.51	25	79	1.59	25	96
Telferia	11.91	24	100	5.32	25	55	4.12	25	91
Melon	39.34	20	105	19.50	3	169	3.64	8	152
Pumpkin	9.02	4	109	0.96	10	67	1.26	24	82
Tomato	4.63	1	-	0.76	8	119	0.72	6	101
Beans	7.87	10	115	-	-	-	1.04	9	81
Pineapple	0.6	7	108	1.23	13	107	0.67	7	97
Pawpaw	0.39	4	165	1.03	25	78	1.86	24	160
Fl.Pumpkin	16.26	9	106	7.49	6	141	0.96	20	101
Onions	-	-	-	0.37	1	-	0.34	1	-
Total	280.75			151.67			119.71		

Onitsha Market Prices (1973)

	Okwe			Umuokile			Owerre-Ebeiri		
	mean	n	CV as %	mean	n	CV as %	mean	n	CV as%
Cowpeas	-	-	-	-	-	-	0.72	16	73
Yam	47.73	21	134	51.53	25	110	48.79	25	67
Cassava	165.77	24	95	38.63	25	102	15.28	25	68
Cocoyam	27.28	4	153	16.01	22	125	35.20	25	56
Maize	19.38	17	90	11.16	25	117	3.14	24	109
Okra	1.21	6	83	1.58	20	83	2.08	23	112
Groundnut	0.12	1	-	20.33	19	164	-	-	-
Vegetables	2.65	24	172	3.51	25	79	1.59	25	96
Telferia	11.91	24	100	5.32	25	55	4.16	25	90
Melon	18.03	19	101	7.83	3	160	1.99	8	142
Pumpkin	9.02	4	109	0.96	10	67	1.26	24	82
Tomato	3.64	1	-	0.83	8	147	0.9	6	140
Beans	9.37	10	118	-	-	-	0.91	9	91
Pineapple	1.06	5	91	1.77	13	82	1.5	7	89
Pawpaw	0.2	5	102	1.12	25	83	1.38	23	134
Fl.Pumpkin	16.26	9	106	4.10	6	130	1.18	21	106
Onions	-	-	-	0.42	1	-	0.39	1	-
Total	270.11			145.99			115.59		

Notes: Figures are average values in Naira. n = number of farmers which have harvested the crop.
Total No. of Farmers: Okwe: n = 24, Umuokile: n = 25, Owerre-Ebeiri: n = 25.

Source: compiled by the author.

Table 33: Average Gross Returns from Major Tree Crops in Three Villages in Eastern Nigeria, 1974/75

	Local Market Prices (1974/75)									Onitsha Market Prices (1973)								
	Okwe			Umuokile			Owerre-Ebeiri			Okwe			Umuokile			Owerre-Ebeiri		
	mean	n	CV as %	mean	n	CV as %	mean	n	CV as %	mean	n	CV as %	mean	n	CV as %	mean	n	CV as %
Oilpalm	93.98	23	158	15.73	23	70	31.02	25	69	78.61	23	160	13.88	23	73	25.57	25	72
Raffiawine	26.16	20	78	84.43	22	108	24.19	15	119	29.64	20	76	89.09	22	106	21.16	15	120
Kolanut	12.95	18	109	13.30	12	81	11.02	8	63	12.38	18	101	19.61	12	82	8.70	8	64
Coconut	3.88	15	108	19.69	12	123	7.58	21	94	4.00	15	100	17.92	12	125	13.21	21	93
Pear	[illegible]	8	98	2.34	18	69	3.07	24	119	0.84	14	100	3.34	18	70	7.78	24	114
Citrus	[illegible]	15	105	5.17	15	105	0.51	4	92	2.42	15	102	7.79	15	96	1.30	9	92
Cocoa	3.46	4	109	8.26	4	82	1.16	1	90	2.92	4	111	7.57	4	82	2.70	2	116
Banana	18.35	23	99	2.89	16	76	3.03	21	74	28.21	23	98	3.63	16	73	5.00	21	86
Plantain	10.54	22	87	3.14	17	72	6.13	21	105	13.62	22	84	3.63	17	74	8.39	21	108
Pawpaw	0.45	16	74	1.43	18	70	0.58	14	76	0.32	16	72	1.81	18	76	0.95	14	88
Mango	2.73	2	5	3.99	1	-	3.67	10	101	2.86	2	1	2.79	1	-	3.14	10	102
Breadfruit	0.30	4	72	1.73	5	45	23.33	20	130	0.32	4	63	2.15	5	52	21.96	20	135
Oilbean	1.34	1	0	43.59	7	163	10.83	14	229	0.94	1	-	43.22	7	157	11.18	14	236
Guava	0.00		-	0.73	10	124	0.70	7	147	0.00		-	0.73	10	124	0.70	7	146
Firewood	15.64	22	147	0.22	7	72	1.20	8	84	15.64	22	147	0.22	7	72	1.20	8	84
Total	168.45			128.83			99.40			168.74			136.60			97.77		

Source: compiled by the author.

APPENDIX X: DETAILS ON NON-FARM INCOME AND EXPENDITURE

1. Non-farm Income

Table 34: Average Sums of Non-farm Income (in Naira) in Three Villages in Eastern Nigeria, 1974/75

		employment	trading	pension	gift	credit repayment	other
Okwe (L)	mean	129.09	159.00	197.75	48.68	14.00	3.66
	n	22	12	4	19	2	6
	CV as %	241	293	111	131	101	92
Umuokile (M)	mean	120.16	163.75	147.00	38.26	250.00	19.16
	n	18	16	15	23	1	18
	CV as %	112	93	243	202	-	207
Owerre-Ebeiri (H)	mean	243.44	373.36	50.20	36.75	48.66	41.64
	n	25	25	5	16	6	17
	CV as %	110	183	108	165	181	182

Note: Figures indicate average amounts of n-farmers in the village

Source: compiled by the author.

Table 35: Variation of Average Non-farm Income (in Naira) over the Year in Three Villages in Eastern Nigeria, 1974/75

weeks	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52
Okwe	44	24	15	21	18	27	21	15	11	23	23	22	36
Umuokile	16	32	21	32	39	35	29	34	6	12	10	15	67
Owerre-Ebeiri	25	32	34	41	70	77	122	86	11	42	51	74	57

Note: These figures include the amounts derived from the 'Esusu' credit groups.

Source: compiled by the author.

2. Expenditure

Table 36: Average Sums of Major Farm Expenses in Three Villages in Eastern Nigeria, 1974/75

Village		Labour	Land Rent	Planting Materials	Livestock Feed	Animals
Okwe	mean	38.85	21.42	2.79	13.89	7.66
	n	23	10	13	6	17
	CV as %	99	96	165	215	90
Umuokile	mean	9.98	12.00	0.89	1.00	3.41
	n	25	1	4	1	12
	CV as %	91	-	88	-	52
Owerre-Ebeiri	mean	14.40	63.26	24.48	3.18	4.41
	n	25	3	23	4	16
	CV as %	108	160	91	152	159

Table 37: Average Sums of Major Non-farm Expenses in Three Villages in Eastern Nigeria, 1974/75

Village		Trading	School Fees	Medical Exp.	Cloth	Housing	Transport	Bicycle	Festivals	Entertainments	Loan rtned.
Okwe	mean	130.52	42.65	25.27	27.19	33.82	8.42	4.14	3.33	3.83	7.60
	n	11	22	23	22	23	22	14	10	16	11
	CV as %	287	124	141	118	215	86	95	118	100	208
Umuokile	mean	142.23	45.16	26.96	18.67	16.89	7.97	8.65	0.71	4.91	0.15
	n	17	21	25	24	19	19	15	7	18	2
	CV as %	75	151	103	87	336	229	166	62	143	47
Owerre-Ebeiri	mean	141.19	138.83	50.21	32.63	39.72	25.97	7.16	16.61	33.57	88.28
	n	21	21	25	24	17	15	21	20	25	15
	CV as %	141	194	124	68	154	139	66	178	158	184

Table 38: Average Sums of Major Food Expenses in Three Villages in Eastern Nigeria, 1974/75

Village		Cassava	Yams	Gari	Cocoyams	Beans	Raffia Palmwine	Rice	Meat	Fish	Salt
Okwe	mean	10.31	8.04	0.76	0.38	2.83	24.09	11.79	20.78	55.86	6.48
	n	14	17	5	1	23	21	23	24	23	23
	CV as %	116	239	54	-	83	94	106	101	43	80
Umuokile	mean	6.60	6.25	37.10	6.04	1.22	2.83	5.50	8.69	31.01	3.18
	n	24	22	24	24	17	20	24	25	25	25
	CV as %	85	134	58	76	118	97	91	106	50	48
Owerre-Ebeiri	mean	32.87	24.14	49.85	4.40	10.78	12.70	26.55	20.86	31.22	4.50
	n	25	25	25	23	25	25	25	25	25	25
	CV as %	78	77	55	84	79	97	54	76	47	71

Sources: compiled by the author.

APPENDIX XI: DETAILS ON CHEMICAL ANALYSIS OF CROPS CONSUMED IN EASTERN NIGERIA

1. Nuts, Seeds and Mushrooms

Table 39: Analysis of Some Edible Nuts, Seeds and Mushrooms Consumed by Farm Families in Eastern Nigeria, 1974/75 1)

Description	Protein (Nx6.25)	Lysine g/100g	Tryptophane g/100g	Oil %	Starch %
Pleuritas sp. (mushroom)	9.5	1.9	1.0	0.3	22.2
Detarium microcarpum (seed)	12.0	0.7	0.2	12.0	35.4
Colocynthis vulgaris (egusi) seed	22.0	3.5	1.7	45.0	6.3
Irvingia gabonensis (agbone) seed	24.0	2.3	1.0	38.0	28.5
Pentaclethra macrophyllum (oil bean)	20.8	5.0	1.2	45.9	19.0
Mucuna urens (shelled)	22.4	5.0	0.9	14.4	40.3
Treculia africana (shelled) seed	19.0	3.7	1.3	15.8	40.3
Dacryodes edulis (native pear) fruit	10.0	0.37	0.10	16	3.08
Cola lepidota (aril)	8.75	0.28	0.18	1.14	2.26

1) Materials analysed by IITA Analytical Services Laboratory.

Source: LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: op.cit. Appendix B2.

2. Oil Seeds and Star Apple

Table 40: Analysis of Edible Oil Seeds and Star Apple Consumed by Farm Families in Eastern Nigeria, 1974/75

Sample	Protein %	Oil %	Total Sugar%	Starch %	Ca %	Mg %	K %	Mn ppm	Fe ppm	P %	S %	Zn %
Egusi (melon) black edges	32.6	55.2	5.80	6.4	0.15	0.45	0.70	40	231	0.83	0.50	70
Calabash seeds	35.4	47.9	6.04	9.4	).10	0.54	0.70	60	250	1.05	0.45	78
White melon seeds	36.3	50.4	6.64	7.6	0.10	0.54	0.70	40	250	1.10	0.36	72
Egusi brown coated	33.8	53.1	6.00	7.1	0.15	0.44	0.65	140	290	0.95	0.38	58
Star apple (Udarn*)	8.8	17.1	20.9*	11.0*	0.55	0.17	2.00	20	200	0.13	0.35	60

* The starch of the Udara must have been converted to sugar during ripening.
Materials analysed by IITA Analytical Services Laboratory.
Source: LAGEMANN, J., FLINN,J.C., OKIGBO,B.N. and MOORMANN, F.R.:op.cit., Appendix B2.

3. Vegetables

Table 41: Analysis of Leaf Vegetables Consumed by Farm Families in Eastern Nigeria, 1974/75

Species	PLANT TISSUE ANALYSIS								
	Total N %	Protein %	Total P %	Ca %	Mg %	K %	Mn ppm	Fe ppm	S %
Leaf Vegetables *Ocimum viridis*	4.67	29.2	0.41	2.05	0.63	3.40	100	460	0.22
Telfaira occidentalis	5.96	37.3	0.62	0.40	0.50	4.00	180	680	0.22
Pterocarpus soyauxii	5.14	32.1	0.40	0.50	0.30	2.50	80	100	0.23
Gnetum spp (Okazi)	2.75	17.2	0.21	1.15	0.41	1.00	700	380	0.19
Pennisetum purpureum	2.45	15.3	0.60	0.45	0.30	10.50	80	320	0.21
Editan E*	2.88	18.00	0.11	1.50	0.45	3.30		350	
Heinsia crinata	2.21	13.81	0.20	1.40	0.50	2.20		580	
Piper guineense	2.74	17.13	0.23	1.25	0.56	3.85		300	
Gnetum sp.	2.84	17.75	0.11	1.13	0.48	1.15		320	

E* = Efik. Materials analysed by IITA Analytical Services Laboratory.

Source: LAGEMANN, J., FLINN, J.C., OKIGBO, B.N.and MOORMANN, F.R.: op.cit., Appendix B3.

APPENDIX XII: DETAILS ON CROPPING PATTERNS AND RELATIONS

1. Cropping Mixtures

Table 42: Typical Cropping Mixtures on Compounds of Two Villages in Eastern Nigeria, June 1974

No	Crops	Number of crops in a mixture																																			
		Umuokile (M)												Owerre-Ebeiri (H)																							
		4			5			6			7			5			6			7			8			9			10			11			12		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1	Yam(1)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	Cassava				x		x	x			x	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x		x	x	x	x		x	x
3	Cocoyam	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
4	Maize			x				x	x			x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5	Melon													x	x					x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
6	Groundnuts											x																									
7	Okra						x									x			x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8	Telferia												x					x		x	x		x	x	x		x	x		x	x		x	x	x	x	x
9	Bitter leaf																	x	x				x	x		x	x			x	x	x					
10	Water leaf																				x												x	x		x	
11	Pepper		x		x	x			x	x	x	x	x				x	x				x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
12	Vegetables	x	x	x	x	x	x	x	x	x	x	x	x	x									x		x	x		x	x		x	x	x		x	x	x
13	Sweet potato																x																		x	x	
14	Tomato																									x				x							
15	Pineapple	x				x			x	x	x		x				x																				
16	Beans							x		x								x						x						x		x	x		x	x	x
17	Sugar cane										x																										
18	Pumpkin																												x								
19	Ukpo																												x								x
20	Ahiahara																																	x			x
21	Nchonwu																																	x	x		
22	Calabash																															x					
23	Alligator pepper																																		x		

(1) All different varieties are included.

Source: compiled by the author.

Table 43: Typical Cropping Mixtures on Near Fields of Three Villages in Eastern Nigeria, June 1974

No	Crops	Number of crops in a mixture																													
		Okwe (L)						Umuokile (M)									Owerre-Ebeiri (H)														
		3			4			3			4			5			4			5			6			7			8		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1	Yam (1)	x		x	x	x	x	x			x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	
2	Cassava	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x
3	Cocoyam					x			x		x		x	x	x	x		x	x	x		x	x		x	x	x	x	x	x	x
4	Maize	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5	Melon		x				x												x		x			x	x		x	x		x	
6	Groundnuts									x		x				x															
7	Okra																	x					x	x				x	x	x	x
8	Telferia			x	x		x									x	x			x	x			x	x	x	x	x	x		
9	Bitter leaf																													x	
10	Pepper												x									x	x								x
11	Vegetables														x														x		x
12	Tomato																									x				x	x
13	Pineapple													x																	
14	Beans																									x	x		x		x

(1) All different varieties are included.

Source: compiled by the author.

Table 44: Typical Cropping Mixtures on Distant Fields of Three Villages in Eastern Nigeria, June 1974

No	Crops	Number of crops in a mixture																														
		Okwe (L)												Umuokile (M)									Owerre-Ebeiri (H)									
		2			3			4			5			2			3			4			2		3		4		5		6	
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	a	b	a	b	a	b	a	b
1	Yam (1)			x					x	x	x	x	x			x	x			x								x		x		
2	Cassava	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3	Cocoyam										x								x	x					x	x	x	x	x		x	x
4	Maize	x			x	x		x	x	x		x	x	x			x	x	x	x	x	x			x		x	x	x	x	x	x
5	Melon		x		x		x	x	x	x	x	x	x									x				x				x	x	x
6	Groundnuts														x			x			x	x										
7	Okra																										x		x			x
8	Telferia			x						x	x	x																	x		x	x
9	Vegetables																							x							x	
10	Beans					x	x	x					x																	x		
11	Alligator pepper																				x											
12	Tomato																						x									

(1) All different varieties are included.

Source: compiled by the author.

Table 45: Average Occurrence of Different Crops in Compounds, Near and Distant Fields in Three Villages in Eastern Nigeria, June 1974

	Compounds		Near Fields			Distant Fields		
Village *	M	H	L	M	H	L	M	H
Yam	19.5	20.5	5.9	9.2	20.4	9.2	2.9	7.1
Cassava	5.8	12.1	47.4	45.2	24.6	53.6	51.7	66.1
Cocoyam	50.1	32.3	5.7	21.9	22.7	2.8	5.5	13.8
Maize	5.2	18.4	25.4	9.0	23.2	14.2	21.7	10.1
Okra	0.06	2.9	1.1		1.1	0.2		0.5
Melon		4.4	11.5	0.1	3.1	14.2	0.2	1.0
Telferia		2.0	2.1		2.1	2.7		0.4
Pumpkin		0.2	0.7			0.2		0.1
Tomato		0.1			0.05			0.5
Beans	0.02	1.6	0.2		0.3	2.3		0.4
Cowpeas		0.4			0.08	0.6		
Pineapple	1.0	0.1		3.1			0.01	
Pepper	(6) 18.3	1.4			2.0			
Sweet potato		0.1						
Bitter leaf		0.5			0.04			
Water leaf		0.3						
Ahihiara		0.8			0.01			
Ukpo		0.02			0.01			
Mmimi		0.03			0.01			
Vegetables	(3)	1.85		(4)	(2)		(5)	(1)
Groundnuts	0 02			11.5			18.0	

* Okwe (L), Umuokile (M), Owerre-Ebeiri (H).

(1) 1 plot - 100 % vegetables

In 5.1 % of the plots vegetables were grown in high density.
In 5.1 % of the plots vegetables were grown in medium density.
In 10.2 % of the plots vegetables were grown in low density.

(2) In 3.4 % of the plots vegetables were grown in high density.
In 11.9 % of the plots vegetables were grown in medium density.
In 20.4 % of the plots vegetables were grown in low density.

(3) In 91.7 % of the plots vegetables were grown in high density.
In 8.3 % of the plots vegetables were grown in low density.

(4) In 19 % of the plots vegetables were grown in high density.
In 6 % of the plots vegetables were grown in medium density.
In 19 % of the plots vegetables were grown in low density.

(5) In 1.5 % of the plots vegetables were grown in medium density.
In 1.5 % of the plots vegetables were grown in low density.

(6) Alligator pepper.

Dep. 1 m^2 vegetables per 1 - 200 crops - high density
1 m^2 vegetables per 100 - 200 crops - medium density
1 m^2 vegetables per 200 or more crops - low density

Source: compiled by the author.

Table 46a: No. of Different Crop Combinations Grown in the Compound Plot in Two Villages, June 1974

Village	Number of Crops in a Mixture															
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total Plots
Owerre-Ebeiri	1	1	2	7	3	7	5	11	5	10	4	2	1	1	1	62
Umuokile	0	1	3	2	8	3	1	0	1	0	0	0	0	0	0	25

Table 46b: No. of Different Crop Combinations Grown in the Near Fields in Three Villages, June 1974

Village	Number of Crops in a Mixture									
	1	2	3	4	5	6	7	8	9	Total Plots
Owerre-Ebeiri	0	3	0	8	6	11	5	7	1	55
Umuokile	2	1	6	2	2	1	0	0	0	16
Okwe	2	3	5	6	3	0	0	0	0	30

Table 46c: No. of Different Crop Combinations Grown in the Distant Fields in Three Villages, June 1974

Village	Number of Crops in a Mixture								
	1	2	3	4	5	6	7	8	Total Plots
Owerre-Ebeiri	2	3	2	3	3	2	1	1	36
Umuokile	2	5	3	4	1	0	0	0	64
Okwe	1	4	10	11	3	1	0	0	65

Source: compiled by the author.

Crops and Useful Plants Survey in Selected Farms of Varying Cropping Intensities in Compounds and Outlying Fields Located in the Derived Savanna, Transition and Oil Palm Belt Zones of Eastern Nigeria.

Key to Locations in which Surveys were Carried out as Indicated in Table

AREA 'A' - Derived Savanna:

Locations:
1. Compound Farm - Abia, Enugu Division
2. Pit in Compound Farm - Abia, Enugu Division
3. Garden in open grassland - Abia, Enugu Division
4. Open Farm 5 km from village - Ngwo, Enugu Division

AREA 'B' - Transition Zone Consisting of Mixture of Derived Savanna and Oil Palm Bush:

Locations:
5. Farm Close to Compound - Nenwe Awgu Division
6. Open Farm 4 km from Compound - Nenwe Awgu Division
7. Open Farm 1 km from Compound - Maku Awgu Division

AREA 'C' - Oil Palm Belt: Very High Population Density: (village H)

Locations:
8. Compound Farm Outside Outer Walls of Compound-Owerre Ebeiri Orlu Division
9. Compound Farm Inside Outer Walls of Compound-Owerre Ebeiri Orlu Division
10. Farm 0.5 km from Compound-Owerre Ebeiri Orlu Division

AREA 'D' - Oil Palm Belt: Medium to High Population Density: (village L)

Locations:
11. Compound Farm on Umuahia-Ikot Ekpene Road, Umuelechi Okwe, Umuahia Division
12. Compound Farm on Edge of Village 3 km from Road-Umuelechi Okwe, Umuahia Division
13. Open Farm on Level Land on Edge of Valley-Umuelechi Okwe, Umuahia Division
14. Open Farm on Steep Slope of Valley-Umuelechi Okwe, Umuahia Division
15. Open Farm on Valley Bottom, Umuelechi Okwe, Umuahia Division

AREA 'E' - Oil Palm Bush: High Population Density: (village M)

Locations:
16. Compound Farm 'A' Umuokile, Mbaise Division
17. Compound Farm 'B' Umuokile, Mbaise Division
18. Outlying Farm, Umuokile, Mbaise Division

Table 47: Crops and Useful Plants Survey in Selected Farms of Varying Cropping Intensities in Compound and Outlying Farms Located in the Derived Savanna, Transition and Oil Palm Belt Zones of Eastern Nigeria

Crops and Other Plants	AREA A				AREA B			AREA C			AREA D					AREA E			% of locations where observed
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Area of Land Sampled in Hectares	0.45	0.003	0.014	0.04	0.04	0.04	0.04	0.3	0.4	0.04	0.25	0.5	0.04	0.04	0.1	0.5	0.5	0.04	
1. ROOTS AND TUBERS																			
Dioscorea rotundata (Aga)	x	x			x	x	x	x	x		x	x				x		x	61
Dioscorea rotundata (Abi)	x				x	x	x		x									x	39
Dioscorea rotundata (Okom)																			0
Dioscorea alata	.							x	x		x	x			x	x	x	x	50
Dioscorea cayenensis	x	x					x			x	x	x			x	x	x	x	56
Dioscorea bulbifera	x				x			x		x							x	x	33
Dioscorea dumetorum	x		x		x		x	x	x	x	x		x		x	x	x	x	72
Dioscorea esculenta	x	x		x					x	x								x	33
Manihot esculenta	x	x		x		x			x	x	x		x	x	x	x	x		67
Colocasia esculentus	x	x			x	x	x	x	x		x	x				x	x	x	67
Xanthosoma sagittifolia	x						x		x	x	x	x				x	x	x	50
Iponoea batatas	x									x	x								17
2. CEREALS AND OTHER STARCHY STAPLES																			
Zea mays	x			x	x	x	x	x	x	x	x		x		x			x	67
Sorghum vulgare					x							x							11
Oriza sativa																			0
Musa sapientum var. Gros Michel	x							x	x	x	x	x					x	x	47
Musa sapientum var. Carendish											x					x	x		17
Musa paradisiaca	x								x		x	x				x	x		33
3. LEAF AND FRUIT VEGETABLES																			
Amaranthus hybridus var. cruentus	x	x	x				x	x	x	x						x	x		50
Amaranthus viridis								x	x		x	x							22

Crops and Other Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	%
Corchorus olitorus	x	x	x		x		x		x		x	x							56
Solanum macrocarpon	x	x	x		x		x	x	x	x	x						x	x	50
Solanum sp.																			0
Telfairia occidentalis	x	x	x					x	x	x	x		x		x	x		x	61
Talinum triangulare			x					x			x								22
Vernonia amygdalina	x		x				x	x	x	x	x	x					x		56
Cucurbita pepo	x	x	x			x		x	x	x	x	x				x	x		61
Hibiscus esculentus	x	x	x		x		x	x	x		x						x	x	61
Justicia insularis			x													x	x	x	6
Capsicum frutescens	x		x						x		x	x							39
Lycopersicum esculentum			x		x		x	x	x	x						x	x		33
Pterocarpus soyauxii	x							x	x	x	x	x				x	x	x	50
Pterocarpus osun									x		x	x					x		22
Pterocarpus santanaliodes											x					x			11
Vitex spp.									x		x						x		17
Pennisetum purpureum											x	x	x		x				22
Gnetum africanum																	x		6
Abelmoschus sp.												x							6
Sesamoides											x								6
4. LEGUMES AND PULSES																			
Vigna unguiculata	x		x	x	x		x	x	x	x									44
Arachis hypogaea	x		x	x									x						22
Phaseolus lanatus	x	x			x		x		x		x						x		39
Mucuna urens	x						x		x		x		x			x	x		39
Sphenostylis stenocarpa											x		x			x			17
Pentaclethra macrophylla	x		x				x		x						x	x	x		39
5. OIL PLANTS, NUTS AND FRUITS																			
Dacryodes edulis	x						x			x	x				x	x	x		39
Elaeis guineensis	x	x					x	x		x	x	x		x		x	x	x	61
Citrus sinensis	x						x	x			x	x				x	x		36
Citrus aurantifolia							x			x	x								17
Citrus reticulata												x						x	11
Carica papaya	x		x				x	x			x	x							38
Chrysophyllum albidum	x							x				x					x		22

Crops and Other Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	%
Chrysophyllum albidum	x								x			x					x		22
Syncepalum dulcificum	x																		6
Treculia africana	x							x	x	x	x	x			x		x		44
Cucumeropsis edulis	x		x					x	x							x	x	x	30
Colocynthis vulgaris			x	x		x				x	x	x	x					x	44
Cocos nucifera	x							x	x		x	x				x			33
Ananas comosus	x										x	x			x	x	x		33
Mangifera indica								x	x			x					x		22
Tetracarpedium conophorum	x															x	x		17
Dioscoreophyllum communsii										x						x			11
Persea americana	x										x	x							17
Irvingia gabonensis									x							x			11
Spondias mombin	x								x		x	x				x	x		33
Dialium guineense													x	x					11
Eugenia sp												x							6
Syzigium comini																		x	6
Cola lepideta												x							6
Cola packycarpa																			6
Aframomum sceptrum								x								x			11
Psidium guajava	x							x		x						x			27
Brachystegia eurycoma										x									6
Annona muricata										x									6
Artocarpus incisa												x							6
6. <u>SPICES AND BEVERAGES</u>																			
Aframomum melegueta								x		x							x		17
Ricinus comunis	x		x				x		x		x	x							33
Cola accuminata	x							x	x		x	x			x	x	x		44
Cola nitida											x	x					x		17
Capsicum frutescens								x				x							11
Ocimum basilicum					x												x		11
Ocimum gratissimum											x								6
Curcuma longa												x							6
Zingiber officinale																	x		6
Raphia sp.								x	x	x	x					x		x	33
Monodora myristica												x							6

Crops and Other Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	%
Coffea liberica																	x		6
Dennetia tripetala								x			x	x			x	x	x		36
Garcinia kola	x							x	x			x			x				28
Theobroma cacao												x				x			
7. <u>MISCELLANEOUS USEFUL PLANTS</u>																			
Newbouldia laevis	x							x	x		x	x				x	x		39
Rothmannia spp.										x									6
Chlorophora excelsa										x		x				x	x	x	28
Crescentia cujete											x	x							11
Saocharum officinarum												x							6
Lagenaria siceraria																	x	x	11
Ficus spp.	x									x	x	x				x			28
Baphia nitida											x	x		x	x	x	x		33
Celba pentandra								x		x		x					x		22
Albizia spp								x		x								x	17
Berlinia grandiflora									x								x		11
Ricinedendron heudeloti	x											x							11
Glyphaea brevis	x									x	x								17
Dracaena arborea	x											x							11
Dracaena nanni											x								6
Marantochloa spp.																			0
Cola milleni									x		x	x					x		28
Acioa bateri													x	x					11
Napoleona imperialis									x					x					11
Anthonotha macrophylla																			0
Spathodea campanulata	x								x		x						x		22
Musanga cecropicides												x			x	x			17
Azadirachta indica																			0
Jatropha curcas												x							6
J. gossypiifolia												x							6
Sansevaria sp.										x									6
Cassia alata							x		x										11
Kigelia africana								x											6
Hibiscus sp.										x							x		11

Crops and Other Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	%
Codaieum variegatum								x				x							11
Amorphophallus sp.										x									6
Icacina mannii																			0
Lonchocarpus cyanescense											x					x			11
Hildegardia bateri	x																		6
Pedilanthus sp.								x											6
Hibiscus sp.												x					x		11
Schumanniephyton magnificum																			0
Casuarina equisetifolia								x											6
Ipomoea hederifolia										x									6
Erythrina spp.										x									6
Notopanax sp.								x											6
Mormodica angustisepala										x						x			11
Rauvolfia vormitori												x				x	x		17
Tetrapleura tetraptera												x							6
Hannoa sp.												x							6
Pandanus candelibrum												x							6
Terminelia catappa												x							6
Kheya sp.																x			5
Total number of Species	52	14	19	6	14	7	19	43	48	40	56	62	11	6	16	44	52	25	

Source: OKIGBO, B.N.: <u>Fitting Research to Farming Systems</u>, op.cit., pp.50 et seq.

2. Plant Densities

Table 48: Plant Densities of Common Crop Mixtures Found on Outer Fields in Three Villages in Eastern Nigeria, June 1974

		Stands per ha (Plants per stand)									
		Cassava	Yam	Cocoyam	Maize	Melon	Groundnut	Telferia	Beans	Vegetables	Okro
3 crop mixtures	Okwe	7800(3-4)	300(1)		400(4)						
		7975(3-4)			1456(4)	1194(1)					
	Umuokile	7400(3)	1000(1)		350(4)						
		8600(3)			1158(4)		13000(1)				
	Owerre-Ebeiri	11200(1)	12050(1)		3640(5)						
			19600(1)		1100(5)	1675(1)					
4 crop mixtures	Okwe	6100(3-4)			1625(4)	850(1)		300(1)			
		8333(3-4)	1133(1)		2667(4)	925(1)					
	Umuokile	6600(3)	1500(1)	3000(1)	250(4)		9500(1)				
		6224(3)	950(1)		440(4)						
	Owerre-Ebeiri	14500(1)		24700(1)	1820(5)			900(1)			
		4800(1)		30500(1)	5040(5)				6700(1)		
5 crop mixtures	Okwe	5800(3-4)	1100(1)		2138(4)	1263(1)		700(1)			
	Umuokile	5733(3)	4167(1)	4967(1)	467(4)					933(1)	
		13700(3)		3000(1)	2175(4)		2200(1)			2300(1)	
	Owerre-Ebeiri	19700(1)		24600(1)	5900(5)			700(1)			500(1)
		23300(1)	15400(1)	3200(1)	1480(5)			1300(1)			

Source: compiled by the author.

3. Crop Rotations

a) Near Fields

Okwe (L)
Only 1 plot was cropped annually, the crop mixture planted does not change over the years. 10% of the fields have a cycle with 2-3 years bush fallow, 8% have 3-4 years bush fallow, 10% have 4-5 years and 72% of the fields remain for 5-6 years under bush fallow.

Examples:

1st year: yam, cassava, maize, melon
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow

1st year: cassava, maize, melon, telferia
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow
6th year: bush fallow
7th year: bush fallow

Umuokile (M)
Besides one plot which was cropped annually, farmers cultivate their near fields for 1-2 years followed by a bush fallow period of 3-4 years.

Examples:

1st year: cassava, maize, groundnuts
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow

1st year: yam, cocoyam, cassava, maize
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow

Owerre-Ebeiri (H)
Only a few fields are cropped annually in this village. Most of the farmers allow their near plots to remain under bush fallow for 1-2 years.

Examples:

1st year: cassava, yam, maize, vegetables
2nd year: cassava, cocoyam, maize, vegetables
3rd year: cassava + bush fallow
4th year: cassava

1st year: yam, cassava, maize, vegetables
2nd year: cassava + bush fallow
3rd year: cocoyam, cassava, maize, vegetables
4th year: cassava + bush fallow

1st year: yam, cassava, maize, vegetables
2nd year: cocoyam, cassava, maize, vegetables
3rd year: cassava + bush fallow
4th year: bush fallow.

b) Distant fields

Okwe (L)

Table 49: Distribution of Rotations with Different Lengths of Fallow Period in Okwe

1-2 year cropping 2-3 year fallow	1-2 yr.crop. 3-4 yr.fall.	1-2 yr.crop. 4-5 yr.fall.	1-2 yr.crop. 5-6 yr.fall.	1-2 yr.crop. 6 yr.fall.
4.9 %	4.9 %	6.6 %	80.3 %	3.3 %

Source: compiled by the author.

Examples:

1st year: cassava, maize, melon
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow.
5th year: bush fallow
6th year: bush fallow

1st year: yam, cassava, maize, melon, telferia
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow
6th year: bush fallow
7th year: bush fallow

Umuokile (M)

The rotation pattern for distant plots in this village is very homogeneous. 3-4 year bush fallow are the rule.

Examples:

1st year: cassava, maize, groundnuts
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: bush fallow
5th year: bush fallow

Owerre-Ebeiri (H)

Table 50: Distribution of Rotations with Different Lengths of Fallow Period in Owerre-Ebeiri

Annually	1-2 yr.crop. 1 yr.fall.	1-2 yr.crop. 1-2 yr.fall.	1-2 yr.crop. 2-3 yr.fall.	1-2 yr.crop. 3-4 yr.fall.	2 yr.crop. 2 yr.fall.
3.0 %	25.7 %	37.6 %	17.1 %	3.0 %	14.3 %

Source: compiled by the author.

Examples:

1st year : cocoyam, cassava, maize
2nd year : cassava + bush fallow
3rd year: yam, cassava, maize
4th year: cassava + bush fallow

1st year: yam, cassava, maize, vegetables
2nd year: cassava + bush fallow
3rd year: bush fallow
4th year: cassava
5th year: cassava + bush fallow

1st year: yam, cassava, maize, vegetables
2nd year: cocoyam, cassava, maize, vegetables
3rd year: cassava + bush fallow
4th year: bush fallow

APPENDIX XIII: DETAILS ON CALORIFIC AND DRY MATTER CONTENT OF CROPS GROWN IN EASTERN NIGERIA

Table 51: Calories and Dry Matter in gr. per kg. Edible Portion

		Cal.	dry matter gr./kg
01	Oil palm bunches	875	101
04	Raffia palm wine	340	60
05	Kolanut	622	156
06	Coconut	1187	176
07	Pear	580	158
08	Citrus	365	108
09	Cocoa	461	161
10	Banana	482	126
11	Plantain	634	162
12	Paw paw	320	92
13	Mango	610	186
14	Breadfruit	1090	281
15	Oil bean	3500	
16	Guava	640	178
18	Cowpeas	3380	886
20	Yams	1140	303
22	Cassava roots	1490	380
23	Cocoyams	1020	269
24	Maize(green cobs)	1520	422
25	Okra	360	114
26	Groundnut (raw seeds)	1520	427
27	Vegetables	358	122
28	Telferia	470	136
29	Melon (seeds with shell)	5180	927
30	Pumpkin	230	74
31	Tomato	210	65
32	Beans	3500	906
33	Pineapple	470	132
34	Pepper	940	258
35	Fluted pumpkin	230	74
36	Onions	410	115

Source: FAO, Nutrition Division and U.S. Dept. of Health, Education and Welfare: 'Food composition Table for Use in Africa' Bethesda, Rome, 1968.

Calculation of Calories and Dry Matter in gr.per 1000 gr. of Oil Palm Bunches (Wild Variety)

Oil 5.3 % Extraction rate with 45 % Extraction efficiency

Kernel 7.0 % of the bunch weight

1000 gr. Palm oil = 8750 Cal. 738 dry matter (gr./kg)

1000 gr. Palm kernel = 5870 Cal. 885 dry matter (gr./kg)

Oil $\frac{8750 \times 53.0}{1000}$ = 464 Cal. $\frac{738 \times 53.0}{1000}$ = 39 gr. of dry matter

Kernel $\frac{5870 \times 70.0}{1000}$ + 411 Cal. $\frac{885 \times 70.0}{1000}$ = 62 gr. of dry matter

875 Cal.per 1000 gr. bunch weight — 101 gr.of dry matter per 1000 gr. bunch weight

Calculation of Calories and Dry Matter in gr. per 1000 gr. of Vegetables

Bitter leaf	520 Cal.	174 dry matter
Water leaf	250 "	92 " "
Garden egg	320 "	95 " "
Lettuce	440 "	157 " "
Spinach	260 "	94 " "

Average: 358 Calories, 122 gr. of dry matter

Calculation of Calories and Dry Matter in gr. per 1000 gr. of Citrus

Grapefruit	340 Cal.	100 dry matter
Lime	320 "	105 " "
Orange, sour	370 "	108 " "
Orange, sweet	430 "	120 " "
Average:	365 Calories	108 gr. dry matter

Calculation of Calories and Dry Matter in gr. per 1000 gr. of Whole Fruits

	whole fruit (gr.)	edible part (gr.)	edible fraction (%)	Cal.	dry matter gr./kg	Cal.	dry matter gr./kg
Cocoa	755	130	16.9	2730	951	461	161
Coconut	865	255	30.6	3880	574	1187	176
Kolanut	210	87.5	42.0	1480	371	622	156
Banana	11020	6020	54.8	880	230	482	126
Plantain	14050	6540	47.0	1350	346	634	162

Calculation of Calories and Dry Matter in gr. per 1000 gr. of Yams (Raw)

	dry matter gr./kg.	Calories
Yam, yellow Dioscorea cayenensis Dioscorda rotundata	192	710
Yam, chinese Dioscorea esculenta	298	1120
Yam, wild Dioscorea dumetorum	327	1240
Yam, winged Dioscorea alata	349	1350
Yam, sp. Dioscorea armata	316	1180
Yam, sp. Dioscorea minutiflora	316	1180
Yam, sp. Dioscorea preussii	312	1160
Yam, spp. Dioscorea spp.	310	1190
Average:	303	1140

BIBLIOGRAPHY

ABALOU, C.O.I. and NORMAN, D.W.: The Scope of Labour Intensive Technology in Indigenous Agriculture, ABU, Zaria, 1975.

ADEGBOYE, R.O.: Procuring Loans by Pledging of Cocoa Trees, Journal of the Geographical Association of Nigeria, 12: 18-30, 1969.

AGRICULTURAL RESEARCH STATION UMUDIKE: Annual Reports, Umudike, 1926-1947.

AMAFFON, A.: Prix de Revient de la Culture Mecanisée du Manioc, in: Centre National de Promotion des Entreprises Cooperatives, Juin, 1975.

ANDERSON, P.P. and DIAZ, R.O.: Present and Potential Labor Absorption in Cassava Production in Colombia, CIAT, Colombia, 1973.

ANENE, J.C.: Southern Nigeria in Transition 1885-1906, Cambridge,1966.

ANGLADETTE, A. et DESCHAMPS, L.: Problèmes et perspectives de l'agriculture dans les pays tropicaux, Maisonneuve et Larose, Paris, 1974.

ANTHONIO, Q.B.O.: Food Consumption and Income Relationships in Nigeria: Engel's Curve Functions, Bulletin of Rural Economics and Sociology, 2: 52-67, 1966.

ANTHONIO, Q.B.O. and IJERE, M.O.: Uboma Development Project, 1964-1972, Published by Shell International Petroleum Ltd., 1973.

ANTHONIO, V.E. and BANTA, R.G.: Multiple Cropping in a Batangas Barrio, IRRI, Los Banos, 1974.

APRIL, J.E., HERSH, G.N., ROGERS, D.J., SLATER, C.C.: A Cross-Disciplinary Systems Analysis of Nutrition Problems in a Cassava Dependent Culture, Nutrition Bureau for Technical Assistance Agency for International Development, 1974.

ATTEMS, M.: Bauernbetriebe in tropischen Höhenlagen Ostafrikas, Afrika-studien Nr. 25, München, 1967.

ATTEMS, M.: Permanent Cropping in the Usambara Mountains: The Relevancy of the Minimum Benefit Thesis, in: Smallholder Farming and Smallholder Development in Tanzania, ed. H. Ruthenberg,Munich, Weltforum Verlag, 1968.

BAKER, E.F.I.: Research into Intercropping Aspects of Farming Systems in Nigeria, Mixed Cropping with Cereals - a System for Improvement, Institute of Agr.Research, Ahmadu Bello University, Zaria, Nigeria, (undated).

BALLAUX, J.C., FLINN, J.C. and SOTO, P.E.: Applied Nitrogen and Plant Protection of Maize - Some Financial Considerations, IITA, Ibadan, Nigeria, May 1974.

BANTA, G.R.: A Philosophy of Surveying Cropping Systems, IRRI, Los Banos, Philippines, (undated).

BANTA, G.R.: Mechanization, Labour, and Time in Multiple Cropping, IRRI, Los Banos, Philippines, 1971.

BARROWS, L.R.: Individualized Land Tenure and African Agriculture Development: Alternatives for Policy, University of Wisconsin-Madison, 1973.

BASDEN, G.T.: NIGER IBOS, Frank Cass & Co. Limited, London, 1966.

BAUM, E.: Land Use in the Kilombero Valley: From Shifting Cultivation Towards Permanent Farming, in: Smallholder Development in Tanzania, ed. H. Ruthenberg, Munich, Weltforum Verlag, 1968.

BENNEH, G.: Small-scale Farming Systems in Ghana, Geographical Research Institute, Budapest, Dec. 1971.

BERRY, S.: Migrant Farms and Land Tenure in the Nigerian Cocoa Belt, University of Wisconsin-Madison, 1972.

BERTALANFFY, L. von: General System Theory Foundations, Development, Applications, Rev.Ed. G. Braziller, New York, 1973.

BHATI, U.N.: Improving the Accuracy in Economics Survey: Some Experiences of an Agricultural Economist, Singapore, 1974.

BLANKENBURG, P. von: Rice Farming in the Abakaliki Area: A Study of the Process of Introduction of a New Crop, Nigerian Institute of Social and Economic Research, Preliminary Report, Ibadan, 1962.

BOHANNAN, P.: TIV Farm and Settlement, Colonial Research Studies, No.15, London, 1954.

BOSERUP, E.: The Conditions of Agricultural Growth, The Economics of Agrarian Change under Population Pressure, London, G. Allen & Unwin Ltd., 1965.

BOURKE, R.M.: Food Crop Farming Systems USED on the Gazelle Peninsula of New Britain, in: Proceeding P.N.G. Food Crops Conference, pp. 82-110, 1975.

BOYNE, D.H.: Changes in Income Distribution in Agriculture, in: Journal of Farm Economics, Vol. 47, Dec.1965.

BRADFIELD, R.: Intensive Multipe Cropping, in: Tropical Agriculture, Vol. 51, No.2, April 1974.

BROWN, L.R.: Seeds of Change, the Green Revolution and Development in the 1970's, Praeger Publishers, New York, 1970.

BUCK, J.L.: Land Utilization in China, Paragon, New York, 1964.

BUTLER, E.J., BROWN, E.E. and DAVIS, L.H.: An Economic Analysis of the Production, Consumption and Marketing of Cassava (Tapioca), University of Georgia, Research Bulletin 97, June 1971.

CADILLON, M.: Evolulion du Sol sous une Rotation Baoulée Traditionnelle, IRAT, Bouaké, (undated).

CHANDRA, S., EVENSON, J.P. and DE BOER, A.J.: Root Crop Production in a Fijian Village, III. International Symposium on Tropical Root and Tuber Crops, Ibadan, Nigeria, Dec. 1973.

CHUBB, L.T.: Ibo Land Tenure, Ibadan University Press, 1961.

CLARK, C. and HASWELL, M.: The Economics and Subsistence Agriculture, MacMillan, London, 1970.

CLEAVE, J.H.: African Farmers: Labour in the Development of Smallholder Agriculture, Praeger, New York, 1974.

COLLINSON, M.P.: Some Guidelines for Farm Economic Data Collection in Rural Areas of Africa, Agricultural Development Council Seminar, Beirut, Dec. 1974.

COLLINSON, M.P.: Farm Management in Peasant Agriculture. A Handbook for Rural Development Planning in Africa, New York, Washington, London, 1972.

COOPER, I.P.: Potential Production and Energy Conversion in Temperate and Tropical Grasses, in: Herbage Abstracts, Vol.40, No.1, pp.1-15, March 1970.

CORVINUS, F. and GRENZEBACH, K.: Afrika-Kartenwerk, Serie W: West-Afrika, Nigeria, Kamerun, Blatt 9: Bevölkerungsgeographie. Berlin, New York (forthcoming).

COURSEY, D.G.: Yams, Longmans, London, 1967.

DART, P.J. and DAY, J.M.: Non-Symbiotic Nitrogen Fixation in the Field, in: Soil Microbiology, ed. N. Walker, Butterworths Scientific Publications, London, 1975.

DIBBITS, H.J.: Trials on Methods of Land Clearing in a Tropical Rain Forest at IITA, IITA, Ibadan, Nigeria, 1975.

DILLON, J.L.: The Analysis of Response in Crop and Livestock Production, Oxford, Pergamon Press, 1968.

DORNER, P.: Needed Redirections in Economic Analysis for Agricultural Development Policy, Land Tenure Center, University of Wisconsin-Madison, Wisconsin, 1971.

DUMSDAY, R.G. and FLINN, J.C.: Soil Conservation and Management in the Humid Tropics, La Trobe University, Australia, IITA, Ibadan, Nigeria, 1975.

EGWUONWU, J.A.: Soil Fertility Studies at Umudike since 1923, Memorandum No. 12, Umudike - Umuahia, 1966.

EKUNDARE, R.O.: An Economic History of Nigeria, 1860 - 1960, London, 1973.

EL HADARI, A.M.: Problems of Field Data Collection in Rural Areas - Some Sudanese Experience, University of Khartoum, Sudan, Beirut, 1974.

EZEILO, W.N., FLINN, J.C. and WILLIAMS, L.B.: Cassava Producers and Cassava Production in the East Central State of Nigeria, IITA, Ibadan, Nigeria, June 1975.

FALUSI, B.: Multivariate Probit: Analysis of Selected Factors Influencing Fertilizer Adoption Among Farmers in Western Nigeria, in: The Nig. Journal of Econ.& Soc. Studies 16(1):3-16, 1974.

FAO: Agricultural Development in Nigeria, 1965-1980, Rome, 1966.

FAO: Agriculture in Nigeria, Rome, 1967.

FAO: Farm Management Data Collection, Analysis, Storage and Retrieval System, Section B - Data Collection Sub-System, Rome (undated).

FAO/AFRICAN RURAL STORAGE CENTRE: Field Progress Report, African Region, Report No. 3, Ibadan, 1974.

FAO: Agricultural Development in Nigeria, 1965-1980 , Rome 1966.

FAO: Food Composition Table for Use in Africa, Nutrition Div. and U.S. Dept. of Health, Education and Welfare, Bethesda, Rome, 1968.

FARRINGTON, J.: Farm Surveys in Malawi, University of Reading, Department of Agr.Econ. & Management, Development Study No. 16, 1975.

FAULKNER, O.T. and MACKIE, J.R.: West African Agriculture Cambridge, 1933.

FEDERAL OFFICE OF STATISTICS: Rural Economic Survey of Nigeria, 1970-71, Lagos.

FEDERAL OFFICE OF STATISTICS: Economic Indicator, Vol.6, No.2, 1973, Lagos, Nigeria.

FEDERAL OFFICE OF STATISTICS: Economic Indicator, Vol.6, No.3, 1973, Lagos, Nigeria.

FINNEGAN, R.H.: Survey of the Limba People of Northern Sierra Leone, Overseas Research Publication No.8, London, HMSO, 1965.

FLINN, J.C.: Cassava Production and Consumption - A Global to Nigerian Overview, IITA, Ibadan, Nigeria, April 1975.

FLINN, J.C.: Economic Considerations in the Conduct of Cooperative Agricultural Research, in: Eastern African Journal of Rural Development, 8 (1 and 2): 105-117, 1975.

FLINN, J.C.: Possibilities for Economic Research into Cassava Production Systems in Africa, IDRC/IITA Workshop on Cassava Improvement in Africa, IITA, November 1975.

FLINN, J.C.: Resource Use, Income and Expenditure Pattern of Yoruba Smallholders, IITA, Ibadan, Nigeria, 1974.

FLINN, J.C.: Scientific Research for Nigeria's Agricultural Development - The Role of IITA, Development Seminar, University of Ife, Nov. 1973.

FLINN, J.C., JELLEMA, B.M. and ROBINSON, K.L.: Problems of Increasing Food Production in the Lowland Humid Tropics of Nigeria, in: Zeitschrift für Ausländische Landwirtschaft, Jhrg.14, H.1/1975.

FLINN, J.C. and LAGEMANN, J.: Experiences in Growing Maize Using "Improved Technology" in South-Eastern Nigeria, IITA, Ibadan, Nigeria, 1976.

FLINN, J.C., LAGEMANN, J.: Farm Management/ Land Utilization Study, East Central State, Nigeria, IITA, Ibadan, Nigeria, 1974.

FLINN, J.C., LAGEMANN, J.: Procedures for Collecting Socio-Econ. Data at the International Institute of Tropical Agriculture, ADC/CIMMYT/ Ford Foundation Seminar on Field Collecting of Socio-Economic Data in Developing Countries, Beirut, 1974.

FLOYD, B.: Eastern Nigeria, Macmillan, London, 1969.

FOGG, C.D.: Ökonomische und soziale Faktoren bei der Entwicklung kleinbäuerlicher Landwirtschaft in Ost-Afrika, in: Zeitschrift für Ausländische Landwirtschaft, Jahrgang 4, Heft 4, 1965.

FORBES, T.R.: A West African Soil Climosequence and Some Aspects of Foodcrop Potential, Unpublished MSc. Thesis, Cornell University, 1975.

FORDE, D.: Yakö Studies, Oxford, 1964.

FORDE, D. and SCOTT, R.: The Economies of a Tropical Dependency, Vol.1: The Native Economies of Nigeria, Faber and Faber, London, 1945.

FRANCIS, C.A.: Impact of New Technology on Small Farm Agriculture, CIAT, Cali, Colombia, (undated).

FRANKLIN, L.D. and SCOBIE, M.G.: Small Farm Systems PROGRAMME, CIAT, Cali, Colombia, 1974.

FRIEDMAN, M.: The Theory of the Consumption Function, Princeton University Press, Princeton, 1957.

FRIEDRICH, K.-H.: Coffee-Banana Holdings at Bukoba: The Reasons for Stagnation at a Higher Level, in: Smallholder Farming and Smallholder Development in Tanzania, ed. H. Ruthenberg, Munich, Weltforum Verlag, 1968.

FRIEDRICH, K.-H.: Manual for Farm Management Investigations in Developing Countries, A Working Paper, FAO, Rome, 1971.

FRIEDRICH, K.-H.: The Collecting and Analysis of Micro-Economic Data in Developing Countries, FAO, Rome, Italy, 1974.

FRIEDRICHS, J.: Methoden empirischer Sozialforschung, Rowolt Verlag, Hamburg, Sept. 1973.

FRIO, A.L. and BANTA, G.R.: Socio-Economic Factors Associated with Systems in Selected Batangas Barrios, IRRI, Los Banos, Philippines, June 1974.

FUCHS-WEGNER, G.: Verfahren der Analyse von Systemen, in: Systemtheorie, Colloquium Verlag, Berlin, 1972.

GAENSSLEN, H. and SCHUBÖ, W.: Einfache und komplexe statistische Analyse, Ernst Reinhardt Verlag München/Basel, 1973.

GALLETTI, R., BALDWIN, K.D. and DINA, J.D.: Nigerian Cocoa Farmers, Oxford University Press, London, 1956.

GALTUNG, J.: Theory and Methods of Social Research, Allen & Unwin Ltd., London, 1967.

GEERTZ, C.: Agricultural Involution. The Process of Ecological Change in Indonesia, University of California, Los Angeles, 1963.

GODDARD, A.D., FINE, J.C., NORMAN, D.W.: A Socio-Economic Study of Three Villages in the Sokoto Close-Settled Zone.
1. Land and People, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, 1971.

GOULD, P.R.: Toward a Model of Population-Land Relationships, in: Prothero, R.M.: People and Land in Africa South of the Sahara, Oxford University Press, London, 1972.

GRACE, M.: Traitement du Manioc, Bulletin des Services Agricoles No.8, FAO, Rome, 1973.

GREEN, M.M.: Igbo Village Affairs, Frank Cass & Co. Ltd., London, 1964.

GREENLAND, D.J.: Bringing the Green Revolution to the Shifting Cultivator, IITA, Ibadan, Nigeria, 1975.

GREENLAND, D.J.: Evolution and Development of Different Types of Shifting Cultivation, in: Shifting Cultivation and Soil Conservation in Africa, FAO, Rome, 1974.

GREENLAND, D.J. and HERRERA, R.: Patterns of Use of Tropical Forest Ecosystems, 4. Shifting Cultivation and Other Agricultural Practices, IITA and Department of Soil, University of Reading, 1975.

GRENZEBACH, K.: Luftbilder: Indikatoren für regionale Komplexanalyse - Orba (E.C.S., Nigeria) - Strukturwandel in einem dichtbesiedelten Agrarraum Ostnigerias, in: Die Erde, Zeitschrift der Gesellschaft für Erdkunde zu Berlin, 105.Jahrgang, 1974, Heft 2, S.97-123.

GRIFFITH-JONES, T.: Promoting Agricultural Change, in: Span, Vol.18, No.2, 1975.

GRIMES, R.C.: Intercropping and Alternate Row Cropping of Cotton and Maize, East African Agricultural and Forestry Journal, 28, 1962.

GRINNEL, H.R.: Agri-Silviculture, a Suggested Research Program for West and Central Africa, IDRC, Ottawa, Canada, and IITA, Ibadan, Nigeria, July 1975.

GRIST, D.H.: Rice, Longmans, London, 1959.

GROENEVELD, S.: Probleme der landwirtschaftlichen Entwicklung im Küstengebiet Ostafrikas, Afrikastudien Nr.19, Weltforum Verlag, München, 1967.

GROVE, A.T.: Land Use and Soil Conservation in Parts of Onitsha and Owerri Provinces, Geological Survey of Nigeria, Bulletin No.21, Lagos, 1951.

GUCELIOGLU, O.: Statistical Data Collection in Rural Areas in Turkey, State Institute of Statistics, Ankara, Turkey, (undated).

GÜSTEN, R.: Studies in the Staple Food Economy of Western Nigeria, IFO-Studies, No.30, München 1968.

GUILLEMIN, R.: Evolution de l'agriculture autochtone dans les savannes de L'Oubangui, Agron.Trop.12, Nos.1,2,3, 1956.

HAHN, S.K., HOWALD, A.K. and TERRY, E.R.: Cassava Breeding at IITA, IITA, Ibadan, Nigeria, 1974.

HARTLEY, C.W.S.: The Oil Palm, Longmans, London, 1967.

HARWOOD, R.: The Concepts of Multiple Cropping, IRRI, Los Banos, Philippines, 1973.

HARWOOD, R.: The Resource Utilization Approach to Cropping Systems Improvement, IRRI, Los Banos, Philippines (undated).

HASWELL, R.: Tropical Farming Economics, Longman Group Ltd., London, 1973.

HEADLEY, J.C.: Environmental Quality and the Economics of Agricultural Pest Control, Brussels, 1973.

HEILER, S. and RINNE, E.: Einführung in die Statistik, Verlag Anton Hain, Meisenheim, 1971.

HELLEINER, G.K.: Peasant Agriculture, Government and Economic Growth in Nigeria, A Publication of the Econ. Growth Center, Yale University, 1966.

HERRERA, W.T. and HARWOOD, R.: Crop Interrelationship in Intensive Cropping Systems, IRRI, Philippines, 1973.

HEYER, J.: Peasant Farm Production Under Conditions of Uncertainty, Journal of Agricultural Economics, 23: 135-146, 1976, 1972.

HILL, P.: A Plea for Indigenous Economics: The West African Example, in: Economic Development and Cultural Change, 1966.

HODDER, R.W. and UKWU, U.I.: Markets in West Africa, Studies of Markets and Trade Among the Yoruba and Ibo, Ibadan University Press, 1969.

HOLLMAN, L.W.J.: A Survey on Cassava Production and Processing for the Government of the Dominican Republic, FAO, Rome, 1964.

HUNTER, G.: Employment Policy in Tropical Africa, in: International Labour Review, Vol.105, No.1, January 1972.

HUSAIN, T.: Operational Constraints and Economic Analysis, ADC/CYMMIT/ Ford Foundation Seminar on Field Data Collection, Beirut, 1974.

ICRISAT: The Farming System Program, Hyderabad, India, Sept. 1973.

IDUSOGIE, E.O. and OLAYIDE, S.O.: Role of Roots and Tubers in Nigerian Nutrition and Agricultural Development, International Symposium on Root Crops, University of Ibadan, Nigeria, December 1973.

IGWEBUIKE, R.U.: Barriers to Agricultural Development: A Study of the Economics of Agriculture in Abakaliki Area, Nigeria, Stanford University, February 1975.

IITA: Annual Report 1973, Ibadan, Nigeria.

IITA: Annual Report 1974, Ibadan, Nigeria.

IITA: Farming Systems Program, 1973, Ibadan, Nigeria.

IITA: Annual Report of the Farming Systems Program, 1974, IITA, Ibadan, 1975.

IRAT: Rapport Analytique 1972 Cultures Diverses, Bouaké, Ivory Coast, 1973.

JAHNKE, H.E.: Tsetse Flies and Livestock Development in East Africa, Weltforum Verlag, Afrikastudien Nr.87, München, 1976.

JEFFREYS, M.D.W.: Average Size of a Native Hoe Farm in Nigeria, in: Farm and Forest, Vol.7, 1947.

JOHNSON, G.L., SCOVILLE, O.J., DIKE, G.K. and EICHER, C.K.: Strategies and Recommendations for Nigerian Rural Development, 1969/1985, Consortium for the Study of Nigerian Rural Development, July 1969.

JOHNSON, R.W.M.: Economics of Smallholder Farming in Rhodesia, Food Research Institute, Stanford University, 1968.

JOHNSON, R.W.M.: The African Village Economy: an Analytical Model, in: The Farm Economist, Vol.11, No.9, 1969.

JOHNSON, V.C.: Land Tenure and Agricultural Development in Nigeria, in: Papers on Agricultural Development Problems and Prospects in West Africa with Special Reference to Nigeria, USAID, Nigeria, (undated).

JOHNSTON, B.F.: The Staple Food Economies of Western Tropical Africa, Stanford University Press, California, 1963.

JONES, W.O.: Manioc in Africa, Stanford University Press, Stanford, California, 1959.

KAUFMANN, H.: Nigeria, Deutsche Afrika-Gesellschaft, Bonn, 1962.

KEAY, R.W.J., ONOCHIE, C.F.A. and STANFIELD, D.P.: Nigerian Trees, Federal Government Printer, Lagos, 1965.

KEHRBERG, E.W. und REISCH, E.: Wirtschaftslehre der Landwirtschaftlichen Produktion, BLV Verlagsgesellschaft, München, 1964.

KIRSCH, W.: Betriebswirtschaftslehre: Systeme, Entscheidungen, Methoden, Betriebswirtschaftlicher Verlag Dr.Th.Gabler, Wiesbaden, 1973.

KNIGHT, C.G.: Ethnoscience: A Cognitive Approach to African Agriculture, Pennsylvania State University, 1974.

KOLAWOLE, M.L.: An Economic Analysis of Cassava Production in Western Nigeria, Dep.of Agr.Econ., University of Ife, Nigeria, (undated).

KRANTZ, B.A.: Cropping Patterns for Increasing and Stabilizing Agricultural Production in the Semi-Arid Tropics,ICRISAT,India (undated).

LAGEMANN, J.: Case Study from a Smallholder with Oil Palm in Eastern Nigeria, IITA, Ibadan, Nigeria, 1975.

LAGEMANN, J.: Increasing Production Through Rural Development Projects: Uboma, IITA, Ibadan, Nigeria, 1976.

LAGEMANN, J., FLINN, J.C. and RUTHENBERG, H.: Land Use, Soil Fertility and Agricultural Productivity as Influenced by Population Density in Eastern Nigeria, in: Zeitschrift für Ausländische Landwirtschaft, Heft 2, 1976.

LAGEMANN, J., FLINN, J.C., OKIGBO, B.N. and MOORMANN, F.R.: Root Crop/Oil Palm Farming Systems: A Case Study from Eastern Nigeria, IITA, Ibadan, Nigeria, 1975.

LAL, R.: Role of Mulching Techniques in Tropical Soil and Water Management, Technical Bulletin No.1, IITA, Ibadan, Nigeria.

LANG, H.: Semi-mechanized Upland Cultivation in African Small Scale Farms. Experiences of the Ivory Coast, in: Zeitschrift für Ausländische Landwirtschaft, Jahrg. 15, Heft 2, 1976.

LANG, H.: Naßreis versus Trockenreis in Westafrika - Intensivierung versus Extensivierung unter den Bedingungen der humiden Tropen, siebzehnte Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues, Berlin, 1976.

LANGHAM, M.R.: A Dynamic Linear Programming Model for Development Planning, in: W.W. McPherson, ed. Economic Development of Tropical Agriculture, University of Florida Press, Gainesville, 1968.

LEAKEY, L.S.B.: Science and the African, unpublished paper, 1934.

LELE, U.J.: The Design of Rural Development: Lessons from Africa, IBRD, John Hopkins University Press, Baltimore, London, 1975.

LINSENMEYER, D.: An Economic Analysis of Maize Production in the Kasai Oriental Region of Zaire: A Research Proposal, African Rural Employment Research Network, Working Paper No.2, May 1974.

LITTLE, T.M. and HILLS, F.J.: Statistical Methods in Agricultural Research, University of California, Berkeley, 1972.

LUDWIG, H.D.: Ukara: A Special Case of Land Use in the Tropics, IFO-Studies, No.22, München, 1967.

LUNING, H.A.: Economic Aspects of low Labour-Income Farming, Agricultural Research Reports 699, Wageningen, 1967.

LYONGA, S.N., FAYEMI, A.A. and AGBOOLA, A.A.: Agronomic Studies on Edible Yams (Dioscorea Spp.) in the Grassland Plateau Region of the United Republic of Cameroon, University of Ibadan, Nigeria (undated).

MacARTHUR, J.D.: The Economic Study of African Small Farms: Some Kenya Experiences, in: Journal of Agricultural Economics(1968).

MANSFIELD, G.B.: A Short History of Agriculture in the British Colonies, Oxford, 1960.

MARTIN, A.: The Oil Palm Economy of the Ibibio Farmer, Ibadan University Press, Ibadan, 1956.

MBAH, I.A.: A History of Ahiahara from the Early Time till 1905, University of Nigeria, Nsukka, June 1973.

Mc COURTIE, W.D.: Traditional Farming in Liberia, University of Liberia, Monrovia, 1973.

MINISTRY OF AGRICULTURE: Eastern Nigeria Farm Settlement Scheme, Agricultural Bulletin No.2 (undated).

MINISTRY OF AGRICULTURE: Third National Development Plan 1975-1980, Enugu, E.C.S. of Nigeria, 1975.

MINISTRY OF ECONOMIC DEVELOPMENT AND RECONSTRUCTION: Abstracts of Statistics, Enugu,E.C.S.of Nigeria, 1974.

MINISTRY OF ECONOMIC DEVELOPMENT AND RECONSTRUCTION: Report on the Survey of Plantations and Other Large Scale Agricultural Undertakings. Statistic Division, Enugu, E.C.S.of Nigeria, 1971/72.

MINISTRY OF ECONOMIC DEVELOPMENT AND RECONSTRUCTION: Retail Market Prices of Foodstuffs in East Central State Nigeria, Enugu, E.C.S.of Nigeria, 1974.

MOHR, E.C.J., VAN BAREN, F.A. and VAN SCHUYLENBORGH, J.: Tropical Soils, Mouton, Ichtiar Baru, Van Hoeve, The Hague, 1972.

MOOMAW, J.C. and HEDLEY, P.D.: Farming Systems in the Humid Tropics: A Research Proposal, in: FAO Conference on the Establishment Cooperative Agr.Research Programs Between Countries with Similar Ecological Conditions - Guinean Zone, Africa, IITA, 1971.

MOORMANN, F.R., WILLIAMS, L.B., FAGADE, S.O. and AJALA, R.O.: Zonal Substations within Nigeria, in: National Accelerated Food Production Program, Dec.1975.

MORGAN, W.B.: Farming Practice, Settlement Pattern and Population Density in South-Eastern Nigeria, in: Prothero, R.M.: People and Land in Africa South of the Sahara, Oxford University Press, London, 1972.

MORGAN, W.B. and PUGH, J.C.: West African University Press, London 1969.

MORIS, J.R.: Multisubject Farm Surveys Reconsidered: Some Methodological Lessons, Institute of Public Administration, Dar-es-Salaam, 1970.

NAGEL, F.W.: Die Ökonomik der Beregnung bei Weizen in semi-ariden Regionen Nordafrikas und des Nahen Ostens- untersucht für die Negev Israels, Zeitschrift für Bewässerungswirtschaft, Sonderheft 4, DLG-Verlag, Frankfurt.

NATIONAL ECONOMIC COUNCIL: Economic Survey of Nigeria 1959, Lagos, 1959.

NDAEYO, I., HYSLOP, J. and OGOR, E.: A Recast and Summary of the Report of the Palm Committee Appointed by the Federal Government to update the Reports on the Oil Palm Industry in Nigeria, Lagos, 1972.

NESTEL, L.: Current Trends in Cassava Research, in: Paper of Agriculture, Food and Nutrition Sciences Division, IDRC, Bogota, June 1974.

NGODDY, P.O.: Gari Mechanization in Nigeria: A Case Study in the Choice of Technology, University of Ife, Nigeria, 1974.

NIJHOLT, J.A.: Report of the Survey on Cassava Production and Processing in Ceylon, FAO, Rome, 1964.

NORMAN, D.W.: An Economic Study of Three Villages in Zaria Province, 1. Land and Labour Relationship, Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria, Nigeria, 1967.

NORMAN, D.W.: Economic Analysis of Agricultural Production and Labour Utilization Among the Haussa in the North of Nigeria, in: African Rural Employment Study, Paper No.4, Michigan State University, East Lansing, Michigan, 1973.

NORMAN, D.W.: Methodology and Problems of Farm Management Investigations: Experiences from Northern Nigeria, African Rural Employment Study, Zaria, Nigeria, 1973.

NORMAN, D.W.: Rationalising Mixed Cropping under Indigenous Conditions, the Example of Northern Nigeria, Samaru Research Bulletin 232, Ahmadu Bello University, 1975.

NORMAN, D.W.: The Rationalisation of a Crop Mixture Strategy adopted by Farmers under Indigenous Conditions: The Example of Northern Nigeria, in: Journal of Development Studies, 11:1, p.3-21, Oct. 1974.

NWACHUKWO, S.O.: A Multi-Period Linear Programming Model for an Economic Evaluation of Cocoa/Oil Palm Settlement Holding in Nigeria, University of Guelph, 1973.

NWAHIRI, L.O.: Nguru Mbaise Before the Coming of the British, University of Nigeria, Nsukka, June 1973.

NWOSU, N.A.: Some Indigenous Cropping Systems of Eastern Nigeria, Umudike, Nigeria, (undated).

NYE, P.H. and GREENLAND, D.J.: The Soil under Shifting Cultivation, Commonwealth Agr.Bureau, Reading, 1960.

OBI, J.K. and TULEY, P.: The Bush Fallow and Ley Farming in the Oil Palm Belt of South -East Nigeria, Foreign and Commonwealth Office, Overseas Development Administration, Micellaneous Report 161, 1973.

OFFOR, R.O.M.: An Address Presented on the Occasion of Uboma Farmers' Day, held on the 22nd March, Uboma, (unpublished paper) 1975.

OFORI, C.S.: The Effect of Ploughing and Fertilizer Application on Yield of Cassava (Manihot Esculenta Crantz), in: Ghana Inl.Agric.Sci.6, 21-24, Ghana University Press, Accra, 1973.

OGUNFOWORA, O., ESSANG, S.M., IDACHABA, F.S. and OLAYIDE, S.O.: A Preliminary Study of the Agricultural Situation in Kwara State: Summary of Situation Questionnaire on Rural Development, Department of Agr.Econ. and Extension, University of Ibadan, Nov. 1973.

OGUNFOWORA, O.: Farm Survey as a Data Base for Analysis and Planning: Experiences from Kwara State of Nigeria, University of Ibadan, 1974.

OKIGBO, B.N.: Fitting Research to Farming Systems: Based on Observations and Preliminary Studies of Traditional Agriculture in Eastern Nigeria, IITA, Ibadan, Nigeria, 1974.

OKIGBO, B.N.: The IITA Farming Systems Program: Its Strategy, Scope and Priorities in Research and Related Activities, IITA, Ibadan, Nigeria, 1973.

OKPALA, E.U. and GLASER, H.J.: First Workshop on Cassava Bacterial Blight in Nigeria, Umudike, 1974.

OLAYIDE, S.O., OLATUNBOSUM, D., IDOSOGIE, E.O. and ABIAGON, J.D.: A Quantitative Analysis of Food Requirements, Supplies and Demands in Nigeria, 1968-1985, Lagos, Nigeria, 1972.

OLUWASANMI, H.A., DEMA, I.S. and others: Uboma: A Socio-Economic and Nutritional Survey of a Rural Community in Eastern Nigeria, The World Land Use Survey, Occasional Papers No.6, London, 1966.

ORR, E.: The Use of Protein - Rich Foods for the Relief of Malnutrition in Developing Countries: An Analysis of Experience, Tropical Products Institute, London, August 1972.

OYENUGA, V.A.: Agriculture in Nigeria, FAO, Rome, 1967.

OYENUGA, V.A.: Nigeria's Foods and Feeding-stuffs, Ibadan, 1968.

PARKER, N.: Intercropping, B.Sc.Honours Thesis, University of Reading, Reading, May 1969.

PARSONS H.: Customary Land Tenure and the Development of African Agriculture, University of Wisconsin-Madison, 1971.

PENNY, H.D.: Hints for Research Workers in the Social Sciences, New York, 1973.

PIESCH, W.: Statistische Konzentrationsmaße, Mohr, Tübingen, 1975, p.43.

PINSTRUP-ANDERSEN, P. and DIAZ, R.O.: Present and Potential Labor Absorption in Cassava Production in Columbia, III. Intern.Symposium on Tropical Root Crops, Ibadan, Nigeria, 1973.

PFLAUMER, G.: Die Grüne Revolution schafft neue Probleme, University of Wisconsin-Madison, 1972.

PHILLIPS, T.A.: An Agricultural Notebook, Longman, Nigeria, second edition, 1975.

PHILLIPS, T.A.: Farm Management in West Africa, Longman, London, 1961.

PHILLIPS, T.P.: Potential Supply of Demand for Cassava in the '70's and '80's, University of Guelph, Ontario, 1974.

PHILLIPS, T.P.: Proposal for an Economic Study of Cassava Production Practices, University of Guelph, Ontario, 1973.

PURSELL, D.E.: Economic Development in Nigeria under Conditions of Rapid Population Growth, Social Development Research Division, Nigerian Institute of Social and Economic Research, University of Ibadan, June 1972.

RANKINE, L.B.: Comparative Performance: Large-Scale Production Versus Small-Scale Production of Yams and Sweet Potatoes in the Caribbeans, Third International Symposium on Tropical Root Crops, Ibadan, Nigeria, 1973.

REHM, S.: Landwirtschaftliche Produktivität in regenreichen Tropenländern, in: Umschau 73, Heft 2.

REHM, S. und ESPIG, G.: Die Kulturpflanzen der Tropen und Subtropen, Verlag E. Ulmer, Stuttgart, 1976.

REUBEN, K.U.: Migrant Tenant Farmers of Nigeria, African University Press, 1975.

REUSSE, E.: A Case for Community-Based Oil Extraction Units in Small-Farmer Oil Palm Rehabilitation Schemes Versus the Large-Scale Central Milling Approach in Nigeria, FAO, Regional Office for Africa, Accra, Ghana, (undated).

ROBINSON, K.L.: The Economics of Increasing Staple Food Production in West Africa, IITA, Ibadan, Nigeria, 1974.

ROBINSON, K.L. and FALUSI, A.O.: Present and Potential Role of Fertilizer in Meeting Nigeria's Food Requirements, IITA and University of Ibadan, Nigeria, 1974.

ROLING, N.: Social Science for What? On the Utilization of Social Science Research for Rural Development, University of Wageningen, Netherlands, 1974.

ROLING, N.: Some Informal Notes on the Problems of Field Data Collection in Nigeria and Kenya, ADC/CYMMIT/Ford Foundation Seminar on Field Data Collection, Beirut, 1974.

ROTENHAN, D., von: Bodennutzung und Viehhaltung im Sukumaland/Tanzania, IFO-Institut, München, 1966.

ROTENHAN, D., von: Cotton Farming in Sukumaland, in: Smallholder Farming and Smallholder Development in Tanzania, ed. H. Ruthenberg, Weltforum Verlag, München, 1968.

RURAL ECONOMIC RESEARCH UNIT: A Progress Report, No.8, Ahmadu Bello University, Zaria, Nigeria, 1974.

RUTHENBERG, H.: Farming Systems in the Tropics, 1st ed., Clarendon Press, Oxford, 1971.

RUTHENBERG, H.: Farming Systems in the Tropics, 2nd ed., Clarendon Press, Oxford, 1976.

RUTHENBERG, H.: Landwirtschaft und anfängliche Kapitalbildung, Zeitschrift für Ausländische Landwirtschaft, Sonderheft 2, 1964.

RUTHENBERG, H.: Some Considerations about the Design of Experimental Work with Farming Systems at IITA, IITA, Ibadan, Nigeria, 1973.

RUTHENBERG, H.: Smallholder Farming and Smallholder Development in Tanzania, Afrika-Studien Nr.24, München, 1968.

RUTHENBERG, H. und JAHNKE, H.E.: Ein Rahmen zur Planung und Beurteilung landwirtschaftlicher Entwicklungsprojekte, Zeitschrift für Ausländische Landwirtschaft, Heft 24, 1974.

SACHS, L.: Statistische Auswertungsmethoden, Springer Verlag, Berlin, 1968.

SCHLIPPE, P. de: Methodes de Recherches Quantitatives dans l'Economie Rural Contumière de l'Afrique Centrale, Bruxelles, 1957.

SCHULTE, E.E., MAKANJUOLA, G.A. and ONOCHIE, B.E.: Mechanization of Cassava Production: I. Planting, III. International Symposium on Tropical Root and Tuber Crops, Ibadan, Nigeria, Dec. 1973.

SCHULTZ, T.W.: Transforming Traditional Agriculture, New Haven and London, Yale University Press, 1964.

SHAH, P.: Problems of Field Data Collection in Rural Areas: Some Observations on Experiences in India, Singapore, 1974.

SHOU-JUNG YANG: Principles of Field Data Collection in Rural Taiwan, Singapore, 1974.

SIMMONDS, N.W.: Bananas, Longmans, London, 1960.

SMOCK, P.R.: Agricultural Development and Community Plantations in Eastern Nigeria, Rural Development Project, The Ford Foundation, Lagos, 1965.

SODERIZ: Project BIRD-CCE, 1975-78, Annexes, Abidjan, Ivory Coast.

SPEDDING, C.R.W.: The Biology of Agricultural Systems, Academic Press, London, 1975.

SPENCER, D.S.C.: Collecting Primary Socio-Economic Data in Africa - Some Experiences from Sierra Leone, University of Sierra Leone, 1974.

SPENCER, D.S.C.: Enumerators Reference Manual: Rice Survey, Njala University College, University of Sierra Leone, 1972.

SPENCER, D.S.C.: Micro-Level Farm Management and Production Economics Research Among Traditional African Farmers: Lessons from Sierra Leone, African Rural Employment Study, Paper No.3, 1972.

SPENCER, D.S.C.: Questionnaire: Rice Survey, Njala University College, University of Sierra Leone, 1972.

SYARIFUDDIN, A., SOEHARSONO and McINTOSH, J.L.: Multiple Cropping in Indonesia, South and Southeast Asia Cropping System Network, IRRI, Los Banos, Philippines, 1975.

STEINHAUSER, H., LANGBEHN, C. und PETERS, U.: Einführung in die landwirtschaftliche Betriebslehre, Allgemeiner Teil, Verlag Eugen Ulmer, Stuttgart, 1972.

STOLPER, W.F.: Planning Without Facts, Harvard University Press, 1966.

TAKAHASHI, A.: Napping, Mapping and Gossiping: Experiences of Fieldwork in Central Luzon, ADC/CYMMIT/Ford Foundation Seminar on Field Data Collection, Beirut, 1974.

TAYLER, R.J.: Agricultural Settlement and Development in Eastern Nicaragua, University of Wisconsin, 1969.

THIESENHUSEN, W.C.: Population Growth and Agricultural Employment in Latin America, with some U.S. Comparisons, in: American Journal of Agricultural Economics, Vol.51, Nov. 1969.

THODEY, A.R.: Marketing of Staple Foods in Western Nigeria, Food Research Institute, Stanford University, 1968.

THORWART, H.: Nichtlineare Modelle und Produktionsfunktionen, University of Hohenheim, Stuttgart-Hohenheim, 1971.

THÜNEN, J.H. von: Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie, I. Teil, 1. Aufl., Hamburg 1826, in: Sammlung sozialwissenschaftlicher Meister, Bd.13, Jena 1910.

TIEFEN, M.: Changing Patterns of Farming in Gombe Emirate, North Eastern State, Nigeria, Samaru Miscellaneous Paper 32, Ahmadu Bello University, Zaria, Nigeria (undated).

TOLLENS, F.E.: Problems of Micro-Economic Data Collection on Farms in Northern Zaire, Dep. of Agr.Econ., Kisangani Campus, National University of Zaire, 1974.

TROPICAL PRODUCTS INSTITUTE: Tropical Storage Abstracts, Buckinghamshire, England, 1975.

UCHENDU, C.V.: Rapid Survey Techniques for Interdisciplinary Research, ADC/CYMMIT/Ford Foundation Seminar on Field Data Collection, Beirut, 1974.

UDO, R.K.: Food-Deficit Areas of Nigeria, in: Geogr.Rev.61(3):415-430, 1971.

UPTON, M.: Agriculture in South-Western Nigeria, University of Reading, Development Studies No.3, 1967.

UPTON, M.: Agriculture in Uboma, in: Uboma - a Socio-economic and Nutritional Survey of a Rural Community in Eastern Nigeria, the World Land Use Survey, Occasional Papers No.6, 1966.

UPTON, M.: Farm Management in Africa, Oxford University Press, London, 1973.

UPTON, M.: Influence of Management on Farm Production on a Sample of Nigerian Farms, in: Farm Economist, Vol. II, No.12, 1970.

UPTON, M. and ANTHONIO, Q.B.O.: Farming as a Business, Oxford Tropical Handbooks, Oxford University Press, 1965.

UNIVERSITY OF READING: Research in Village Development South East Ghana, an Interim Report, Reading/Legon Joint Project, May, 1972.

UZOZIE, L.C.: Patterns of Crop Combination in the Three Eastern States of Nigeria, in: The Journal of Tropical Geography, 33: 63-72, 1971.

VANDEPUTTE, J.M. and BAKER, C.B.: Specifying the Allocation of Income Among Taxes, Consumption and Savings in Linear Programming Models. American Journal of Agricultural Economics, 52: 521-527, 1970.

VANDEVENNE, R.: Mécanisation de la Culture de l'Igname en Côte d'Ivoire, IRAT, Bouaké, Ivory Coast, (undated).

VERMEER, D.E.: Agricultural and Dietary Practices Among the Tiv, Ibo, and Biron Tribes, Nigeria, University of California, 1964.

WALKER, H.: Die wirtschaftliche Bedeutung des technischen Fortschritts im Ölpalmanbau, Universität Hohenheim, Diplomarbeit, 1976.

WANG, Y., NAGEL, F. und RUTHENBERG, H.: Bodennutzung und technischer Fortschritt auf Taiwan, Zeitschrift für Landwirtschaft, Sonderheft Nr.7, DLG Verlag Frankfurt, 1969.

WASTIE, R.L. and EARP, D.A.: Advances in Oil Palm Cultivation, the Proceedings of the International Oil Palm Conference Held in Kuala Lumpur, Malaysia, Nov. 1972.

WELSCH, D.E.: Response to Economic Incentives by Abakalaki Rice-Farmers in Eastern Nigeria, in: Journal of Farm Economics, Vol.47,No. 4, 1965.

WHETHAM, E.H. and CURRIE, J.I.: The Economics of African Countries, Cambridge University Press, Cambridge, 1971.

WICKHAM, T.: Managing Irrigation Systems for Increased Rice Fields, IRRI, Los Banos, Lagua, 1972.

WILSON, G.F. and ADEMIRAN, M.D.: Observations on Land Productivity Under Maize and Cowpea in Pure Stands and in Mixed Cropping with Cassava, IITA, Ibadan, Nigeria, 1975.

WILLIAMS, A.V., FLINN, J.C., LAGEMANN, J. and KNIGHT, C.G.: Farming Problems as Perceived by two Groups of Smallholders in South-Eastern Nigeria, IITA, Ibadan, Nigeria, 1975.

YANG, H.: Fact-Finding with Rural People, a Guide to Effective Social Survey, FAO, Rome, 1955.

YANG, W.Y.: Methods of Farm Management Investigations, FAO, 2nd Ed., Rome, 1965.

ZEISEL, H.: Die Sprache der Zahlen, Studien-Bibliothek, Kiepenheuer & Witsch, Köln, Berlin, 1970.

ZUCKERMANN, P.S.: Yoruba Smallholders Farming Systems, Department of Agricultural Economics and Management, University of Reading, Reading, 1973.

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[illegible] Zusammenhänge zw[illegible] [illegible] Produktion in den hu[illegible] [illegible]ussetzung für die Aufstellung von e[illegible] [illegible]icklungsprogrammen. Die vorliegende [illegible] [illegible] Bodenfruchtbarkeitsprobleme [illegible] [illegible] vorliegenden [illegible] versuchen die Landwi[illegible] [illegible]läufigen Verarmungsprozeß durch innerbetriebliche Diversifizierung und Nebenerwerb zu entgehen. Neben den hier gemachten Ergebnissen geben Beispiele aus anderen Versuchen und landwirtschaftlichen Projekten weitere Anregungen für zukünftige Entwicklungsmöglichkeiten.

The knowledge of the relationships between population growth and agricultural production in the humid tropics is an important prerequisition for the establishment of development programs. This study which is based on empirical data, examines these relationships for the case of Eastern Nigeria. Soil fertility problems are particularly pronounced on sandy tropical soils. The peasants try to overcome the process of diminishing returns by an increasing differentiation of their farming systems and by off-farm activities. Results from experiments and agricultural projects lead to avenues for the development of the farming systems.