THE IMPACT OF IMPROVED MAIZE TECHNOLOGY ON RESOURCE USE AND FARM INCOME IN THE NORTHERN GUINEA SAVANNA OF NIGERIA

BY

USMAN BAUTA KYIOGWOM

A DISSERTATION

Submitted to

apartment of Agricultural
Economics and Rural Sociology
Ahmadu Bello University Zaria

Partial Fulfillment of the
Requirements for the Degree
DOCTOR OF PHILOSOPHY

1997

A

ABSTRACT

The oil boom experienced in Nigeria in the 1970's precipitated a crisis in the agricultural sector. Government in retu::n, had initiated deliberate Policy measures to arrest the situation. The introduction OF the improved maize technology into the Northern Guinea Savanna (NGS) is one of such measures. The technology was introduced with the aim of increasing food production, reducing food import bills and to increase the farm income of farmers.

The main objective of the study was to determine the extent to which the technology has affected farm income and resource use. This is necessary because of the importance government attaches to equity as an objective of developmental efforts;.

In order to accomplish the objective of the study, five villages were selected based on past history of maize production, intensification of agricultural production, closeness to urban center (market) and accessibility. Ten farmers were selected from each village for an in depth study. Since all the farmers interviewed produced maize, they were categorized into three categories; Big, Intermediate and Small.

This was with a view to seeing the effect of the technology on different category of farmers and the implications for income distribution. The maintained hypothesis in this respect was that Big farmers by virtue of their position have better access to modern agricultural

inputs than the other categories and are likely to gain more from a modern technology which may exacerbate income inequality.

It was found that the maize technology has been widely adopted in the study area, but its increased use or acceptance is beinc threatened by inadequate and untimely availability of fertilisers, draught, possibility of contamination and the lack of proper understanding of the technology.

Ths pattern of labour use for the technology was the same with the competing enterprises with a peak demand at the time of weeding and harvesting. Resource were more productive in maize compared to the competing enterprises. In addition, the technology was more capital intensive.

The average net farm income of farmers seem to have increased and so was income inequality among farmers. The quantify of maize produced was significant in determining the net farm income. The inequality was more between villages than between individual members of households.

It was therefore concluded that though the technology has great potentials for increasing yield and farm income of farmers, the potential may not be sustainable unless it is modified to suit the socio-economic characteristics of the farmers and the bio-physical characteristic of the environment.

DECLARATION

This is to certify that the thesis entitled "THE IMPACT OF IMPROVED MAIZE TECHNOLOGY ON RESOURCE USE AND FARM INCOME IN THE NORTHERN GUINEA SAVANNA OF NIGERIA" submitted in partial fulfilment of the requirement for the degree of DOCTOR OF PHILOSOPHY Agriculture Economics, of Department of Agricultural Economics and Rural Sociology Ahmadu Bello University, Zaria, is a record of bona fide research carried out by Usman Bauta Kyiogwom and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation and sources of literature have been duely acknowledged.

(Prof. A.O. Ogungbile)
Chairman
Supervisory Committee

CERTIFICATION

This thesis entitled "The Impact of Improved Maize Technology on Resource Use and Farm Income in the Northern Guinea Savanna of Nigeria" by Usman Bauta Kyiogwom meets the regulations governing the ward of the degree of DOCTOR of Philosophy in Agricultural Economics of Ahmadu Bello University, Zaria, and is approved for his contribution to knowledge and literary presentation.

(Prof. A.O. Ogungbile)
Chairman, Supervisory Committee

Signature and Date 31/10/

(Prof. J.O. Voh)
Member Supervisory Committee

Oct 31, 1997
Signature and Date

(Dr. M. I. Kolawole)
Member, Supervisory Committee

31/10/97
Signature and Date

(Dr. D. Phillip)
Member, Supervisory Committee

31/10/97
Signature and Date

(Dr. D. Phillip)
Head of Department

4-11-97
Signature and Date

DEAN, POST GRADUATE

ACKNOWLEDGMENT

I am grateful to God and all those who contributed in one way or the other to the successful completion of this thesis. Space may not allow me to mention all names.

I specifically wish to express my sincere appreciation and deep sense of gratitude to Professor A.O. Ogungbile, Chairman of my Supervisory Committee for his valuable guidance, continued patience, encouragement, ungrudging help, inspiration and constructive criticism and suggestions in the course of this study.

I also wish to express my indebtedness and deep sense of gratitude to Prof. J.Voh and Dr. M.I. kolawole for serving as members of my Supervisory Committee. I am very thankful to them for their valuable help and suggestions. The comments and suggestions of Dr.D.A.Phillip are highly appreciated.

My sincere gratitude and appreciation to Dr. J. Smith, formerly of Research and Crop Management Programme, International Institute for Tropical Agricultural (IITA) Ibadan for her supervision at the early stage of this study.

I will ever remain grateful to all my colleagues in the Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto. I specifically wish to thank the Head of Department of Agricultural Economics and Extension, K.M. Baba, the Dean Faculty of Agriculture, Usmanu Danfodiyo University,Sokoto, Dr. M.D.Magaji, I. Mohammed, C.O. Mouneke, H.M. Bello, Dr. Dogara Bashir and Saminu Ibrahim for the help they rendered to me. The encouragement from Dr.A.M.Awodola and Prof.B.R.Singh is highly

TABLE OF CONTENTS

LIST OF TABLES

TABLE

PAGE

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Technological Change and Agricultural Production

The conventional wisdom, especially among policymakers in most developing countries, is that accelerated increase in agricultural production can only be achieved by the introduction of modern agricultural technologies. This may be informed by the consideration that the traditional farmer is efficient, within the constraints that he finds himself (Schultz, 1964 and Norman, 1972).This is referred to as efficient but poor hypothesis.

Hopper (1975) further elaborated that in a largely traditional agriculture, the marginal increment to production will be small due partly to the low productivity inherent in traditional factor inputs and partly to diminishing returns to the additional factors of production in the production process. This has been well articulated in the high pay-off input model of Agricultural production (Schultz, 1964)[1]

Schultz argued that high pay-off inputs from outside the agricultural sector together with relevant education are necessary before an appreciable change can take place. Reference is often made to the success of Green Revolution, through the introduction of new seed varieties and associated inputs T.W. Schultz (1964), p.37 Transforming Traditional Agriculture, New Haven, Yale University Press.

In the recent past there has been considerable interest in the process of generation and diffusion of agricultural technology. Cromwell (1990) considered seed as probably the single most important input in all crop based farming systems and emphasized that the key to agricultural progress in developing countries is based on the adoption of improved seed technologies. Singh (1982) had observed that the production and diffusion of new farm technologies is one of the significant factors responsible for breaking the age-old stagnation that has characterized agriculture of some of the developing countries.

Experiences of agricultural technology policies in developing countries have been mixed. With respect to improved cereal varieties, the experiences with rice and wheat in Asia, termed the Green Revolution, had notable and encouraging examples of the development and promotion of modern agricultural technology. In some instances, modern technology may not be in the interest of the generality of the rural poor. Even when new technologies had helped increased production there might have not been a matching increase in income for majority of the rural population. In some cases, change may be accompanied by declining income equality or growing income disparity. In fact, there appears to be two central economic issues in the current debate on the impact of seed-fertilizer technology in developing countries; efficiency of production and income inequality. This study attempted to determine the impact of the improved maize technology on the farmers, farm resource use and on farm income in the study area.

1.2 Improved Maize Technology

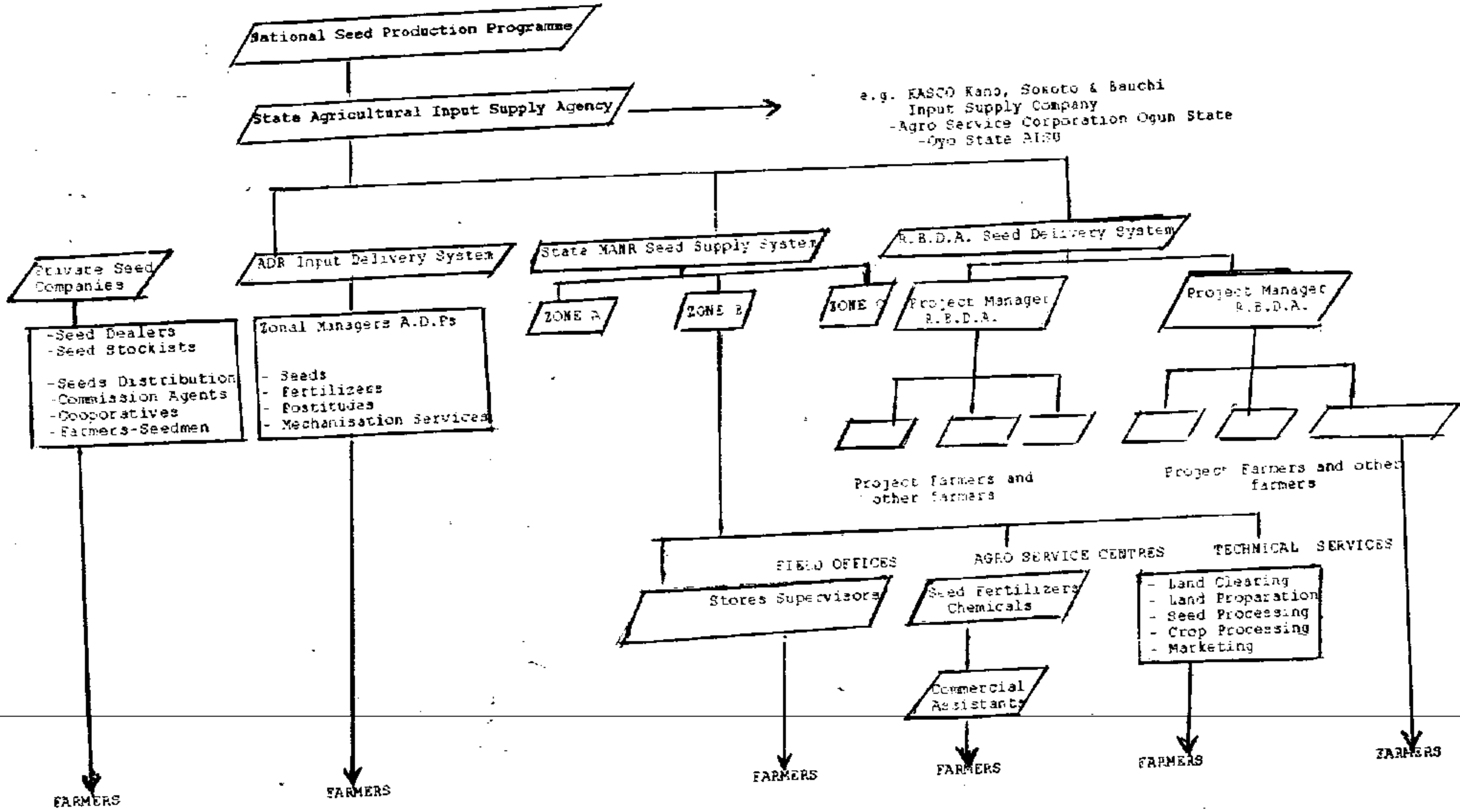
Faced with debilitating food crisis exacerbated by the oil boom experienced in the 1970's which led to increase food demand, soaring import bills and spiralling inflation, government adopted measures to ameliorate the situation. The introduction of improved maize technology into the Northern Guinea Savannah(NGS) is one of such measures. The measure aimed at increasing agricultural productivity, improve farmers well- being in particular and close the food gap in general. The technology is made up of a number of varieties and standard recommended practices.

Maize is one of the most important cereal crops in Nigeria. It is widely grown in the southern parts of the country where it can be grown two (2) times in a year. It has, of recent, acquired almost the same status in the Northern Guinea Savanna where its greatest potential is said to exist (Ologunde, 1987).

1.2.1 The Varieties

The improved maize varieties grown in the country are products of International Agricultural Research Centers (IARCs). Two germplasms TZB and TZPB were developed during the early days of the International Institute for Tropical Agriculture's (IITA), programme on maize. TZB originated from Africa and Latin America with a major contribution from the composite B. TZPB which was derived from "Tuxepeno Planta Bojat" by International wheat and Maize Improvement Center (CYMMT). These varieties were first released as new varieties with the names FAR27 (TZPB) and FAR34 (TZB). Both varieties have a good resistance to tropical rust and lowland blight. TZPB is widely grown in the Forest Zones whereas TZB is widely grown in the savanna zones (Federal Ministry of Science & Technology, 1985).

Recommended varieties for the NGS which were initially introduced are TZB, TZA and NCA, NCB and S123. Recently TZESR which is early maturing has been introduced into the drier Northern part of the NGS while TZSR has been introduced into the Southern part. In addition to these open pollinated varieties hybrid maize is also widely grown in the study area. These seeds were produced and distributed to farmers through various agencies as shown in Figure 1.1



Source: Joshona, A. (1985)

Fig. 1.1 FLOW OF IMPROVED SEEDS TO NIGERIAN FARMERS

1.2.2 Recommended Cultural Practices

The other components of the technology are recommended cultural practices which include activities that need to be carried out beginning from site selection to the time of harvest and during storage in order fully exploit the advantages of the technology.

1.2.2.1 Site Selection.

Maize grow well in all well-drained tropical soils with plenty of organic matter. Soil that has been cropped with maize without fallow should be avoided even if adequate fertilizer is to be used. Maize should be rotated with legumes, cereals and especially deep rooted crops.

1.2.2.2 Land Preparation.

Land clearing should be carried out well ahead of the rains. Suitable ridges should be made as soon as the rains start.

1.2.2.3 Planting Date.

Maize should be planted early when the rains are well established and immediately after a good rain to enable the seeds benefit from early release of nitrate from the soil.

1.2.2.4 Seed Treatment.

Maize seed should be dressed with Aldrex T" or "Fernasan D" to protect the seeds from soil-borne pest and birds before and after germination. A sachet of the chemical should be used per 3 "mudus" of seed (i.e. above 4.02kg).

1.2.2.5 Spacing.

For open pollinated maize varieties, planting should be done on ridges 75cm apart with 25cm spacing between stands. For good quality, seed planting should be one seed per hole, otherwise plant 2 to 4 seeds per hole and then thin to one plant per stand 2 to 3 weeks later. This seed rate will required 20-25kg seeds per hectare. For hybrid maize plant one seed per hole on ridges that are 75cm apart and 18 to 25cm between stands. This will require about 15kg/ha of seed. No recommendation has been given on the spacings for inter-cropped maize.

1.2.2.6 Fertilizer Application.

For open pollinated maize, apply 100kg of N_2/ha and 50kg of P_2O5/ha. This can be obtained from any combination of the available types of fertilizers. Application should not be delayed beyond planting time because it promotes good roots development and must be made available as the roots start to develop. For hybrid maize apply 150kg N_2O/ha and about 60kg/ha of P_2O5 and K_2O. For both hybrid and open pollinated maize 3.4 metric ton/ha of Farm Yard manure(FYM) can be used as an alternative to artificial(inorganic) fertilizer.

1.2.2.7 Weeding.

Timely weeding is very essential especially at the early stages of growth. Weeding should be done 2 to 3 times before harvest.

1.2.2.8 Harvesting. No specific time or method of harvesting is recommended but the crop should be harvested in the form and time desired.

1.2.2.9 Storage. Maize meant for future use should be dried to 10-12% moisture content and properly stored. The store or granary should be very clean before and during storage. This is aimed at preventing loss of grains due to storage pests. Apart from hygienic condition of the granary, chemical control measures must also be used. Maize that will be stored up to six (6) months or more should, in addition to hygiene in the store be treated with Actellic 2% dust. The EC formulation should be used at the rate of 10ml in 200ml of water per metric ton of maize.

1.3 Conceptual Framework

Technology is the totality of ways or means of carrying out an activity. Technological change in agriculture means all new forms of farm inputs, practices and services, new crop varieties, chemical fertilizers, insecticides, herbicides, farm machines and equipments, agricultural extension and so on. Technological change is one of the main determinants of production relationship and income of farmers.

Technological change usually has two effects on agriculture. It may alter the structure of the agricultural production process by changing the physical and value productivity of farm resources. In this type of technological change, the production function change with a greater output from a given level of input of farm resources as depicted graphically in Fig 1.2. This change may lead to an increased discounted profits or decreased losses of the farm-firm. This typifies biological innovation which according to Olayide and Heady(1982), include improved varieties, fertilizers and improved Livestock rations which have physiological effect in increasing output from a given level of resources.

Another effect of technological change in

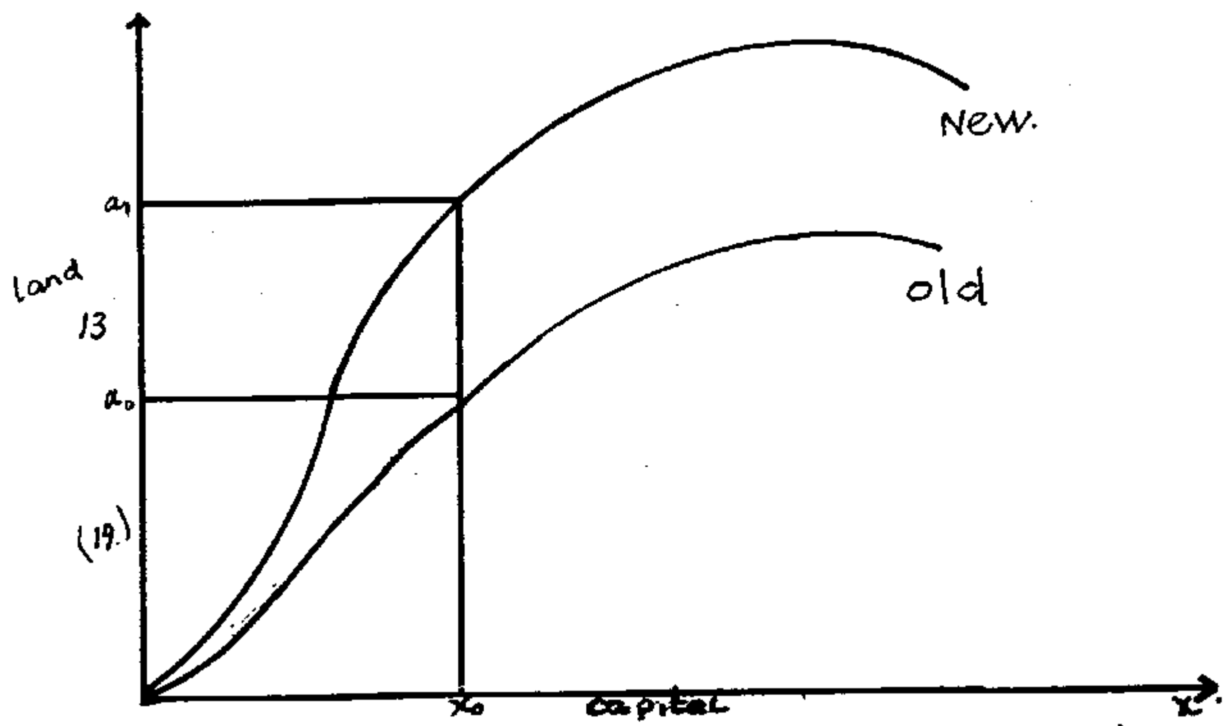


Fig 1.2

Shiff in production function due to technological change.

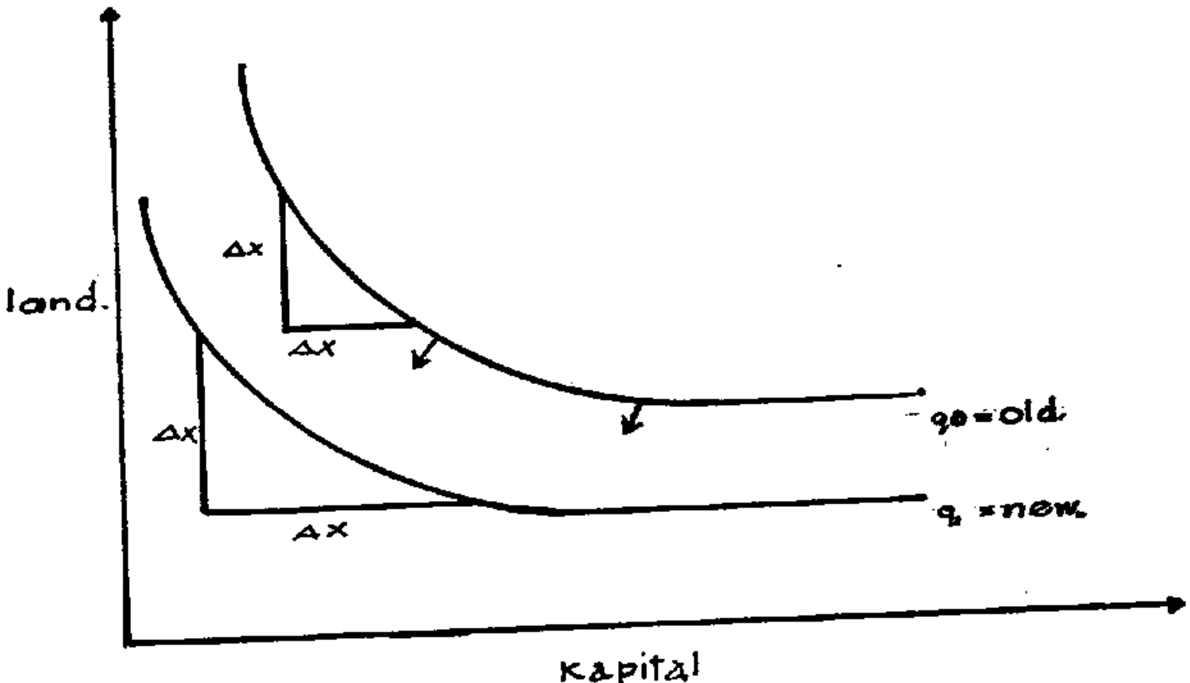


FIG 1.3

Factor - Saving Technological Change

agricultural production is on resource substitution or factor share. This imply the innovation alters the marginal physical rates of substitution(the elasticity of substitution) in favour of one factor of production. This type of technological change, alters the entire production surface since the production coefficients of factors of production or relative factor shares change. Fig 1.3 represents a change in the production surface where q_0 is the old isoquant and q_1 is the new isoquant. According to Olayide and Heady(1982), mechanical innovations that substitute capital for labour without changing the physiological constitution of plants or animals are typical of this type of technological change.

The extent to which technological change affects net returns depend mainly on the price elasticity of demand for the specific product and also its effect on output and cost of production.While not detracting from the former, this study focused on the later.

The ultimate effect of a technological change is that it transfers income and wealth between individuals irrespective of whether total net income is increased or decreased(Olayide and Heady 1982). Income redistribution or transfer may be inter or intra-industry. Intra Industry transfer occur when the techniques for one commodity or geographical region are improved more than for a competing commodity or region. Inter-sectoral transfer is outside the scope of this study.

Technology in this text is the application of knowledge involving the use of a combination of material inputs of bio-chemical nature . One main characteristics of modern agricultural technology is it is complementary in nature and underline the "package of practices" approach in contrast with the single factor approach (Rayu, 1973). Traditional Technology is referred to as the cultivation of traditional crops like millet and sorghum using small dose of chemical fertilizer, while the improved technology refers to cultivation of improved maize varieties with project recommendations*. Traditional Technology was considered as farm practices that do not fall under project recommendation. The sorghum or millet varieties grown in the area are still mainly the local varieties under the traditional system of production.

1.4 The Research Problem

The adoption of new farm innovations has attracted considerable attention among development economists. This is predicated on the low level of agricultural production in developing countries and the opportunities offered by

---

The improved maize technology was introduced initially in the area through the Funtua Agricultural Development Project. Sorghum was introduced too but it was met with limited success. Millet was not considered as a target crop in the ADP (Balcet and Candler, 1981 pp. 147-165).

farm innovations for increasing agricultural output and income substantially.

The introduction of new agricultural technology has many shortrun and longrun implications for the economy in general and for the agricultural sector in particular. In the shortrun the technology may increase the incomes of those who adopt it though the extent of the increase on various categories of farmers in the longrun may be debatable.

With the introduction of the improved maize technology in the study area, the precise nature and the exact magnitude of its impact on the income of farmers have not been investigated. It is important to know the impact of the technology because it is increasingly being felt that the real farm problem is not only due to low average incomes in agriculture but also to its unequal distribution (Buting, 1985). In fact, most developing countries realize that growth in per capita Gross National Product (GNP) can best be considered as a rough proxy for development. Genuine development takes place only when there has been an improvement over time in unemployment, poverty levels and inequality.

The Third National Development Plan 1975 to 1980 recognized the importance of inter-factorial and inter-personal distribution of incomes in development policy. The main limitation had been the complete lack of relevant data on the subject to achieve the interpersonal equity objectives.

The main issues of concern in the impact studies of modern agricultural technology on farmers are; efficiency and equity. Efficiency is looked at in terms of the intensity of resource utilization and productivity among the different categories of farmers and regions. While equity is looked at in terms of the distribution of gains in output and income between different categories of farmers in an area. Related to these issues is the impact of the technology on the cost and organization of production.

The issues highlighted in the preceding paragraphs arouse concern on the nature of the improved maize technology. Answers to the following questions will help in understanding the nature of the technology:

(1) What is the effect of the technology on factor productivity and pattern of resource use?

(2) Are some resources more productive than others due to the nature of the technology?

(3) Do all categories of farmers use factor inputs proportionately?

(4) What is the effect of the technology on farm incomes?

(5) Do some categories of farmers reap more from the technology than others?

(6) Does this lead to great disparities in incomes between the various categories of farmers?

(7) Have the technologies affected the farming system or the organization of production in the area?

(8) Is there any tendency towards monocropping as most modern agricultural technologies recommend?

The study attempted to address some of these questions raised.

1.5 Study Objective

The main objective of the study is to determine the impact of improved maize technology on resource use and on the incomes of farmers in the study area. The following are the specific objectives:

1. To describe the historical trend and the extent of the adoption of the technology;
2. To determine the effect of the technology on resource productivity, resource use, farm incomes and cropping pattern.
3. To determine the degree of income inequalities among farmers as a result of the adoption of improved maize.
4. To determine the effect of the technology on cropping pattern, and
5. To recommend how the technology can best be used to increase agricultural production and income equality among farmers in the study area.

1.6 Justification of the Study

Most researches on the adoption of improved technology in Nigeria have often concentrated on the characteristics of farmers and communication variables as explanatory variables of adoption (Manu, 1979; Clark and Akinbode 1968; Basu, 1969; Alao, 1971). The shortcoming of this approach is that it focuses entirely on the farmer. Factors such as the nature of the technology and institutional support system are not always considered.

The adoption of any technology is an outcome of the interaction of bio-physical characteristics of the environment and the characteristics of the technology itself. Moreover, technology is dynamic. A study of this nature will help to determine the suitability of the technology to the bio-physical, and socio-economic characteristics of the environment. This will help to set further research priorities, extrapolation of result to similar environments and target existing technology and future technologies to appropriate areas.

It is evident from past efforts that government's strategy to increase food production and improve farmers' welfare is to motivate them to adopt yield augmenting technologies (Federal Government of Nigeria, 1972 and IITA, 1977). So, the public sector in Nigeria, like other developing economies, has assumed a major role in furthering technology advancement in agriculture. Social service make up an important aspect of the total quality of services being directed at new inputs, and in speeding their adoption. So, government should be concerned about equitable distribution of the benefits resulting from the use of the new technologies.

Government policy on technology advancement can alter the pattern of farm income distribution among farmers. However, for the design of policies to effectively intervene in this respect, it is necessary to gain a prior understanding of the nature and the magnitude by which the new technology has influenced farm incomes.

A knowledge of the constraints to production at different income levels and area can permit a more efficient targeting of interventions to specific groups and regions. This is particularly relevant in developing countries where resources levels are often low and the urgent concern to produce as much as possible with those scarce resources is prevalent. Lack of adequate information will restrict effective policy action. So the need to understand the effect of the technology on incomes among farmers will assist in the development of a sound research and development policies for a more equitable agricultural growth in the sector in Nigeria.

1.7 Outline of the Study

The study consist of eight chapters. Chapter one is the introductory chapter. It highlighted the research problem, the general focus and the relevance of the study. Relevant literature on farm productivity and the need for the introduction of modern technology into traditional agricultural system and its effect income distribution are contained in chapter II. Chapter III describes the data collection methodology and provides a general overview of the ecological and economic characteristic of the study area.

The historical trend of the adoption of the improved maize technology in the study area is contained in chapter IV. The socio-economic characteristics of the respondents are examined in chapter VI. While the impact of the technology on resource productivity, intensity of resource use and cropping pattern is contained in chapter VI. Chapter VII examined the impact of the technology on farm incomes of farmers. The summary and conclusion are contained in chapter VIII.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Modern Technology in Traditional Agriculture

Agriculture in Developing Countries (DC) is characterized by low productivity conditioned by the traditional mode of production. These methods are based on age-old traditions using traditional factors of production; land and labor. Capital inputs are sparingly used and where they are used they are mostly the direct embodiment of labor in the form of land improvement, building and ownership of small tool.

Early theories on economic development considered development in a two sector model. This involved the allocation of surplus agricultural labor whose contribution was considered to be zero, to industries where they become a productive part of labor force at a wage rate equal to or tied to institutional wage in agriculture (Lewis, 1956; and Ranis and Fei, 1961). It was then argued that labor can be removed from small farms in the agricultural sector without a noticeable effect on output and nourish the expanding modern industrial sector for an effective take-off to a self-sustaining growth.

Schultz (1964) disagreed with the surplus labor doctrine of traditional agriculture. Using data from India and elsewhere he elaborated that the marginal productivity of labor in agriculture is zero. He, on that basis propounded his "efficient but poor" hypothesis. It explained that there are comparatively few significant inefficiencies in the allocation of factors of production in traditional agriculture. This view has been supported by Singh (1976) who also observed that whatever inefficiencies that exist in traditional agriculture are probably due to inherent bottlenecks such as lack of knowledge and low level of technology. By implication, farmers in Developing Countries are caught in a low level of equilibrium(low level equilibrium trap) and no appreciable increase in agricultural production can be achieved by reallocating the factors at the disposal of the farmer. In addition, for agricultural development to take place in the traditional system of production, modern inputs must be supplied and used by farmers.

This may have informed the considerable interest developed on the generation and diffusion of new agricultural technologies in the Developing Countries in the recent past. Cramwell (1990) summed the general perception of modern inputs in the traditional agricultural system that seed is probably the single most important input in all crop-based farming systems which determine the upper- most of crop yield and productivity. These new seed varieties have in turn stimulated interest in other aspects of agricultural development like resource productivity, intensity of resource use, and income distribution.

2.2 Resource Productivity in Traditional Agriculture

The importance of productivity as a factor in economic development is universally accepted. The state of development in most Developing Countries has been attributed more to lack of increase in resource productivity than anything else. Increase in resource productivity is imperative in most developing countries where resource are often low and there is the ever urgent concerns to produce as much as possible within those scarce resources. In fact, it has been observed that productivity growth is an absolute requirement in developing countries and a fundamental requisite in any form of planning irrespective of the stage of development and the socio-economic system (Cheema, 1987).

Increased agricultural production is one of the prerequisites for economic development. This is particularly true for developing countries where a large proportion of the population live in the rural areas and depend on primary production. Heady (1966) opined that one of the potent strategies for increasing agricultural production particularly in traditional agricultural system, is a measure designed to increase the level of farm resource as well as make efficient use of the resources already committed to the farm.

Policies for effective attainment of this cherished objective require knowledge of aggregate farm level resource availability and the difference in productivity of these resources. Such knowledge would help to indicate the possibilities of increasing agricultural production and the desired adjustment in resource use and allocation.

One of the early studies on resource use conducted in Africa was carried out in East Africa by Clayton (1956). It was designed to estimate labor requirement for individual enterprises. The data were collected from demonstration plots. He concluded that the viability of the farm plans in the area he studied depended on adequate human nutrition, soil fertility and cash incomes.

In a more elaborate study in Zambia Elliot *et al* (1970) examined farm labor productivity using indices to represent factors such as good farm practices, experience and knowledge of farmers, formal education, general awareness. A regression analysis was used and it was found that 49% of production per acre was explained by basic physical farm inputs like labor, oxen and tractor power use. While 38% was explained by social variable like formal education general awareness, experience and knowledge of farming and so on.

Spencer and Byerlee (1977) in a study of agricultural labor use, income and productivity in Sierra Leone found that there was significant difference in productivity between regions but there was more difference between traditional and modern system of production.

Ogunfowora *et al*, (1974/75) in a similar study in Kwara State, in Nigeria used the Marginal Value Products (MVP) computed from production function coefficient as measures of resource productivity and compared farm resource productivity between villages. It was found that the MVP of resources differed greatly between villages. The differences was attributed to inputs used, value of crops produced and climate prevailing in the villages in the survey years.

In Northern Nigeria a number of farm level studies have been carried out as early as the early 1960's. The first was by Lunning (1967) in Sokoto Province in the 1961/62 production session. About 30-40 households from seven villages were used. Output was regressed against its determinants like farm size, labor, recurrent expenditure and so on. It was found that family size was positively related to area put into cultivation. Farm expenditure was the most important determinant of gross-returns from major crops and labor the least. Though the ratio of the marginal productivity of labor to its opportunity cost was 0.72 statistical test proved the labor was efficiently used.

In a study conducted by Norman (1972) in Zaria area, which was a part of a larger study replicated in Bauchi and Sokoto areas and later in Kwara State by Olukosi (1979) under the auspices of Rural Research Unit of Ahmadu Bello University, Zaria, a detailed farm inputs and outputs data were collected from 124 farmers. It was found that the seasonal nature of farm work resulted in labor shortages at peak periods of labor demand. Norman's results supported Lunning's that family size was an important determinant of farm size.

Norman (1972) regressed the inputs of agricultural production against the outputs and found that the quality of land was the most important determinant of farm productivity. The result in addition indicated that hired labor was almost as much as six (6) times more productive than family labor. Test of significance to test whether or not the marginal value product of the inputs differed significantly from their opportunity cost showed that they were not, except in the case of hired labor. So, in terms of the allocation of inputs only hired labor was not used in optimally efficient manner

In a production function analyses of data collected from farmers in South-west Kano in 1974/75 production year, Matlon (1977) found that higher income households generated substantially greater incomes than poorer farmers after controlling for differences in size of holding. The return to household labor, management and capital per hour were N0.16, N0.20 and N0.32 for low, middle and high income categories respectively. He also found that the three measures of productivity; the value of output per hectare, gross margin per hectare and the returns to household labor, management and capital all indicated a strong direct relationship between production relationship and income. Higher income households farmed their upland fields more intensively with respect to both fertilizer and labor. Though fertilizer use was generally low high income farmers applied about 27% more fertilizers per hectare on the average than low income ones.

Mijindadi (1981) in his study of the production efficiencies on farms in Northern nigeria used 340 farmers selected from Kaduna, Bauchi and Sokoto States. The study aimed at isolating factors which determine farm level productivity, determining the level of technical efficiency of individual producers and to identify factors which contributed to variation in technical efficiency within and between farm areas. He used production function analysis.

He found a significant difference in output per man within each area as well as between areas. Factors that significantly contributed to the difference in output per farm were identified as total cultivated area, the imputed cost of seed and cuttings, and the amount of labor employed. Significant inter-area difference in marginal productivities for a number of factors were also revealed. This study investigated what the situation is like after the introduction of the improved maize technology on different categories of farmers and areas.

2.3 Resource Use in Maize Production

The West African uniform - maize trials began in 1967 with the aim of identifying high yielding germplasm among improved maize varieties. Samaru-Zaria in Nigeria and Farako-Ba in Upper Volta, both in the Guinea Savanna Zone of West Africa gave the highest yield (Kassam *et al*, 1975).

Maize requires adequate annual rainfall of between 760-1530mm preferably evenly distributed. It also requires a high level of soil fertility. The relatively low fertility of savanna soils had placed maize at a disadvantage compared with millet and sorghum which are the traditional crops in the area and they thrive reasonably well under these harsh conditions. In fact, Norman *et al*, (1976) observed that the enormous potential for maize production can only be realized, with a high level of fertilization, optimum plant population, and adequate weed control measures. This arouse concern about the cost structure and consequently the profitability of the improved maize technology compared with the main and competing traditional crops in the area; millet and sorghum.

Kitsopanidis and Psychadakis (1972) analyzed the economies of maize production in the Macedonian districts of Greece from 1968 to 1970. They used records and accounts of farms and a production function analysis. They found that yields were favourably affected by land and fertility. Profits, return to labor and capital expressed as a percentage of farm income increased more rapidly than yield. In addition, maize production was found to be more profitable and competitive than other crops.

Marginal analysis indicated that marginal productivity of land was higher than land rent. On the other hand, marginal productivity of labor was lower than labor wage. Though the marginal productivity of fertilizer covered cost, there was no room for further increase in the use of fertilizer from economic point of view. The authors concluded that the production of improved maize varieties depended on better quality land, appropriate fertilization and a direct decrease of production cost by substituting labor with machinery. The study was based on experimental data which may not reflect the true position of things at the farmer's level.

Adesimi (1982) examined resource use efficiency and the productivity of maize among farmers in farm settlement in Western Nigeria, a sub-humid rain forest region. He also used marginal analysis and found that ratios of the marginal operating costs, costs of seeds, fertilizers, hired farm machinery, spraying chemicals, and size of area planted with maize to their marginal value products (MVP's) were greater than one. While the ratios of labor used and expenses on services of durable assets were less than one. This suggested that farmers would benefit more if they spent more on operating expenses and use more land for maize production.

Balcet and Candler (1981) in a study of farm technology adoption in Northern Nigeria observed that maize, with adequate fertilization was more profitable than the existing mix-cropping system and other crops when grown sole except sugar cane. Sole crop sorghum gave gross revenue much lower than maize but significantly higher than traditional crop mixtures in the area like cotton/groundnut, sorghum/rice and cotton/maize. They believed that the differentials in the productivity of maize compared with other crops could more than compensate for the greater variability of yields and prices of maize. For instance, while maize yielded an average of 1500 - 2000 kg/ha with an upper limit of 3000 kg/ha on farmers' field compared with an average of 3,500kg/ha and peaked at over 6,000kg/ha on demonstration plots, sorghum yielded 1000 - 1500kg/ha, both on farmers' field and demonstration plots.

Ahmed (1985) in a production function analysis studied the scale economies of maize in the savanna region of Northern Nigeria. He observed that the large farmers were more technically efficient than the small ones. However, the difference was not statistically significant. He concluded that capital intensive method of production lowered the cost of production and consequently increased the economic returns. The cost of producing maize was found to be negatively related to farm size. This imply that the smaller the farm size the higher the cost of production of maize.

Ogungbile and Olukosi (1992) compared the economic performance of hybrid maize with popular Open Pollinated Varieties (OPV) of maize grown by small-scale farmers in the NGs of Nigeria under the farmers managerial condition using economic analysis, they found that the average yields were 3.5 ton/ha and 3.0 ton/ha for hybrid maize and OPV respectively. Net returns per hectare for hybrid maize production were 76% and 46% higher than that of OPV in 1987 and 1988 respectively.

They concluded that though the production of hybrid maize and OPV were profitable to both small and large farmers, scarcity of fertilizer and its soaring cost may jeopardize the prospect for sustainable maize production in their area of study. The data were collected from monitored farmers. This study compared the profitability and productivity of maize with traditional competing crops in the study area; millet and sorghum. This is with a view to determining the prospects of maize production in the study area in the face of the scarcity of fertilizers and competition from millet and sorghum.

2.4 Income Distribution in Nigeria

Literature on income distribution is relatively recent. The focus had been on economic growth. Kuznets (1955) in one of the pioneering studies examined the nature and causes of long term. Changes in the personal distribution of income. He concluded that income inequality would worsen for a period and then improved. His views were well articulated in his inverted "U" shaped hypothesis.

Since Kuznets' exposition similar studies ensued. Ahluwaha (1974), and Adelman and Morris (1973) used static comparative analysis in a longitudinal studies of within country distributional changes over time to support Kuznets' findings. Similar results were obtained by Mincer (1960) and, Ranis and Fei (1964). They used cross-sectional data to compare income distribution within country.

Undoubtedly the Nigerian economy has experienced tremendous growth, but like most Developing Countries little is known about the size distribution and structure of personal incomes. Most studies on income distribution in Nigeria considered whether inequality was higher in rural or urban areas. Most of these studies have been based on income tax returns data, public sector staff list, and a few on surveys conducted.

In an analysis of tax return by the Central Bank of Nigeria, Eronini and Ndiomu (1978) found that the Gini Coefficient of income concentration was between 0.55 and 0.60 in Nigeria in 1969/70 and 1971/72 seasons. Etukudo (1979) in a survey conducted in Lagos and Ibadan found the coefficient to be between 0.53 and 0.54. Abudu (1980) in his analysis of Western tax returns for 1969/70 to 1974/75 seasons found that the coefficient ranged between 0.44 to 0.57. These figures showed a concentration of income to some extent but the data represented only the urban population which may not have reflected the true picture of what may have obtained in the rural areas .

A pioneering work on the intra-sectoral distribution of income in Nigeria was carried out by Baldwin and Dina (1956). Their analysis of income distribution among 187 farmers revealed that the poorest 27% received only 5% of the income whereas 50% of the income accrued to the top quintile.

Essang (1970) described and explained the patterns of income distribution among cocoa farmers in Western Nigeria. He reported a skewed distribution for both land and income. The Gini coefficient was 0.68 for the cocoa holding and 0.79 for cocoa earnings. He also found a high correlation between political status and the distribution of cocoa earnings. He attributed this relationship to the tenurial system which gave the traditional rulers custody over traditional lands. He concluded that the richer class had access to land as well as to modern inputs and credit than the poorer ones. Essang's study only covered earnings from cocoa but earnings from other crops and off-farm also affect the nature and pattern of income distribution among farmers.

In a more comprehensive study of farm income in Western Nigeria a high income concentration was observed and family farm income was found to have been determined by situation and scale of operation (Anon, 1972). Lageman (1977) in a similar study of three (3) villages in Imo State of Nigeria, a high population density area, found that the Gini coefficient was as low as 0.3 - 0.4. This indicated that there was not much income concentration.

The study conducted by Hill (1972) was among the pioneering studies on income distribution in Northern Nigeria. She examined factors associated with relative poverty and proffered causal relationship among farmers in the then North Central State of Nigeria, now Kaduna and Katsina States. She used about 171 farmers from a single village. Farming units were grouped into four (4) categories based on their relative ability to withstand the shock of severe poor or late harvest.

High Income households had more working members, more wives and larger farms. The problem with Hill's study is that it was carried out in a single village which may not bring out the locational effect and the effect of population density on income distribution. Besides, only crude farm management data were collected and no direct estimates of incomes were used.

Norman (1972) carried out a more comprehensive and broader studies on levels and distribution of incomes at village levels in Northern Nigeria too. Zaria was covered in 1967/68, and Bauchi and Sokoto in 1968/69 production seasons. Table 2.1 shows that income distribution was relatively equitable within villages than between villages.

Table 2.1: Income Distribution Among Farmers in Sokoto, Bauchi and Zaria Areas of Northern Nigeria.

Area/Village	Gini Coefficient	Mean Income Per capital N	Year
Sokoto			
Takatuku	0.2648	111.34	1968/69
Kaura Kimba	0.4043	-	-
Gidan Karma	0.2990	-	-
Zaria			
Hanwa	0.3588	196.73	1967/68
Doka	0.2986	-	-
Dan Maihawayi	0.5002	-	-
Bauchi			
Bishi	0.3728	75.15	1968/69
Nasarawa	0.3612	-	-
Mabayi	0.3873	-	-

Source: Norman and Pryor (1979).

Norman's studies were also cross-sectional. It only considered net income from crops, Livestock and did not include non-farm earnings. But, non-farming activities too may be a significant determinant of the distribution of income.

Matlon's (1977) work which estimated household income from all sources in 3 villages in Kano State is probably the most comprehensive study on rural income distribution in Northern Nigeria.

Table 2.2: Distribution of Income Among Farmers in 3 Villages in Kano State, in 1974

Income Measure	Village	Gini Coefficient
Total Income Per capita	Barbeji	0.2898
	Zoza	0.2251
	Rogo	0.3034
	All	0.2823
Farm Income Per capita	Barbeji	0.3298
	Zoza	0.2108
	Rogo	0.3504
Off Farm Income Per capita	Narneko	0.4588
	Zoza	0.5562
	Rogo	0.5404
	All	0.5306
Non-Agricultural Income per capita	Barbeji	0.5574
	Zoza	0.6759
	Rogo	0.5775
	All	0.6097
Total Income Per Household	Barbeji	0.3426
	Zoza	0.2624
	Rogo	0.3176
	All	0.3146

Source: Matlon (1977).

Matlon, like Norman found that there was less concentration of income among farmers. Productivity of land and labor were found to be the most important determinant of income. Off-farm income provided by hired farm labor employment was found to reduce inequality in the lower income households but income earn from petty trading increased income inequality among the upper income households.

Malton further revealed that access to agricultural extension and modern inputs were closely correlated with the relative income ranking of a household. He concluded that efficiency of resource use rather than variation in resource endowment was more important in explaining income inequality.

A more recent study by Olukosi (1979) was conducted in Kwara State. He described and explained the structure and distribution of income among rural farmers. One notable feature of the study is that it was longitudinal. The study was initiated in 1969 and was repeated in 1974 to observe the determinant of income changes over time. Table 2.3 and 2.4 summarize his findings.

Table 2.3: Summary of size Distribution of Household Incomes in Sampled Villages in Kwara State, Nigeria, 1969

Income Measure	Village	Gini Coefficient	Coefficient of Variation
Net Farm Income	Ipetu	0.3842	0.9146
per capita	Odo-ore	0.4257	0.8006
	All	0.4027	0.8950
Net Farm Income	Ipetu	0.3648	0.7883
per consumer	Odo-ore	0.4157	0.7853
	All	0.3951	0.8250
Net Farm Income	Ipetu	0.3275	0.6219
Per Household	Odo-ore	0.4185	0.8402
	All	0.3772	0.7199

Source: Olukosi (1979)

Table 2.4: Summary of Size Distribution of Income by Household and sampled Villages in Kwara State, 1974

Income Measure	Village	Gini Coefficient	Coefficient of Variation
Net Farm Income Per capita	Ipetu	0.3492	0.6769
	Odo-ore	0.3609	0.7380
	All	0.3818	0.7380
Net Farm Income per Consumer	Ipetu	0.3548	0.6786
	Odo-ore	0.3802	0.7731
	All	0.3879	0.7396
Net Farm Income Per Household	Ipetu	0.369	0.7831
	Odo-ore	0.5456	0.8472
	All	0.4871	0.8068

Source: Olukosi (1979).

Olukosi's findings corroborated that of Matlon and Norman. An average Gini Coefficient of 0.350 was found indicating that income was fairly equitably distributed. In addition, it was observed that the causes of poverty could not be attributed to one factor but rather to a combination of factors which include nature of cropped land and operating capital. Poverty was found to be a major cause of low productivity among rural farmers. It was consequently observed that this need to be taken into serious consideration in the development of improved technologies if they are to be compatible with resource poor nature of farm families.

The preceding literature can be summarized as below:

1. Agricultural production in most developing economies has been caught at a low level equilibrium trap. Increase in production and productivity can only be achieved through the introduction of modern technology, and seed technology is one of such technologies. This probably informed the introduction of the improved maize technology in the NGs.

2. Studies on the profitability of maize production in the study area in the past have compared Open Pollinated Varieties (OPV) of maize with hybrid maize production (Ogungbile and Olukosi, 11992 and Edwin, 1991). Hybrid maize was found to be more profitable than OPV. Balcet

and Candler (1981) compared maize with other crops enterprises and maize was found to be more profitable than other crops but the study was under supervised condition in the former Funtua Agricultural Development Project. This study compared the improved maize technology with other competing crops like millet and sorghum under the farmers' managerial conditions given their resource-poor nature. Besides, Balcet and Candler's studies was carried out at the introductory stage of maize in the area; it would be interesting to see what has happened now that it has been established in the area.

3. Studies on resource productivity by Lunning (1967), Norman (1972), Matlon (1977) and Mijindadi (1981) compared resource productivity between farmers. This study not only compared resource productivity between farmers and villages but also between the improved maize technology and other competing crops in the area like millet and sorghum.

4. Matlon (1977) and Norman (1972) found not much income concentration among farmers in the study area. This imply that income in the study area seemed equitably distributed. This study examined what the situation is now like after the introduction of the improved maize technology. Essang (1970) and Matlon (1977) found that all categories of farmers were not equally accessible to

modern inputs. So, the improved maize technology may has been a factor that have influenced income distribution in the area.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 The Study Area

The study was carried out in 5 villages located in the Northern Guinea Savannah of Nigeria. Northern Guinea Savannah has been aptly described in other studies by Norman, 1972; Kowal and Knabe, 1972; Matlon, 1979 and Elemo, 1985. The proceeding sub-sections are a summary of their description.

3.1.1: Agro-Climate

The area lies within latitudes $8-13^{oN}$ and longitudes $3-4^{oE}$. It covers an estimated area of 23 million hectares.

The climate can be classified as dry sub-humid with a severe deficit in rainfall from October to September. From November to April a little growth in vegetation is possible with irrigation. At this period locally adopted weedy vegetation show net loss of dry matter but manage to survive. The average annual rainfall is between 760mm to 1150mm while the average annual evaporation from the water surface is about 1900mm. Water is said to be the primary factor limiting agricultural production in this semi-arid region with a highly variable annual rainfall.

The farming system in the area is determined by the seasonality and the duration of rainfall. The rainfall pattern is unimodal peaking in August. The wet season start from May when precipitation exceeds evaporation. The water regime in this area is in accord with the production of annual crops. Crops such as millet (Gero), sorghum, maize, groundnunts and cowpea are grown mostly in mixture in such a way as to enable them effectively exploit the environment.[1] The water requirement of annual crops is small in the early stages when it covers only a fraction of the ground but rises with increasing cover to full cover and falling off again towards harvest as the crops dry up.

The pattern of water requirement is well matched by the pattern of water availability and a wide range annual crops can be grown. The limitation being water shortage at the end of the growing season for long season crops like cotton and wet condition's at harvest for short season crops.

---

1 Other advantages of mixed cropping have been documented. It had been observed that it is a strategy for income maximization (Norman, 1975, p.12); risk avoidance (Abalu, 1976, p.17); Balance Nutrition (Abalu & Da'Silva, 1976) and income maximization, subject to risk aversion and subsistence food production constraints (Balcet and Candler 1981, p.xiv).

The area has a distinct dry and wet seasons. Immediately after the cessation of rains the North-East trade winds blow dry cool and dusty winds. The dry season is initially cool with the lowest temperatures occurring in December and January.

3.1.2: Vegetation

The vegetation is savanna woodland typified by the preponderance of Isoberlina doka and Hyparrhenia species. In many places the woodland has given way to parkland and dominated by Parkia biglobosa and Adosonia digita. Striga spp constitute a serious menace to cultivated cereals crops in the area. Spear grass (Imperate cylinderica) corn grass (Rottbellin exaltata) and sedges (Cyperus spp) always become a problem when the plot is continuously cultivated.

3.1.3: Soil Type

Highly weathered ferruginous soils predominates in the Northern Guinea Savannah. The soils vary depending on the parent stock. The soils are highly laterised due to loss of silica components which release metal oxides that tend to cement the soil and are often deposited in the profile as mottles concretions or hardpan. Immobilization

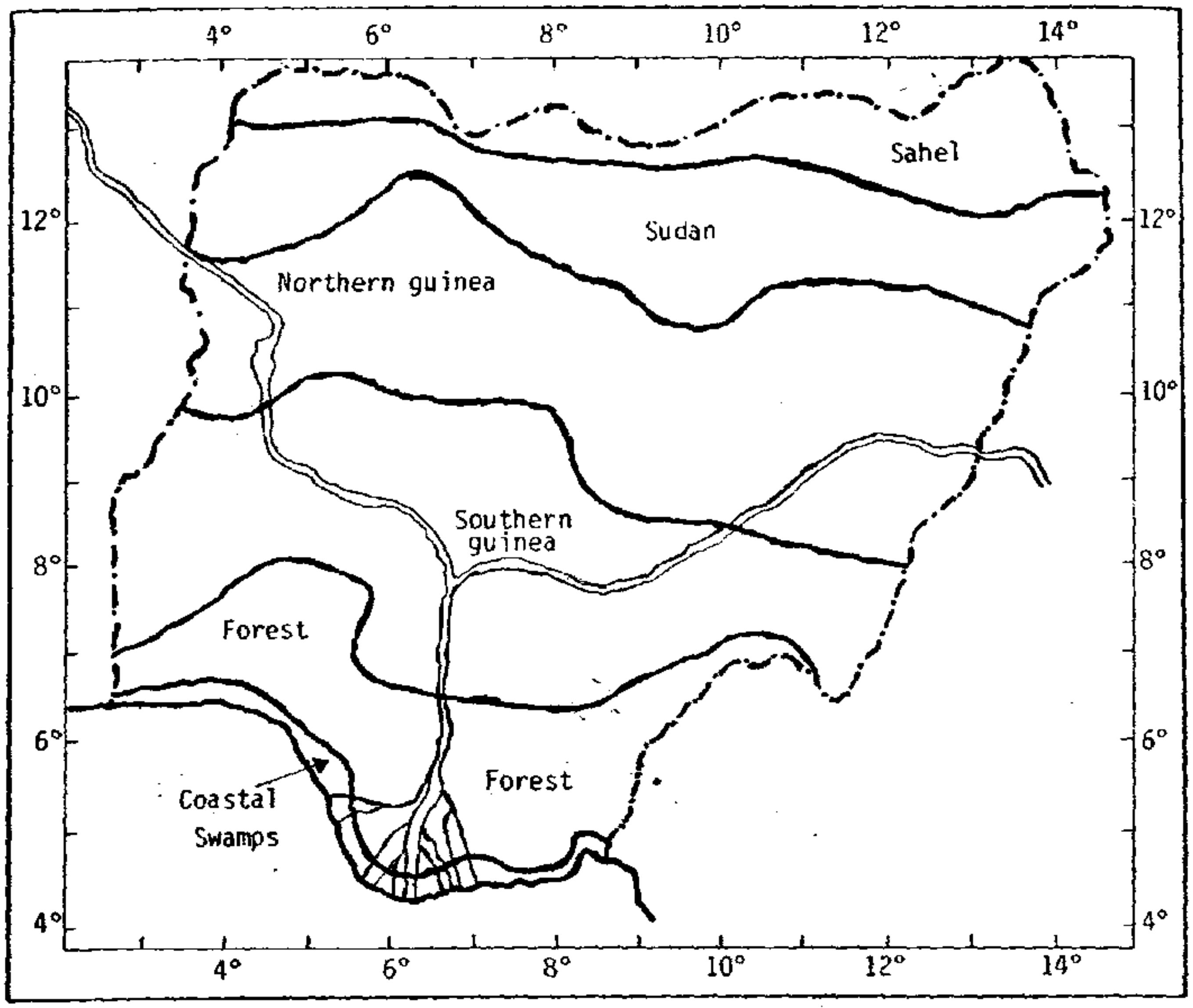


Figure 3.4 Major vegetation zones of Nigeria.

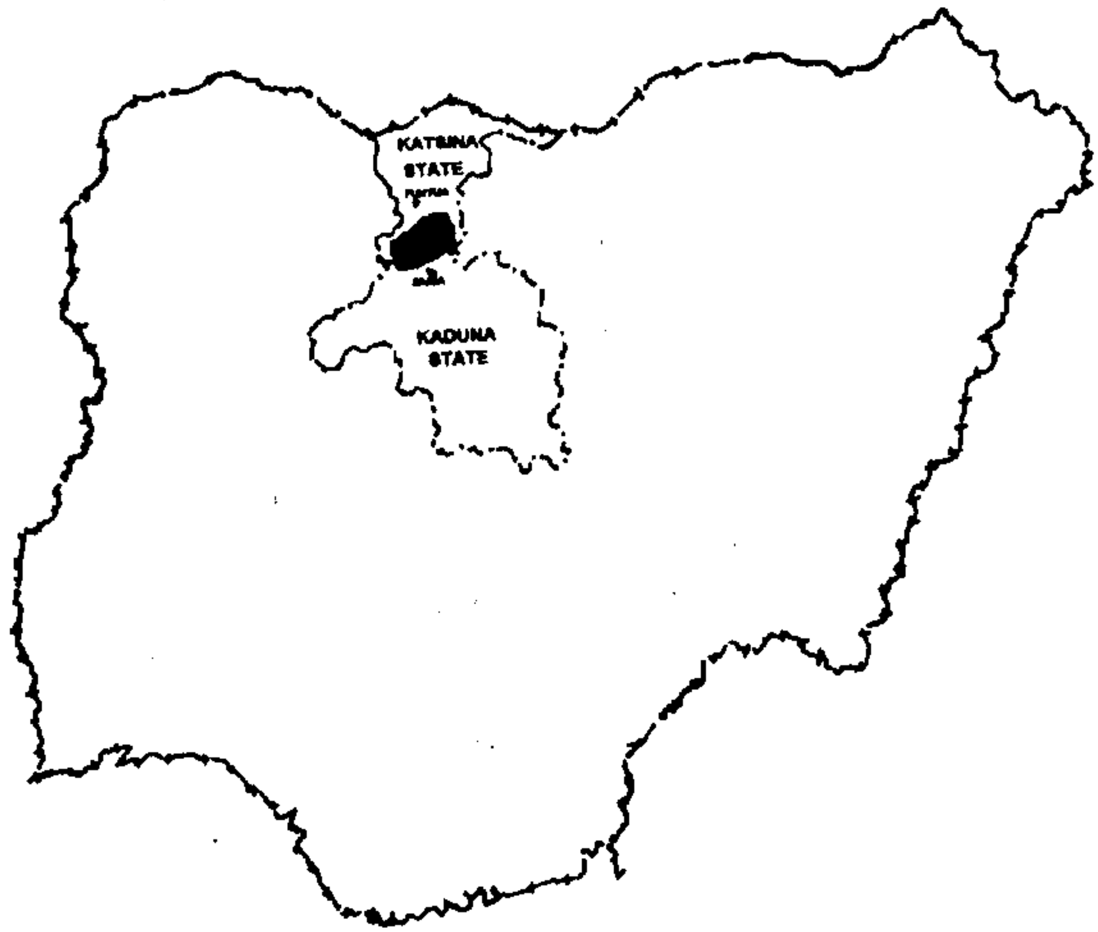


Fig. 3.2 Map of Nigeria showing the states of the study area.

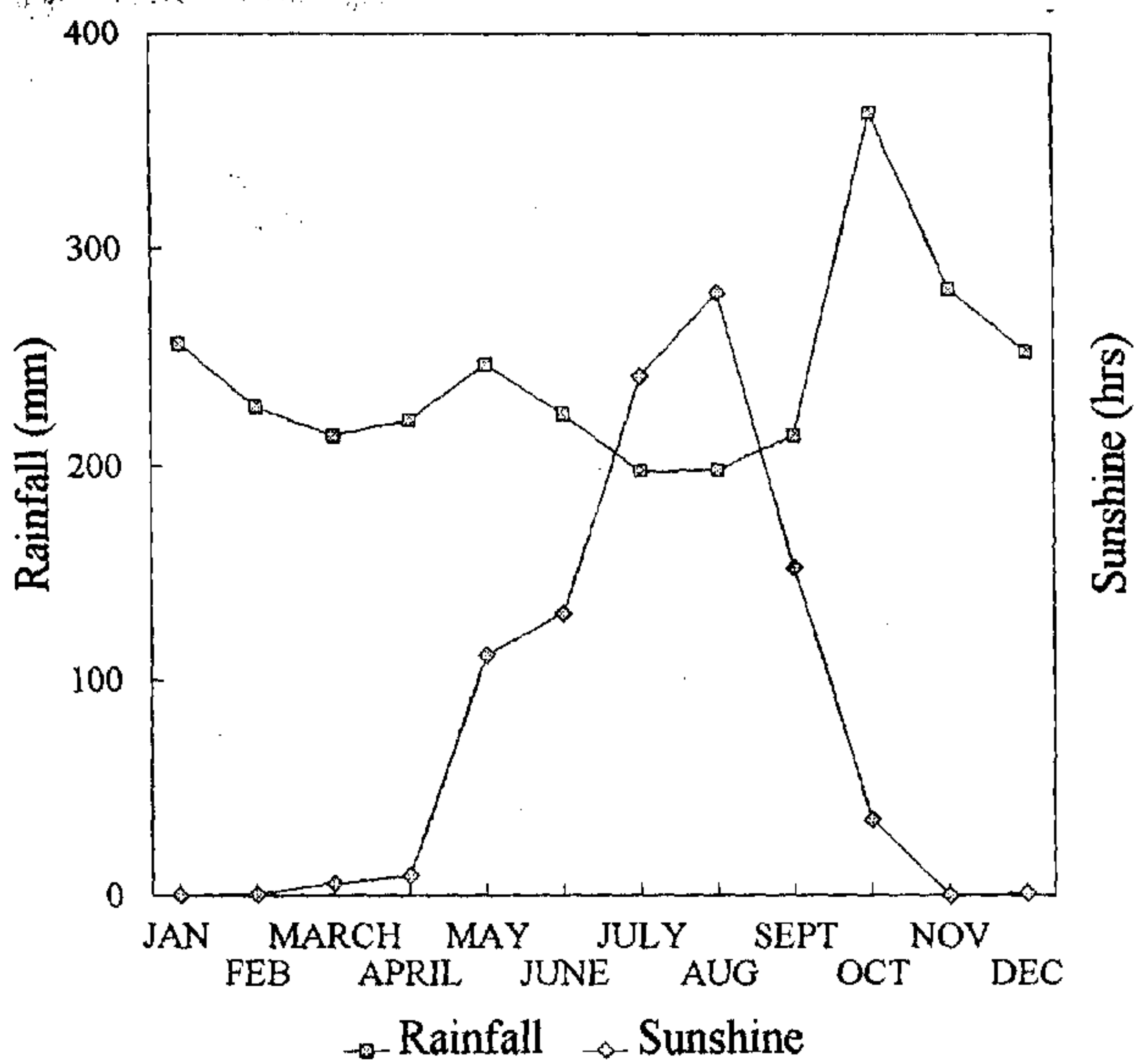


Fig. 3.3 Average Monthly Rainfall (mm) and Sunshine (hrs) in the study Area.

of phosphate is high because of abundant free metal oxides resulting into deficiency of available phosphorus.

The soils have sandy tops with rather low organic matter and base exchange capacity and a sub-soil that is compact due to accumulation of clay which is predominantly kaolinitic. The soils are poorly buffered with cation exchange capacity as low as between 1-10 me/100g of soil depending on the soil organic matter status which rarely exceed 2-3% carbon.

The soil physical status is poor with the bulk density of the topsoil rarely less than 1.4-1.5g/cm^3. The soil aggregate are normally very small and unstable with the tendency to compact under wet conditions. The soil's water holding capacity depend on the structural composition of the soil. Most of the soils are liable to form surface crusts and are highly erodible. Because of leaching, run-off and erosion, available plant nutrients are very low. Crop residue removal and burning deprive the soils of a lot of nitrogen and sulphur. Deficiency in micronutrient like boron and molybdenum could be prevalent due to continuous cultivation under intensive arable farming.

3.1.4: Socio-Economic Elements

Farming is the main occupation of majority of the inhabitants. The farming system used to be bush fallow with organic manure used to maintain an adequate level of soil fertility. But, today with population pressure, access to markets and the influence of modern inputs, bush fallow is not as prevalent as it was before. One often notices continuous cultivation using inorganic fertilizers to main soil fertility. Land is owned communally and individuals only possess usufructuary rights to it with considerable inequalities arising in its distribution.

Hausa and Fulani predominate among the inhabitants. The Maguzawa could be found in large numbers in the area. While the Hausa and the Maguzawa are mostly farmers using mostly traditional technology for their crop production, the Fulani are mainly cattle nomads.

Two types of family units exist in the area; a single unit (Iyali) comprising of a married adult with his wives and dependents and children, and a composite unit (Gandu) comprising of two or more male adults together with their wives and children.

Labour is the most important limiting factor to crop production. Landless labourers are rare in the area. Most of the farm operations are performed by males. On the average a male adult works for about 226 days per year at an average of five (5) hours per day. The main seasonal peak of labour requirement is for planting weeding and cultivation. Consequently, hiring labour is prevalent at this period of farm operation.

3.2 Methodology

3.2.1 Selection of Villages

A preliminary survey was carried out in the form of group interviews of farmers in 29 villages which were covered by Balcet and Candler (1981) and Norman (1972) in their surveys.Five villages were then randomly selected for an in depth study based on the preliminary data collected. The villages selected are Kaya, Tsibiri and Gwanki in Kaduna State, and Borindawa and Barde in Katsina State. The selection was based on cropping systems, level and history of intensification of agricultural production, availability and use of fertilizers and history of maize cultivation in the areas.

A major consideration in the selection was the location of the villages. Elaborating on his famous locational matrix hypothesis of economic development, Schultz (1953) was of the opinion that economic development takes place in specific locational matrix and these matrices, are essentially industrial-urban in nature. A number of empirical studies have confirmed

Schultz's postulation. For instance, Ruttan (1955) and Tang (1956) found urban-industrial centres to be associated with more rapid development of agriculture. Griliches(1957) in a related study observed that profitability determined by market density, innovations and marketing costs, were important factors that influence the process of diffusion of modern agricultural technology. The locational effect can help in isolating the extent to which maize production affects the income of farmers in the study area.

3.2.2 Location of the Sampled Villages

3.2.2.1 **Kaya** is on latitude 11°16'N and longitude 7°14'E and it is about 70km from Zaria and about the same distance to Funtua. It is situated between Zaria in Kaduna State and Funtua in Katsina State. It is about 70km North-West of Zaria off Zaria Funtua road Yakawada Junction for Kuyello and about 30km from that Junction. The settlement is accessible with a tarred road leading into the village. It is a large settlement of a semi-urban status but it is kind of isolated; it is not close to any urban centre or major town. Due to the fact the settlement is large, three wards were selected for the study; Namama, Allah Namama and Kayawa. The total number of households in these wards were 101.

3.2.2.2: **Tsibiri** is on latitude 11°12'N and longitude 7°32'E and it is about 7km from Shika-Zaria. While it is close to an urban centre, it is not accessible from Shika particularly in the raining season. It is a small settlement with about 98 households.

3.2.2.3: **Gwanki** is on latitude 11°21'N and longitude 8°02'E and it is by the main dual carriage road from Zaria to Kano. It is situated at about 100km from Zaria, and it is accessible. So, while Gwanki is not close to an urban centre or major town, it is very accessible, and it is on a very busy highway. It is a small settlement of about 115 households.

3.2.2.4 **Barde** is on latitude 11°40'N and longitude 7°14'E and it is a very remote settlement. It is not close to any major town. The nearest urban centre or major town to it is Funtua and it is 40km away. The access road is bad both in the dry and rainy seasons. It is also a large settlement so two (2) wards: layin Mahutta and Amfani were selected for the study. The total number of households in these wards were 88.

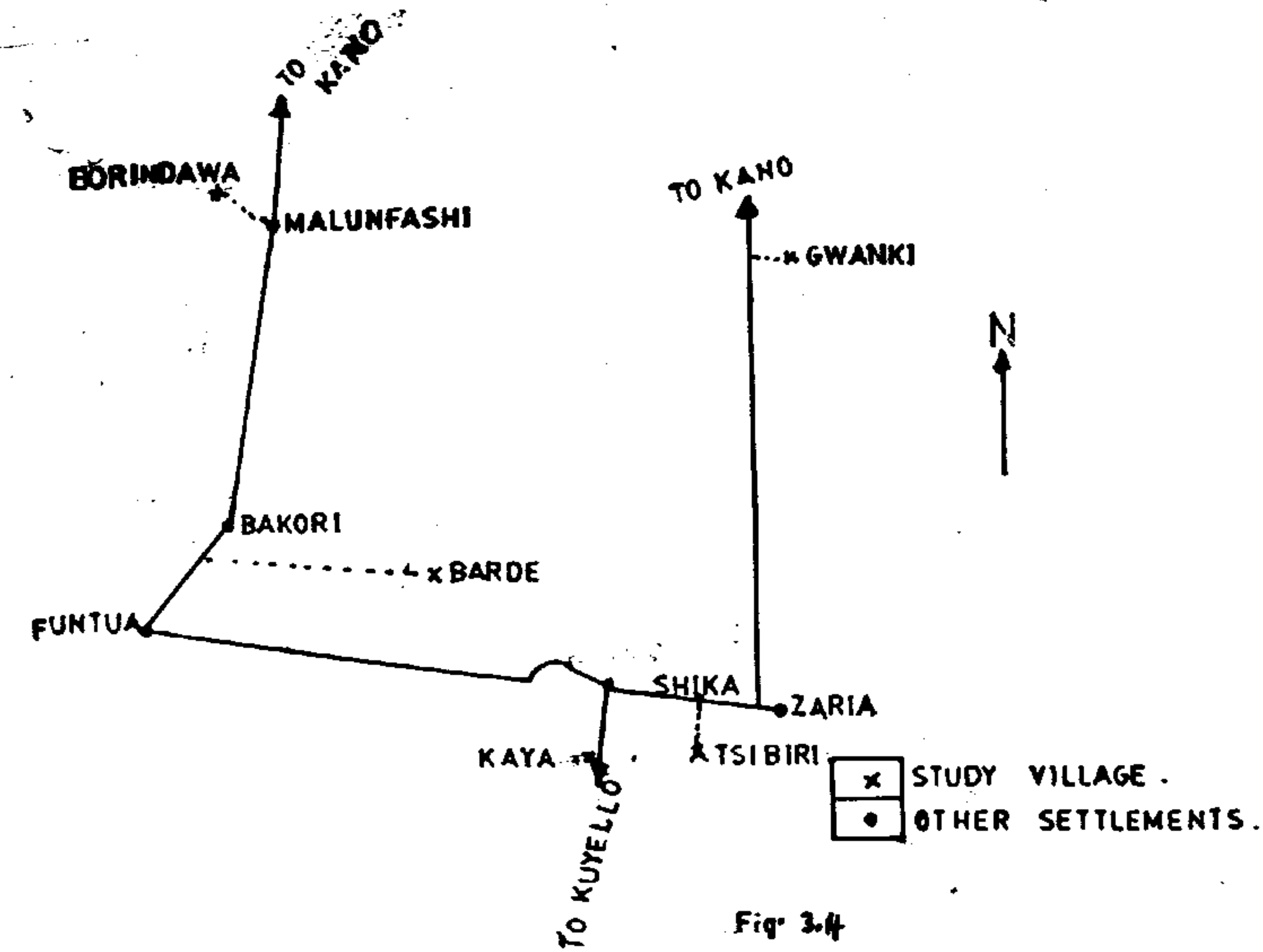


Fig. 3.4

The Study Villages

3.2.2.5. **Borindawa** is on latitude 11°43'N and longitude 7°38'E.

It is about 5km from Malumfashi. can go for an urban centre. So, while Borindawa is near an urban centre it is not so accessible. The road from malumfashi to Borindawa is a laterite road. It is a small settlement of about 48 households.

3.2.3: Classification of Farmers

Several criteria have been used to classify farmers. In the absence of income data. Mellor (1975) and King (1976) used land as a proxy variable to classify households into income classes. Balcet and Candler (1981) used land-man ratio and size of holding to classify farmers into almost landless, subsistence and large farmers.

Almost Landless Farmers are those that have so small farms that they can only provide an adjunct to labour. Haberd (1979) estimated that an area of 0.28ha is required under normal circumstance to provide sustenance for an adult. So Balcet and Candler considered the category of household that had holdings with a land-man ratio of below 0.28 as almost landless or small farmers. Similarly a household with a total holding of less than 1.5ha in size fall into the small category, given that the average household size was found to be 5.

Subsistence Farmers were considered to be those who can feed themselves without the need for supplement from any source. Farmers with land-man ratio of between 0.28 - 1.4 which correspond to 1.5 to 7 hectares per household were included in this category.

Large Farmers were those considered to be in no danger of going hungry during the season. This included semi-subsistence farmers who still produce the bulk of their subsistence requirement with a size of holding between 7 -25 hectares and the commercial farmers who are profit maximizing oriented and produce mainly for the market and rely exclusively on the market for their food requirement. This category of farmers included those with farm holding above 25 hectares.

In this study the value of the level of total production was mainly used in categorizing the farmers because it seems to give a more objective proxy for the household's wealth status. Land-man ratio may not give a true picture of the total value of crops produced by each household since production and productivity depend on other factors than size of holding. While the land proxy variable to strategy households into income or welfare class may be convenient for land shortage environment or where land tenure institutions result in restricted access to land, it may not be relevant to a land abundant environment like Northern Nigeria. Matlon (1979) found that factors other than land use clearly accounted for the major proportion of income variation. At the most general level, these factors included income generated in off-farm activities and/or inter-household productivity. So farmers were classified for the purpose of this study into small, medium and large farmers as follows (also see Table 3.2).

Small farmers were considered to be those whose per capita food crop production (PCFP) and per capita cash crop production (PCCP) were less than N500 and in addition do not have another source of income except maybe earnings from hired labour.

Medium farmers were those who had PCFP and PCCP of between N500-N1000 and may or may not have other sources of income in addition.

Large farmers were grouped into 3 categories. Those that had PCFP of over N2000 and do not produce cash crop nor have other sources of income were considered as large farmers. Secondly those that had PCFP of equal to or less than N1000 and PCCP of equal to or less than N500 and with no any other source of income were also considered in this group. Thirdly, those that had PCFP of equal to or less than N800 and do not produce any cash crop but had other source of income were included in the group too. The classification was based on the preliminary survey conducted (see Table 3.2).

3.2.4: **Selection of Farmers**

Multi-stage sampling procedure was used. A sampling frame was established by listing household heads in the selected villages. A household was used as the unit of analysis. A household is defined as a man with his wife or wives, children and other dependents who live, work and eat together. A household is considered as both a production and consumption unit.

A complete enumeration of the villages was carried out with the household as the unit of study. Where complete household listing was not possible in big settlements such as Kaya and Barde, household listing was restricted to selected wards. A ward is defined as a sub-division within a village consisting of a close-unit compounds in most cases with a head. Table 3.1 indicate the number of households selected in each village as a percentage of the total number.

Base on the household size and production levels of crops produced by households per capita production of food crops (PCFP) and per capita production of cash crops (PCCP) were computed. The classification was then based on per capita production of food crops (PCFP) and per capita production of cash crops (PCCP) for the previous production year (season) taking into due consideration ownership of secondary occupation (see Table 3.2). The final sample was made up of 10 households heads randomly selected across the three categories in all the villages making a total of 50 households.

3.2.5: Data Collection

Survey method and direct measurements were used to collect the required data in the 1990/91 production year. Direct measurements were used to collect information on field sizes and yields. crop-cut method was used to supplement farmers' reported yield at the time of harvest.

Table 3.1: Sample Frame of Households in The Selected Villages

Village	FARMER Large	CATEGORY Medium	Small	Total
Barde	14a	31	43	88
	(16)	(35)	(49)	
Borindawa	8	23	17	48
	(17)	(48)	(35)	
Gwanki	26	34	55	155
	(22)	(30)	(48)	
Kaya	33	40	28	101
	(32)	(40)	(28)	
Tsibiri	4	33	61	98
	(4)	(34)	(62)	

Source: From study

a The figures in bracket are percentages of the total number of household in each village. The percentages were rounded up to the nearest whole number.

Table 3.2: **Classification of the Sampled Farmers in The Survey Villages**

Category	Sub-Category	Criteria of Classification[a] Per capita food production (N)	Per capita cash crop Production (N)	Other sources of Income
Big	A	≥2000	None	None
	B	≥1000	≥500	None
	C	≥ 800	None	Has
Medium	-	≥ 500 but <1000	≥ 500 but <1000	Has/ Has not
Small	-	≤ 500	≤ 500	None

a. The criteria were authenticated through discussions with key informants in each village.

Table 3.3: The Distribution of Households Selected From Each Category of Farmers in the Sampled Villages

Village	FARMER CATEGORY			Total
	Big	Medium	Small	
Barde	2	3	5	10
Borindawa	4	5	1	10
Gwanki	3	5	2	10
Kaya	6	3	1	10
Tsibiri	1	5	4	10
Total	16	21	13	50

Source: From Study.

Multiple visits or cost route survey method was used with the help of structured questionnaires to collect the needed information. This method was used for these reasons suggested by Spencer (1986).

(a) The literacy level in the area of study is low and so farmers used their recall abilities to provide the required information. A long delay may lead to memory lapse.

(b) The habit of a wide use of moslem prayer time by respondents make the need to be present to ascertain the precision of the timing particularly in the case of labour data collection.

(c) The complexity of information require detail monitoring of the activities to get detail information on output, input and cost of production. Trained enumerators were stationed in each of the sampled villages to collect the required information from the sampled farmers for the 1990/91 production season.

3.3: Analytical Procedures

3.3.1 Analytical Framework

Objective one which sought to examine the history of the adoption of the technology was achieved by examining the trend of the adoption of the technology. Objective two which sought to determine the effect of the technology on the productivity of resources was achieved through budget analysis. Regression analysis was used to achieve objectives three and four which sought to determine the effect of the technology on intensity of resource use and farm incomes of farmers.

Measures of income inequality such as Gini Coefficient, the standard deviation of the logarithm of income and the coefficient of variation were used to achieve objective six.

3.3.2: **Measure of Resource Productivity**

Different methods have been used in the literature to estimate resource use efficiency. These include budget analysis, production function analysis and linear programming among others.

Production function analysis has traditionally been the tool used for examining the problem of resource use efficiency at the farm level. It is often used because of the nature of data available and its merit over other techniques. One obvious advantage is that, unlike the other methods of measuring productivity, its parameters can be subjected to statistical test of reliability.

A number of functional forms exist and they include quadratic, linear, spillman, power and square functions. Functions used to estimate farm survey data have traditionally been power and linear functions. This is because of the relative ease of computation and the smaller degrees of freedom involved in estimating the parameters. According to Ogunfowora

et al 1974/75, quadratic and other functional forms fitted to survey samples lead to loss of many degrees of freedom and often result in many regression coefficients which may not often be significant in probability sense. The linear and power functions are particularly useful if the concern is the quantitative estimates of resources as the measure of inputs used. The efficiency of resource use is computed by comparing the marginal value product (MVP) of each resource to its opportunity cost in the form of ratio. If the ratio is unity that means the resource is efficiently used. If the ratio is less than one that means less of the resource is used but if it is greater than one that means too much of the resource is being employed.The ratio can
then be compared between enterprises, areas and categories of farmers.

But in the study area, the cropping system is predominantly mix-cropping. This may create difficulties in imputing inputs and cost to specific crops grown in mixture. Moreover, it may be difficult to aggregate physical output in a production function model. Besides, this may lead to specification errors in the production function model which may render the parameters obtained unreliable.

linear programming is another approach through which the marginal value product (MVP) of resource can be derived as a by-product of linear programming analysis. But, the problem with this approach are as below;

(a) only resources that are used up in the production have marginal productivity in the solution. Resources which are not used up have zero marginal productivity.

(b) the marginal product (MP) of resources relate only to their use in a given enterprise system considered in the linear programming and may vary significantly in use for individual enterprises that constitute the system. In other words, generalization cannot be made on the basis of the result. In addition, the data requirement may be quite substantial and therefore difficult to generate in a largely traditional agriculture. Like input-output ratios, linear programming results can not be tested statistically to know the degree of reliability.

Input-output ratio is another measure of resource productivity that can be used. It is the ratio of output per unit resource used. This can be computed as output per unit capital (output/capital), output per unit land (output/land) and output per unit labour (output/labour). The advantage of this approach is that it is simple. Its problem is that it ignores the quantity and quality of other resources used and the result obtained can not be subjected to statistical test of validity. Budget analysis was used to measure resource productivity because as observed by Matlon (1979) the measures indicate strong and direct relationship between production efficiency and income.

3.3.3: Measure of the Impact of Improved Maize Technology on the Income of Farmers

Regression analysis was used to determine the effect of the technology on farm income.

Model Specification

The regression model used is as specified below:

$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + u$ ____(3.1)

$\log Y = a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + U$ ____(3.2)

where:

Y = Average Total Farm Income per Household (N)

X_1 = quantity of maize produced

X_2 = quantity of sorghum produced

X_3 = quantity of millet produced

a = Intercept term

b_1-b_3 = Coefficients (elasticity)

U = The Error Term.

Equation 3.1 and 3.2 are the linear and logarithms relationship of the regression respectively. Positive elasticity would mean that the quantity of maize cultivated relate positively to the total farm income of farmers.

3.3.4: Measure of The Impact of the Technology On The Intensity of Resource Used

The same method of analysis was used to determine whether the technology has been a factor in the intensification of farm production. Area put into the cultivation of improved maize was regressed against labour used per hectare and capital used per hectare as the dependent variables.

Model Specification

The regression equation is specified as below:

$A = a + bx_1 + b_2 \; x_2 + b_3 \; x_3 + u$ ____(3.3)

$\text{Log } A = a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + u$____(3.4)

where:

A = Intensity of resource used (labour/ha, capita used (N/ha)

a = Intercept term

$b_1 - b_3$ = Coefficient (elasticity)

X_1 = adjusted area put into maize cultivation (ha)

X_2 = adjusted area put into sorghum cultivation (ha)

X_3 = adjusted area put into millet cultivation (ha)

U = Error term.

Equations 3.3 and 3.4 are the linear and logarithms relationships of the regression respectively. Positive elasticity would show that the cultivation of the crop lead to increase use of resources, while negative elasticity would mean otherwise.

3.3.5: Measure of Income Inequality

Gini concentration ratio (Coefficient), standard deviation of the logarithm of incomes and the coefficient of variation were used to measure income inequality. These measures are sensitive to different levels of income inequality. Coefficient of variation is an effective measure in the high income range. Standard deviation of the logarithm of income gives weight to income in the lower range, while Gini Coefficient is more sensitive to income differentials in the broad middle income range.

3.3.5.1: The Gini Coefficient

The ratio can be estimated either from the Lorenz curve or from the mean difference of incomes. Lorenz Curve shows the percentage of all income earned by households at successive income levels. It measures the cumulative percentage of households (ranked from lowest to highest incomes) on the horizontal axis and the cumulative percentage of income earned

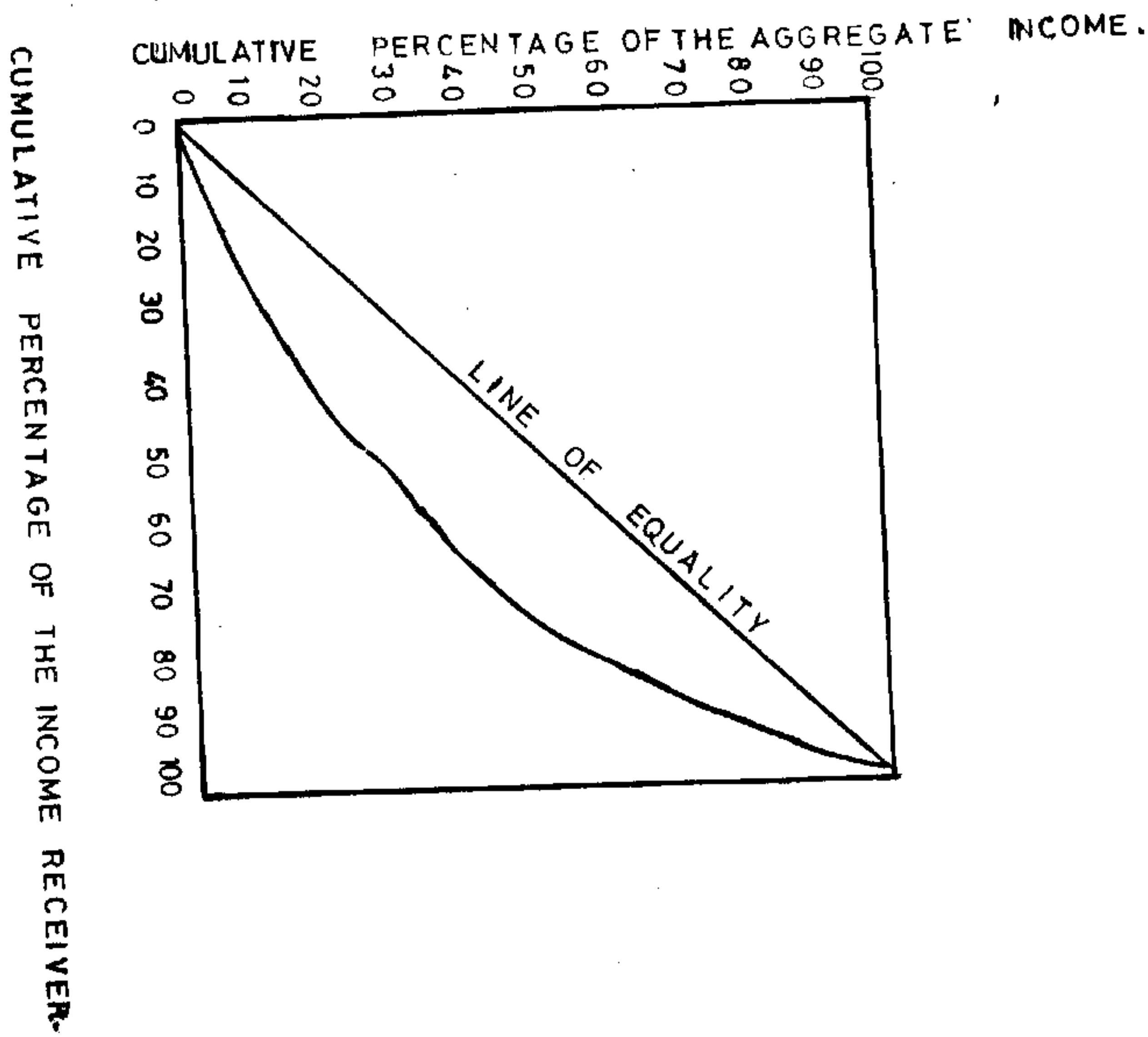


Fig 36. A LORENZ CURVE

by the households on the vertical axis (Fig.3.5).

If households earned the same income (perfect equality) the Lorenz Curve would be a 45-degree line i.e. line of perfect equality. The bowed out line or curve shows an unequal distribution of income. The more the line or curve for a society is bowed out away from the line of perfect equality the greater the inequality in the distribution of income in that society.

Gini concentration coefficient is a numerical measure of inequality. It is the area between the 45-degree line (perfect equality) and the bowed out line/curve divided by the total area under the 45-degree line coincide and the Gini Coefficient is zero. If there is perfect inequality, the difference between the bowed out curve or line and the 45-degree line equals the entire area. Under the 45-degree line and the Gini Coefficient is one (1). In between these two extremes, the Gini Coefficient can measure whether income distribution is more or less unequal than others. (Benson, 1970 and Matlon, 1979).

The Gini concentration coefficient can also be computed from the mean differences as specified in the model below:

Model Specification

$$C = \sum_{i=1}^{n} \sum_{j=1}^{n} f_i \; f_j / X_i - X_j / 2XN \quad \_\_\_\_\_\_ 3.5$$

where:

c = the gini coefficient

n = the number of income group classes

f_i = the frequency of each income class

X_i = income in each class

f_j = the frequency of income classes

X_j = the mean income in each class

X = the mean of the distribution

N = $\frac{n!\ (n-I)!}{2}$ i.e. the degree of freedom

3.3.5.2 **The Coefficient of Variation**

This is a more popular measure of income inequality. It is a more refined measure of deviation. The standard deviation is expressed in absolute terms and is given in the same unit of measurement as the variable itself. There are occasions, however, when this absolute measure of dispersion is inadequate and a relative form becomes preferable. For instance, to compare distributions with the same variable but with different arithmetic mean or a comparison between the variability of distribution with different variables. This relative measure is coefficient of variation as specified in the model bellow(Atkinson, 1970 and Matlon, 1979).

Model Specification

$$V = \left[1/N-1 \sum_{i=1}^{n} (X_i - X)^2 / X \right]^{\frac{1}{2}} \quad - \quad 3.6$$

V = the Coefficient of variation; The smaller it is the more equitable the distribution of income is and the higher value the more inequitable the distribution is.

N = total number of individuals.

X_i = the income of each individual.

X = the mean income of all the individual.

3.4.5.3: **The Standard Deviation of the Logarithm of Incomes**

This is another common measure of inequality. It is also an improvement on the use of coefficient of variation as a measure of dispersion.

Most income distribution profiles are skewed with a long right-tall. Analysis of such skewedness as a departure from a normal distribution function lead to the use of standard deviation because using the coefficient of variation as a measure of dispersion is predicated on the assumption of the existence of normal distribution conditions. This necessitates the use of logarithms of income as specified in the model overleaf. (Benson, 1970 and Atkinson, 1970).

Model Specification

$$S.D = 1/N-1 \sum_{i=1}^{n} (\log X_i - \log X)^2]^{½} \quad - \quad 3.6$$

where:

S.D. = the standard deviation of the logarithm of incomes. The higher value the more inequitable income distribution is the lower the more equitable income distribution is.

X_i = Income of each individual.

X = is the overall mean income.

CHAPTER FOUR

TREND IN MAIZE PRODUCTION

The section examines the extent of the adoption of the technology and the production behaviours of farmers. This is with a view to identifying farmers' needs and the problems they encounter. The outcome of the findings will help in the development of acceptable varieties that do not only suit farmers' socio-economic condition, but also the physical condition of their environment in future. This, it is hoped, will enhance the acceptability of the technology among the farmers. For it has been observed that the acceptance of any technology is an outcome of the interaction between bio-physical characteristics of the environment, the socioeconomic characteristics of farmers in the area and the characteristics of the technology itself (Smith, 1990).

4.1 Cycle of Release of Improved Maize Varieties in the NGS

The gerplasms of maize grown in the country are TZPB and TZB. TZPB is widely grown in the Forest Zones whereas TZB is most widely grown in the Savannah Zones.

They are the products of International Agricultural Research Centres (IARC's) and were developed during the early days of International Institute of Tropical Agriculture's (IITA) programme on maize. TZB originated from African and Latin American sources with a major contribution from Nigerian composite B. TZPB was derived from Tuxpeno Plants Boja 7 from International Wheat and Maize Improvement Centre (CIMMYT). They were first released as new varieties with the names FARZ27 (TZPB) and FARZ24 (TZB). Both varieties have good resistance to tropical rust and lowland blight.[1]

Improved maize varieties were introduced into the study area in the mid 1970's through the World Bank's Assisted Agricultural Development Projects (ADP's) and other agencies like State Ministries of Agriculture, River Basin Development Authorities and private concerns. The varieties introduced into the area include the following:[2]

TZB (FARZ24) white

1 Fed. Min. of Science and Technology. The Impact of the National Agricultural System on Agric. Development in Nigeria, Skoup and Co. Ltd, Associate Business Consultants, Sept., 1985, p.84.

2 This information was collected from Technical Unit of the Zonal Headquarters Kaduna and Katsina States Agricultural Development Projects (ADP).

TZPB (FARZ27)

SAMARU123 (FARZ122) Yellow

NCA (FARZ11)

TZSR (Yellow and White)

TZESR (Yellow and White)

Bomo Local.

Before the establishment of ADP's FARZ24 and FARZ27 were already in the area. Samaru 123 (FARZ122) and NCA (FARZ11) were introduced latter. These two later varieties were not accepted by farmers because of their yellow colour, so they were not improved upon.

TZB though higher yielding and more acceptable to farmers, they complained that the cobs were getting smaller and the seeds tinier. Besides, it was not streak resistant so it was improved upon in the mid 1980's. This lead to the release of TZESR and TZSR.

4.2 Farmers Views of the Improved Technology

Generally, maize is grouped into 3 main categories by farmers in the study area. These are the local variety (Yar Hausa or Yar Gari), improved varieties (Yar Project) and hybrid maize (Yar Aure). They also distinguished maize based on colour; white and yellow.

The white maize is most preferred and it was grown by all the farmers interviewed. The main reason given for its preference is that it is marketable; it is easily disposed of whatever the quantity produced. Other reasons given for its preference included, the appealing colour of food prepared from it. Besides, the majority of the farmers claimed that it produces more cobs per plant and yield more, have larger seed that can easily fill bags and that it is soft and can easily be processed. It is also said to be more floury than the yellow maize. They claimed that white maize can be sold green to Dairy companies for use in the production of industrial milk (Yorgout).[3]

On the other hand, the yellow maize is said to have smaller cobs and tiny seeds. It is said not to be as high yielding as the white maize, but it is less fertilizer demanding and requires less care. The seed is hard and not easy to be grinder into flour. It is mainly planted with the early rain or in lowland areas (Fadama) and it is mostly eaten green and sometimes dried. The yellow maize comes in handy in the "hungry period" in late May and the whole of June when the

---

3 There is a Dairy Company in Funtua that processed Yorgourt, but no attempt was made to confirm the assertion from the authorities of the Company.

previous year's food reserve has been depleted and new farm produce are just about to be harvested.

So, the white maize predominates though the yellow type is grown in small quantities mostly for home consumption in most cases green to be roasted. The traditional variety is grown in much smaller quantity. Only less than 5% of those interviewed said they still grow the traditional variety. The redeeming features of the local variety is that it is very palatable and can store well. It is also not easily susceptible to pest attack.

4.3 Sources of The Improved seed Varieties

Farmers were asked their initial source of the improved seed technology and for how long they last acquired new seeds . The result is summarized in table 4:1. Farmers are required to obtain new seeds every year if the desired characteristics of the varieties are to be maintained.

From Table 4:1, Kaya, Gwanki and Borindawa started growing maize earlier than the other villages. These villages are more accessible than the others and may have had easy and early contact with extension agents compared to others.

Kaya and Barde, though relatively remote have resident extension agents in their settlements. Borindawa had the highest number of those who said they got their seed from Funtua Agricultural Development Project, may be because it is the closest to an urban centre.

Farmers interviewed do not acquire new seeds of the improved technology every year as they are required to. They still grow seeds which they acquired for an average of between 6-9 years to the time of the study. Some were still growing the seeds that they inherited from their parents.

All farmers interviewed select seeds for the following growing season from their harvest in the current year. They look for and preserve big cobs. They believe that seeds from big cobs germinate well and the seedlings grow more vigorously compared with seeds from other cobs. It was also observed that seeds from different type of maize are rarely mixed in storage or when planting.

Table 4:1 **Source and Years of Use of the Improved Maize Technology by Farmers in the sampled Villages**

Village	Average years of growing maize	Year acquired new seed last[a]	Source[b] Market	Project	FASCO	Friends /Neighbours	Inherited
Barde	8	6	8 (16)[c]	27 (54)	4 (8)	8 (16)	4 (8)
Gwanki	15	7	11 (22 0	11 (22)	0 (0)	17 (34)	11 (22)
Tsibiri	10	7	11 (22)	11 (22)	3 (6)	8 (16)	12 (34)
Kaya	15	11	13 (26)	25 (50)	0 (0)	6 (12)	6 (12)
Borindawa	15	9	0 (0)	42 (84)	0 (0)	4 (8)	4 (8)

Source: From the Study. n- 50

a This most probably is the time they started growing he improved maize.

b The percentages may not add up to exactly 100% exactly because values were rounded up and moreover respondents gave more than on source.

c The figures in bracket are percentages.

To maintain their characteristics new seeds of the improved varieties have to be planted each year. This is because the varieties lose some of their qualities or grow "stale" or in other words lose their vigour if same seed is grown continuously.

Though most farmers do not mix different varieties either in storage or when planting, but since crops are grown on adjacent continuum of fragmented plots, maize being a cross pollinated crop, there is the possibility of seed contamination. This has a serious consequence on yield and the future cultivation of maize in the face of increasing cost of its production, scarcity of fertilizer and competition from traditional crops in the like of sorghum and millet.

Farmers got their seeds from various sources, local sources like friends, neighbours and inheritance seemed to be significant sources of seed to farmers. Farmers Supply Company (FASCO) and the Funtua Agricultural Development Project (ADP) which are institutional sources of seed did not fair better than other sources. A significant proportion said they acquired their seeds from the market.

The production and distribution of new seed technology like maize is very necessary for its successful adoption. There is the need for an effective organizational or an institutional arrangement for the production of not only the seed but other complimentary inputs of the entire package of the technology. Unfortunately, this seemed lacking in the study area and may be a serious impediment to the successful adoption of the technology.

4:4 Perspective of Maize Production in the NGS

Before the introduction of the improved maize varieties in the NGs, maize was a backyard crop, grown to take advantage of manure from household waste products. It was occasionally grown in lowland areas (*Fadama*) which has a high water table and is more fertile than the upland (*Tudu*). But gradually, maize is not only an important food crop but also an important cash crop in the NGs. Farmers in the sample villages were asked the food and cash crops that they grow in order of priority and the result is given in table 4.2.

Table 4.2: **The Three Major Food and Cash Crops Grown by Farmers in the Sampled Villages**

		Villages				
Type of Crops	Ranking	Gwanki	Borin-dawa	Tsibiri	Barde	Kaya
Food	1st	Maize	Sorghum	Maize	Sorghum	Maize
Crops	2nd	Sorghum	Maize	Sorghum	Maize	Sorghun
	3rd	Millet	Millet	Millet	Cowpea	Yam
Cash	1st	Pepper	Maize	Cotton	Maize	Maize
Crops	2nd	S/Cane	Cotton	Yam	Cowpea	Yam
	3rd	Maize	Cowpea	Maize/ Rice	Cotton	Rice

Source: From the Study.

Maize is now both an important food and cash crop in all the villages. Maize is on the average, among the first three food and cash crops in the study villages when ranked in order of priority as depicted in Table 4.2.

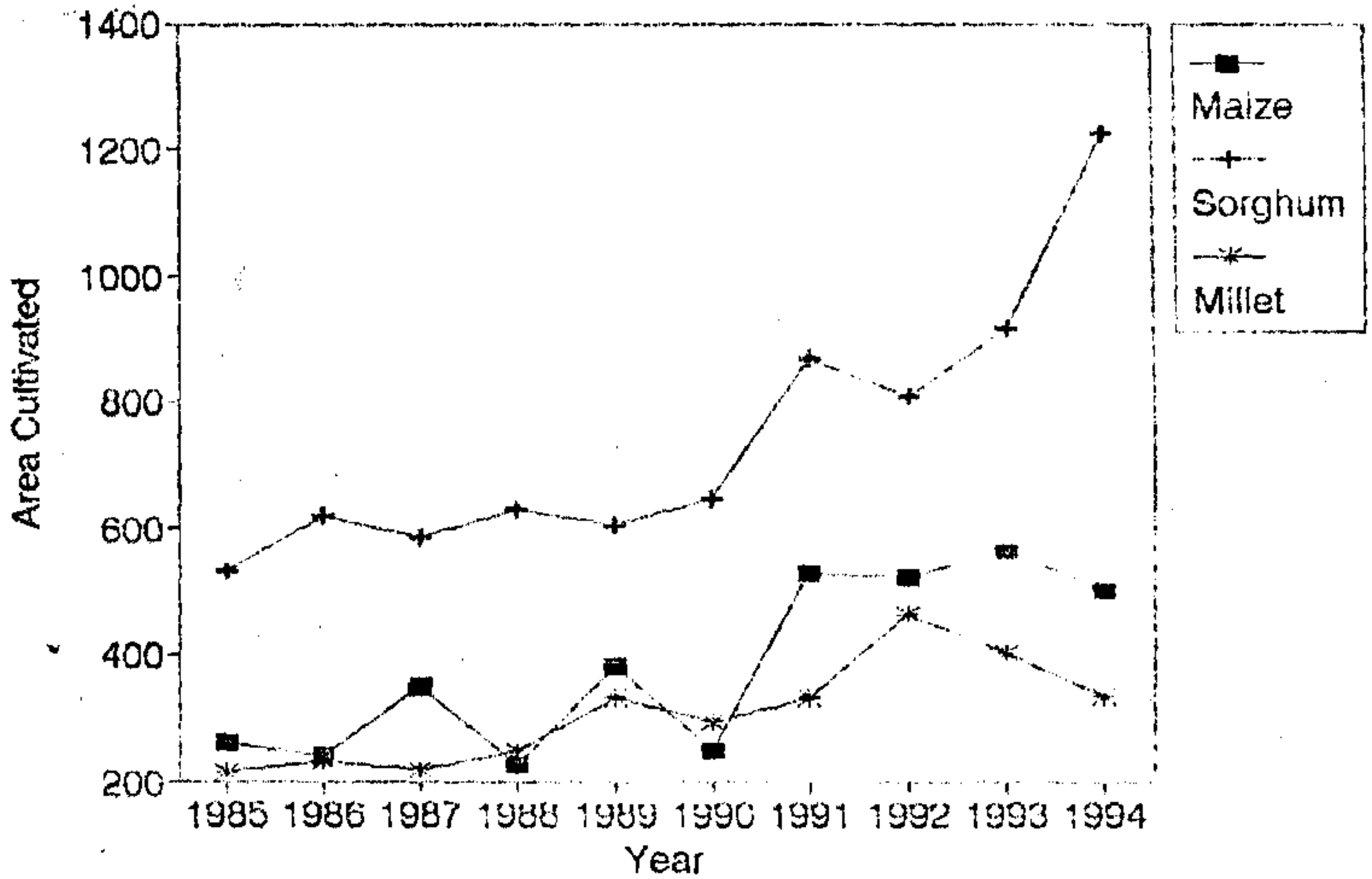
The introduction of inorganic fertilizer in large quantities from the early 1970's made the production of maize attractive to farmers.[4] Maize can now be cultivated extensively in the upland unlike before when it was restricted to backyard and lowland areas (Fadama). However, the difficulties involved in processing maize locally which used to be a major deterrent to its cultivation has been reduced with the introduction and proliferation of grinding machines in the areas.

Maize, in addition, seemed attracted to farmers because it serves as source of "food security"[5]. It provides food early enough to overcome the "hungry period". Millet provides early food too, but maize is preferred because farmers claim millet takes a longer time to process before it can be brought to the table. Figures 4.1 and 4.2 depict the increase of maize in terms of area put into cultivation and production (tons) in the study area. The sharp drop in 1988 in the

---

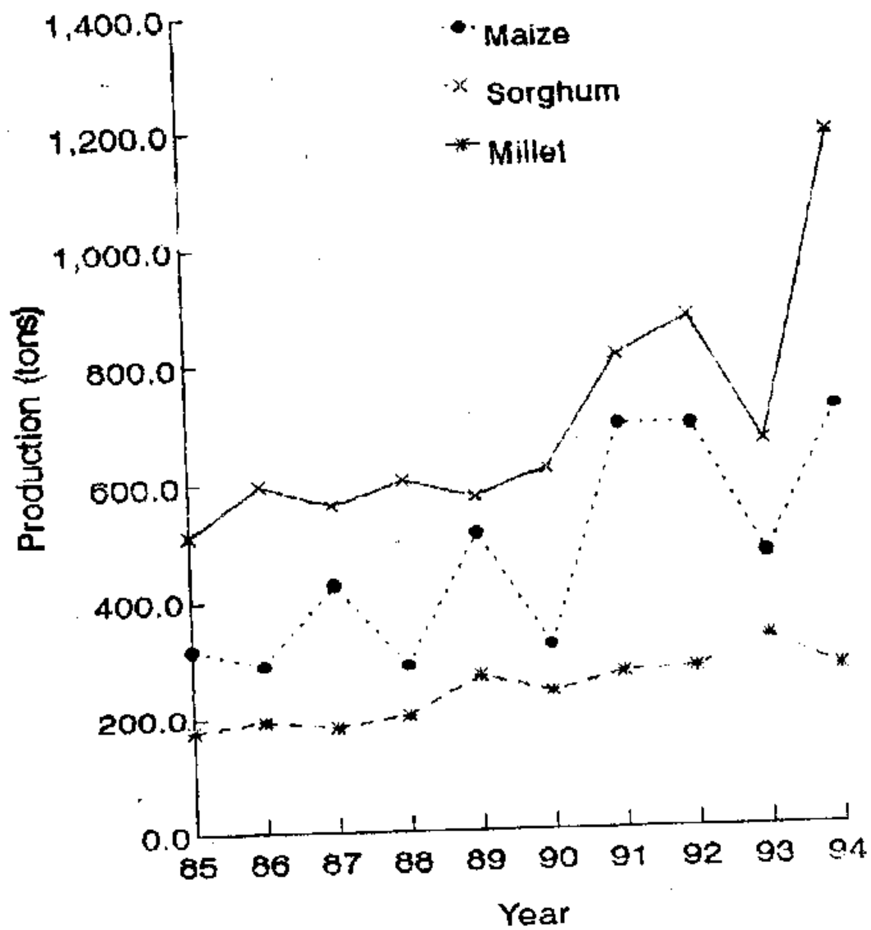
4 It has been observed that the infertility of Savannah regions is the main constraint to maize production, Norman *et al* 1976, p.12.

5 This is one of the main objectives of subsistence production.



Source: Survey Data

Fig. 4.1 Cultivated Area of the Three Major Crops in the study Area (000 ha).



Source: Survey Data

Fig. 4.2 Production (tons) of the three major crops in the Study Area.

area put into the cultivation of maize may be due to the effect of Structural Adjustment Programme (SAP) introduced in 1986 by the Federal Government[6]. The introduction of maize seemed to have reduced the importance of millet in terms of the area put into cultivation and the production levels. The sharp drop in the area put into cultivation and production levels may be due partly to SAP as mentioned earlier and partly to the creation of States because only information on Kaduna State was available[7]. So, the relative values of the production quantities contained in the figures are of importance not the absolute values. Maize is also an industrial crop used in the breweries and weaning food manufacture.

4.5 Extent of The Adoption of the Technology

According to Feinerman and Yaron (1990), for a better understanding of technology adoption, a precise quantitative definition of adoption is necessary. Such a definition should be able to distinguish between individual level adoption and aggregate adoption. Adoption of technology can be dichotomous or non-dichotomous. For dichotonomous adoption, it is either

---

6 Maize is a seed-fertilizer technology and yield could be as low as zero if fertilizer is not applied. The SAP reduced the subsidy on fertilizer and it not only made fertilizers expensive but scare because the sale of fertilizers got into private hand.

7 Katsina State was created out of the former Kaduna in 1987.

one adopts the technology or one does not. This is for indivisible technology which is lumpy. In this case the degree or extent of adoption can only be determined by the number of users and non-users.

Non-dichotomous adoption is applicable to a divisible technology which has component parts which one can selectively adopt. The improved maize technology is a divisible technology with component parts as in table 4.3. In this respect the extent of the adoption of the technology was measured by the degree or intensity of use of the technology.

Adoption and awareness scores of the technology were determined. A score of one (1) was given for awareness and zero (0) for non-awareness of each component of the technology. Similarly a score of one (1) was given for the adoption of each components as on table 4.3.

It was found that there was 72% awareness and 30% adoption scores for the technology in the area of study. In a similar study in the Zaria environs by Banta *et al* in 1986 it was found that the average knowledge and adoption score were 33% and 75% respectively. Voh and Razah (1986) in another study in the area found that the mean maize area doubled to

0.02ha and the proportion of household growing maize rose from 30% to 63% after the first phase of the Funtua Agricultural Project. Comparatively maize seem to have done better than sorghum. In a general note the improved maize technology appeared to have been widely adopted because all the farmers interviewed grow maize to some extent. But, though the technology has been widely adopted the extent to which individual components have been adopted was still disappointingly low.

Table 4.3: Awareness and Adoption Scores of the Improved Maize Technology in the Sampled Villages

Component of the Technology	Total Awarenes s Score	Average Awarenes s Score	Total Adoption Score	Average Adoption Score
Improve Seed	50	1.0	50	1.0
Seed Dressing	20	0.4	10	0.2
Sowing Date	25	0.5	5	0.1
Spacing	10	0.2	0	0
Fertilizer Application	50	1.0	10	0.2
Rate of Fertilizer Application	15	0.3	0	0
Time of Fertilizer Application	45	0.9	5	0.0
Method of Fertilizer Application	50	1.0	50	1.0
Time of Weeding	50	1.0	45	0.9
Pest and Disease Control	45	0.9	20	0.4
TOTAL	360	7.2	192	3.9

Source: From Study.

Table 4.4: Yield Potentials and Actual Yield of the Three Major Crops in the Study Area (ton/ha)

Crop	Yield Potential	Average Actual Yield			
		1987	1988	1989	1990
Maize	3-4	1.60	2.45	1.60	1.88
Millet	2-25	0.62	1.20	0.82	0.88
Sorghum	3-3.5	0.59	0.53	1.20	1.11

Source: Adopted from Balcet & Candler (1981; p. 166) and KSADP (1990; p.15).

Particularly worrisome is the fact that adoption scores for essential components of the technology such as fertilizer and its application were low, maize being a seed-fertilizer technology, this may be a serious impediment which may impair maize from attaining its avowed potentials in the NGS. Table 4.4 depicts the performance of the major crops in the study area.

Table 4.4 shows that there is a remarkable difference between the yield potentials and the actual yield of maize and some for other crops. Surprisingly, the awareness score for the improved maize technology was high, so farmers were asked the problems they encountered with the technology with the view to eliciting factors responsible for the low yield. The next section examines some of these problems.

4.6 Problems Encountered by Farmers in Using the Technology

In view of the low adoption score of the technology, farmers were asked some of the main problems they encountered in growing maize. This will further help in determining whether the technology suit the resource-poor nature of farmers and their bio-physical environment or not. Table 4.5 show some of the responses given by the respondents.

Table 4.5: Problems Encountered by Farmers Growing Maize in the Sampled Villages.

Problem	Frequency	%
Fertilizer Availability	50	100
Pest Infestation in Storage	40	80
Need for Credit	15	30
Provision of Improved Seeds	30	60
Drought	30	60
Means to Expand Production	5	10
Not as Profitable as the Local Varieties	6	12
Small Cob Size	5	10

Source: From Study N = 50

The main problems they said they faced were inadequate and untimely availability of fertilizers, pest infestation in storage, lack of credit with which to acquire modern inputs, non-availability of the improved seeds and the problems of drought. The problem of fertilizer was so prevalent and acute that most of the farmers, out of frustration, expressed the temptation to stop growing maize. Some claimed that they have considerably reduced the quantity of maize they grow. Few of them, about 30% complained that fertilizers were not only scarce but too expensive and strongly expressed the desire for credit facility. Most farmers expressed their strong desire to acquire fertilizers at any cost provided it is made available to them and saw the use of fertilizer as the only profitable means of growing maize. So, the problem of fertilizer is more of availability than the price.

The problem of drought ranked next to that of fertilizer. Farmers complained that there is always a spell of drought in May, after the rains have established (fig. 4.3 and 3.3). After the early rains, between weeks 1 to 4 of planting, there is always a period of rain cessation which always last for between 20 - 30 days. It can be so severe to the extent that it

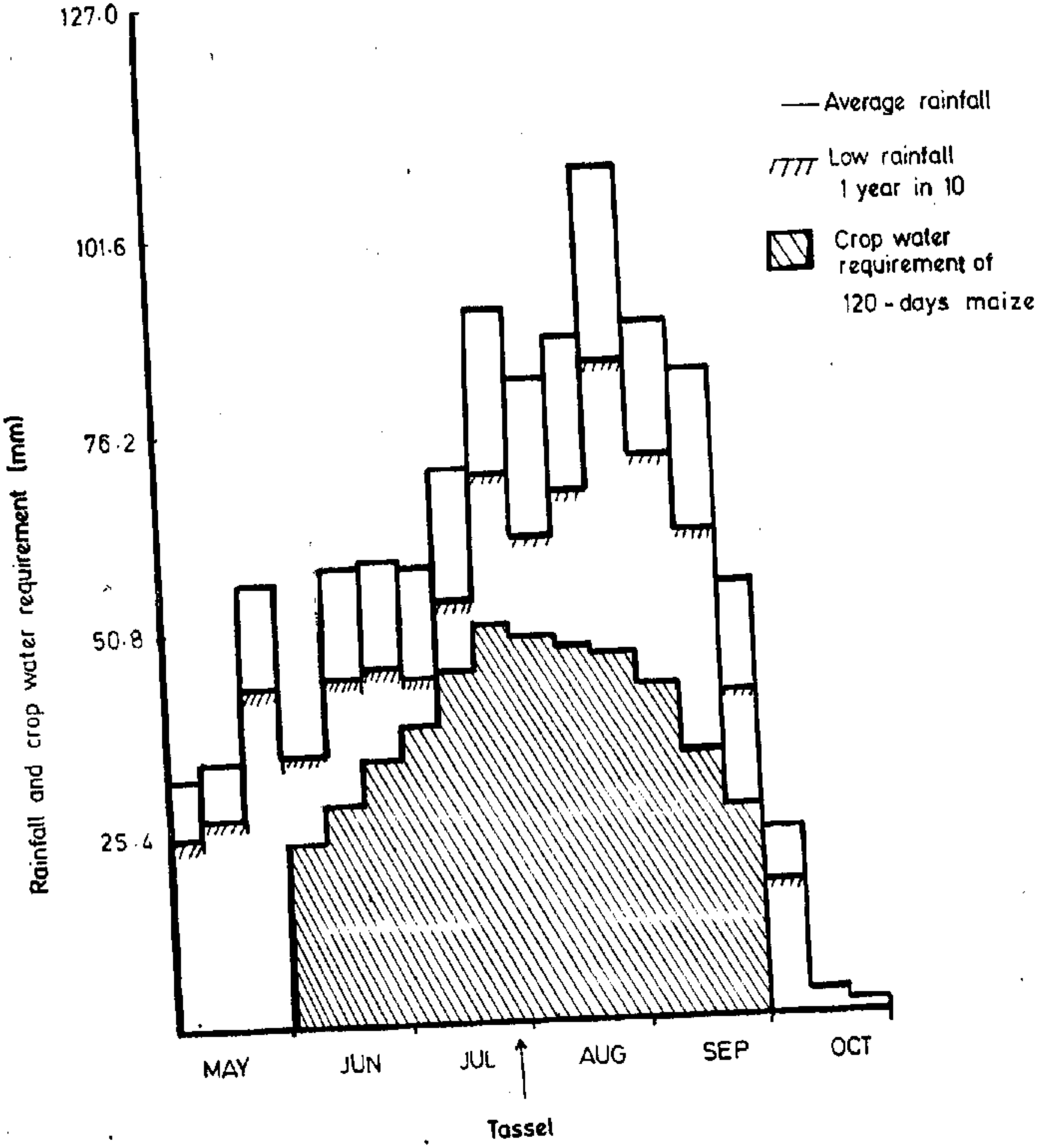


Fig. 4.3 Rainfall and water requirement of 120 days maize at Samaru (11° 11' N) [Kassam et al. 1975]

may lead to total crop failure because the crop would be at its susceptible stage at this period. The drought may stunt the crop's growth and recovery may be impossible. At times, a whole field may be cut and replanted with new seeds.

The farmers seem to be in a dilemma. Early planting, in April/May, to get the seedlings established to avoid the spell of drought always leads to early maturity; the crop will mature in August, when the rain will be at its peak which may affect the cobs. The cobs may rot either on the field or when harvested because drying the seed will be difficult.

The recommended planting or sowing date is early to mid-June. Planting at this time may expose the crop to drought later in the year in the event of early rain cessation which is not only a possibility but is also unpredictable (see fig. 4.3).[8]

It is only the big farmers who can afford to take risk and sow their maize crops as late as mid-June.[9]

---

8 The maturity days for the main three crops in the area are maize (TZB), 120 days; maize S.23 126 days; Sorghum 155 days - 180 days for a; varieties and millet 80-90 days Balcet and Candler 1981, p.166.

9 Very bid farmers refer to large scale mechanized commercial farmers that grow maize in very large quantity. None was in the selected sampled.

CHAPTER FIVE

SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

This section examined some of the socio-economic characteristics such as demography, family organization, size and size distribution of land, land tenure and so on. These are factors that are likely to affect production and consequently farm income.

5.1 Family Organization

The household was taken as the unit of analysis in the study. In Hausaland the household represent the production and consumption unit.[1] The household heads were interviewed because generally decisions on household consumption and production are made mainly by the household head. But as observed by Simmons (1976) the concept does not lend itself to easy definition.

The respondents live in compounds fenced by mud walls, cornstalks or thatch grasses walls. A compound is made up of an extended family consisting of several related nuclear families. The compounds were fragmented into various consumption and production units refers to as "pots" or household. A "pot" or household in this context therefore referred to a collection of individuals within a compound who eat and work together.

Within the compound household were organized either as nuclear

---

1 The National Federal Office of Statistics had used it as an acceptable interviewing unit in it farm management survey, Fed. Office of Statistics, 1956/57 p.5; Norman, used it too in his survey of some villages in Zaria and found that the concept of "consuming unit, was in accord with the composition of farm production unit", D.W. Norman, 1974, p.5.

families (Iyali) or as extended units (Gandu). A gandu unit consisted of two or more male adults, in most cases married with wives and children and it involved the distribution of certain rights and obligations among members pertaining to the production and disposal of their farm produce.[2] The household head controlled the land, labour and management of technology and production in farming and in return provided basic necessities for those under his control. However, a male adult in gandu had the right to farm his field on which he had control. Table 5.1 shows the selected number of households indicating the existence of gandu in the study area.

---

2 This involved a more complex structure of relationships which have been explored in detail by M.G. Smith, 1955 pp. 18-20, D.W. Norman, 1974, p. 4 and B.J. Buntjer, 1969, p.10.

Table 5.1: The Distribution of sampled Households Including Those in Gandu Farmer Categories

Village	Big	Intermediate	Small
Barde	2(0)a	3(1)	5(7)
Borindawa	4(2)	5(3)	1(8)
Gwanki	3(0)	5(1)	2(3)
Kaya	6(0)	3(0)	4(7)
Tsibiri	1(1)	5(0)	4(7)

Source: Survey Data.

a) The figures in bracket are the numbers of household in gandu. Some of the households selected initially were in Gandu and this later increased the sample size.

As observed in Table 5.1 the occurrence of gandu was less among the big farmers category. Apparently, the institution may be a sort of a social security system that caters for the weak in the system. Gandu was also less in sampled villages with traces of modernity.[3] There was less occurrence of gandu in kaya and Gwanki.[4]

5.2 Demography

Population list of the study villages were not available at the time of the study. The results presented in the preceding tables were collected at the preliminary survey.

Age and sex for the sample villages are presented in Tables 5.2a to 5.2e. The higher age group were more in number than the other categories.[5]

---

3 This supports the declining incidence of gandu which had been observed by B.J. Buntjer op. cit., p.12. Similarly in another study in the study area it has been found that about 80% of the respondents belonged to gandu and about 56% were out of Gandu, Anon, 1981, p. 26.

4 Kaya though relatively isolated, it is on a major road to Birningwari via Kuyello and it is of a semi urban status while Gwanki is a busy commercial settlement on the Zaria-Kano dual carriage way.

5 This seem to beat variance with the findings of Mortimore and Wilson, 1965 pp. 29-33 and D.W. Norman, 1974 p.5 who in a separate study in same villages around Zaria in a similar environment to this study area, found a higher percentage of the total population in the lower age groups. This

Table 5.2: Age Distribution of The Respondents in the Sampled Villages

a. Barde

Age(yrs)	Male	Female	Total	% of total	Cumulative %	Male/ Female Ratio
6	10	13	23	28.75	28.75	0.77
7-14	7	3	10	12.50	41.25	2.34
14-64	20	27	47	58.75	100.00	0.74
65	0	0	0	0	100.00	0

b. Borindawa

Age(yrs)	Male	Female	Total	% of total	Cumulative %	Male/ Female Ratio
6	12	15	27	23.90	23.90	0.8
7-14	18	11	29	25.66	49.56	1.67
14-64	25	30	55	48.62	98.23	0.34
65		2	2	1.77	100.00	-

could be attributed to improvement in medical services and modernization.

c. Gwanki

Age(yrs)	Male	Female	Total	% of total	Cummulative %	Male/ Female Ratio
6	18	12	30	44.11	44.11	1.5
7-14	3	1	4	5.89	50.00	3.0
14-64	15	19	34	50.00	100.00	0.79
65	-	-	0	1.77	100.00	-

d. Kaya

Age(yrs)	Male	Female	Total	% of total	Cummulative %	Male/ Female Ratio
6	12	6	25	20.53	20.53	2.83
7-14	11	20	31	27.68	48.53	0.55
14-64	18	40	58	51.79	100.00	0.45
0 65		-	0	0	100.00	0

e. Tsibiri

Age (yrs)	Male	Female	Total	% of total	Cummula tive %	Male/ Female Ratio
6	12	19	31	34.07	34.07	0.63
7-14	13	6	19	20.88	54.95	2.17
14-64	18	22	41	45.05	100.00	0.82
65		-	-	-	-	-

Table 5.3: **Average Household Size and Composition by Farmer Category**

	Farmer Category			
Age Category	Big	Medium	Small	Overall Average
Adult Male	2.1	1.7	1.1	1.63
Adult Female	2.5	2	1.4	1.97
Children (M&F)	2.4	1.6	1	1.63
Small Children (M&F)	3	2	2	2.33
Total	10.0	7.3	5.5	7.6

Source: Survey Data.

Table 5.4: Labour Unit Equivalents of Households by Farmer Category

Age Category	Big	Medium	Small	Overall
Adult Males	2.1	1.7	1.1	1.63
Adult Females	1.88	1.5	1.05	1.48
Children (M&F)	1.20	0.8	0.50	0.83
Small Children (M&F)	0	0	0	0
Total	5.18	4.0	2.05	3.94

Source: Survey Data

There appeared to be an imbalance in the male/female ratio of this age category from where the bulk of the work force is supposed to come. The ratio was low and this is significant in terms of the number of persons in the household who can contribute to farm production and consequently farm income of the household.[6]

Table 5.3 shows that big farmers had larger average household size than the small ones. This labour available to them than the other categories. Average household sizes of 10.0, 7.3 and 5.5 were found for big, medium and small farmer categories respectively. The average household size for the whole sample was 7.6 Since the agricultural production in the area was basically subsistence, labour force available to a household would be important in determining total production and farm incomes of farmers.

In order to determine the contribution of each potential work force in a household to production and farm income in quantitative terms, each household composition was converted to labour unit equivalent. The conversion factor used by Norman (1974) was used.[7]

---

6 As indicated earlier respondents were mainly Muslim and practice of seclusion (kule) an Islamic injunction was common. It does not expose women, at their active age, to partake in rigorous field work.

7 Based on some maintained hypotheses on labour productivity, labour units were converted into labour unit equivalents as below.

Age(yrs)	Sex	Labour Unit Equivalent
6	Male and Female	0.00
7-14	Male and Female	0.50
15-64	Male	1.00
15-64	Female	0.75
65	Male and Female	0.50

D.W. Norman, op. cit., p.7.

labour unit equivalents as in table 5.4. The big farmer category had a larger labour equivalent unit than the other categories. This further reinforce the indication that the big farmer category had an advantage of labour force over the other categories.

5.3 Occupation of Household Heads

The study area being a semi-arid region, with a long period of dry season, the tendency for farmers to engage in other occupations as a source of revenue to supplement that from agriculture is prevalent. Farmers were asked their main occupation and the result is presented in table 5.5.

Secondary occupation may be an additional source of income and provide a means for investment in agriculture. Table 5.5 indicates that most respondents were full-time farmers. Next to farming was trading on agricultural and non-agricultural products. Generally, farmers were engaged in non-paid occupation. This made the estimation of income from these sources difficult.

5.4 Size and Size Distribution of Holdings

The size of holdings or farms of households were estimated. The estimation was based on those holdings on which households had rights of production in the survey year. The measurement was done by direct measurement of fields using prismatic compasses.

Table 5.6 and 5.7 summarize information on size and size

Though proponents of gender studies argue that the coefficients depend on the operation and the conversion may not be tenable distribution of holdings. Unequal distribution of land holding was manifested between farmer category. While the average size of holding ranged between 0.82 and 0.66 hectares among villages, it ranged between 0.65 and 5.45 among farmer categories. The average size of holding was 1.80, 1.53, 0.83, 6.66 and 0.98 hectares for Barde, Borindawa, Gwanki, Kaya and Tsibiri in the respective order. It was 5.45, 1.74 and 0.65 hectares for big and medium farmers category respectively. The overall average size of holding in the area of study was 2.17 hectares.[8] Kaya particularly had larger size of holding. This may not be unconnected with its isolated location. Barde though isolated too, but because it is not easily accessible, farmers there might not have had adequate economic exposure to motivate them to cultivate as large holdings as Kaya. Villages such as Gwanki, Borindawa and Tsibiri that were either close to urban centres or to centres of economic activities had relatively smaller average size of holding. Size of holdings may be a constraint to production for the small farmer category and might not have allowed them the benefits of the technology like the big category.

---

8 The Federal Office of Statistics estimated an average size of holding of about 1.82 hectares in 1957/58 and 1.86 hectares in 1963/64 for Zaria area and the whole northern states respectively. Fed. Office of Statistics, lo. cit., p.12. Norman too in his study on Zaria province, the average size of holding of 2.40, 3.56 and 4.08 hectares for Hanwa, Doka and Dan Mahawayi respectively were reported, D.W. Norman, lo. cit., p.10.

Table 5.5: Distribution of The Main Occupations of the Respondents in the Sampled Villages

	Village									
Occupation	Barde		Borindawa		Gwanki		Kaya		Tsibiri	
	No.	%	No.	%	No	%	No.	%	No	%
Farming	15	18.8	29	25.7	15	22.1	24	21.4	28	31.1
L/Stock Husbandry	0	0	1	0.9	2	2.9	0	0	0	0
Fishing	0	0	2	1.8	0	0	0	0	0	0
Processing Agric.Products	20	25.0	0	0	6	8.8	3	2.7	0	0
Milling Agric. Products	0	0	0	0	6	8.8	0	0	0	0
Trading in Agric.Products	3	3.7	16	14.2	2	2.9	3	2.7	3	3.3
Trading in Non-Agric Products	2	2.5	3	2.7	1	1.5	2	1.8	13	14.4
Salaries Worker	3	3.7	0	0	0	0	0	0	0	0
No Paid Occupation	32	40	64	54.4	31	41.6	82	73.2	46	51.1
Student	5	7.4	0	0	5	7.4	0	0	0	0
Others	3	3.7	1	0.9	0	0	0	0	0	0

Source: Survey Data

Table 5.6: Size Distribution of Holdings by Village in

Table 5.6: Size Distribution of Holdings by Village in the Study Area, 1990

Size of Holding	Village									
	Barde[a]		Borindawa		Gwanki		Kaya		Tsibiri	
	No.	%	No.	%	No.	%	No	%	No.	%
0.25	-	-	1	5.56	-	-	-	-	1	7.69
0.25-0.49	-	-	4	23.22	5	38.46	1	9.09	6	46.15
0.50-0.99	6	50.00	-	-	3	23.08	1	9.09	2	15.38
1.00-1.49	2	10.67	4	22.22	4	30.77	-	-	-	-
1.50-1.99	1	8.34	3	16.67	1	7.69	-	9.09	-	-
2.00-2.49	1	8.34	4	22.22	-	-	1	9.09	-	-
2.50-2.99	-	-	-	-	-	-	-	-	2	15.38
3.00-3.49	-	-	-	-	-	-	1	9.09	-	-
3.50-3.99	-	-	2	11.12	-	-	2	18.18	-	-
4.00-4.49	1	8.34	-	-	-	-	-	-	-	-
4.50-4.99	-	-	-	-	-	-	1	1.09	-	-
5.00-5.49	-	-	-	-	-	-	1	1.09	-	-
5.50-5.99	1	8.34	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	4	36.36	-	-

Source: From the Study.

a) The percentages may not add up to 100, exactly because they were rounded up.

Table 5.7: Size Distribution of Holdings by Farmer Category in the Study Area, 1990

Size of Holding	Farmer Category: Big No.	Big %[a]	Medium No.	Medium %	Small No.	Small %
0.25	-	-	1	4.54	1	4.17
0.25-0.49	-	-	2	9.09	14	38.33
0.50-0.99	-	-	4	18.18	5	20.83
1.00-1.49	2	14.28	6	27.27	2	8.33
1.50-1.99	2	14.28	3	13.64	1	4.12
2.00-2.49	2	14.28	2	9.09	-	-
2.50-2.99	1	7.14	1	4.54	-	-
3.00-3.49	-	-	1	4.54	-	-
3.50-3.99	2	14.2	1	4.54	1	4.17
4.00-4.49	-	-	-	-	-	-
4.50-4.99	1	7.14	-	-	-	-
5.00-5.49	-	-	-	-	-	-
5.50-5.99	1	7.14	-	-	-	-
6.	3	21.42	11	4.54		

Source: From the Study.

a) The percentages may not add up to 100 exactly because they were rounded up.

Table 5.8: Average Household Size of Holding in The Sampled Villages (ha)

Village	Size (ha)
Barde	1.80
Borindawa	1.53
Gwanki	0.83
Kaya	6.66
Tsibiri	0.98

Source: Survey Data.

Table 5.9: Average Size of Holding by Farmer Category

Category	Size (ha)
Big	5.45
Medium	1.74
Small	0.65

Source: Survey Data.

5.5 Land Tenure

The tenurial system in the area was also examined. This was with a view to determining whether access to land constituted an impediment to farm production in the area. Table 5.11 summarizes some of the findings.

The table indicates that most of the plots were acquired either through inheritance, or purchased. Generally it could be concluded that farmers had security of tenure because most of them most owned their farms. This may be an incentive for long term investment in agriculture.

Table 5.10: Nature of Tenure of Holdings by the Respondents

Nature of Tenure	Frequency	%
Owned/Bought/Personal/ Inherited	275	84.1
Rented	9	2.8
Borrowed	42	12.8
Others	1	0.3

Source: Survey Data.

CHAPTER SIX

RESOURCE USE, PRODUCTIVITY AND CROPPING PATTERN

One of the main features of seed-fertilizer technology is that it is always a package developed through selective breeding of highly fertilizer responsive varieties with shorter maturity periods. This usually leads to an increase in the relative importance of some inputs which may change the input -output pattern of production. Besides, the cost structure of the new technology may bring about a new crop calendar, given the shorter maturity period, which may change the existing cropping pattern.

Resource use in maize production was compared with other competing enterprises: sorghum and millet. This is with a view to comparing resource use for improved maize production with the competing crops. Comparison was made between improved maize and these crops because local varieties of maize in the area is virtually extinct.

Resource productivity is very important in any production process. It is important in:

a) providing a framework for formulating and evaluating policy;

b) serving as a guide to adjustment of resources in production process;

c) indicating problem areas that need further research;

d) and above all, serve as a barometer of economic progress.

Resource productivity in maize was also compared with millet and sorghum.

The general objective of productivity studies is to determine how output per unit of input can be increased and to attain a desirable inter-firm, intra-firm and inter-sectoral transfers of productive resources and consequently provide the means of raising the economic level of society in general. The concept of resource productivity impinges on income distribution and the allocation of resources. While this section deals with resource use and productivity the next section will examine the possibility of income distributional effect of the technology on the respondents.

6.1 Resource Use

The resources employed in any process of production are land, capital ,labour and management. Management plays a coordinating role for the other factors and is often difficult to quantify, so it was not examined in depth in the study. Norman (1972) had observed that management is a complex factor and is outside the competence of an economist to investigate.

6.1.1 Land

Land is considered as one of the most important factors that determine farm income difference among farmers, particularly in developing countries. Essang (1970) in his study of income distribution among cocoa farmers in Western Nigeria found inequality in income distribution and attributed the difference to access to land. Though Matlon (1979) found that land may not play such a significant role in a more land abundant environment such as the study area. But with the present population pressure, land is undoubtedly a determinant of farm production and consequently income.

Land was estimated as the total holdings which households cultivated in the production year. No distinction was made between lowland (fadama) and upland (gona). A detail soil survey was not carried out but the little information collected on soil quality indicated that there was no great variation that would lead to significant productivity difference between enterprises and between villages. Moreover the comparison was made between maize, sorghum and millet which are crops grown mostly on upland gona.

Size and size distribution of holding have been discussed in chapter five. Table 6.1 and 6.2 further analyse the data. This is with a view to determining the quantum of land available to each work force or labour unit equivalent. There was not much difference in the distribution of size of

There was not much difference in the distribution of size of holding per labour unit by village and farmer category compared to size distribution of holding by village and by farmer category as shown in table 6.1 and 6.2.

Table 6.1: Size Distribution of Holding Per Labour Unit Equivalent by Farmer Category.

Farmer Category	Average Size of Holding (ha)	Labour Unit Equivalent	Size of Holding Per Labour Unit Equivalent
Big	5.54	5.18	1.05
Medium	1.74	4.0	0.44
Small	0.65	2.65	0.25

Source: Survey Data.

Table 6.2: Size of Holding Per Labour Unit Equivalent by Village

Village	Average Size of Holding (ha)	Labour Unit Equivalent	Size of Holding Per Labour Unit Equivalent
Barde	1.8	3.36	0.54
Borindawa	1.53	3.35	0.44
Gwanki	0.83	2.40	0.35
Kaya	6.6	5.77	1.14
Tsibiri	0.98	3.38	0.29
Average of Total	2.35	3.65	0.55

Source: Survey Data.

Kaya had a higher holding per labour unit than the other village. Kaya had 1.14 hectares per labour unit equivalent as the highest among the villages while Tsibiri had 0.29 hectares per labour unit. The overall average of holding per labour unit equivalent was 0.55 ha/per labour unit equivalent or per adult man. The size of holding per labour unit equivalent was 1.05, 0.44 and 0.25 hectares per labour unit equivalent for Big, Medium and Small farmers. According to Haberd (1979) an area of 0.28ha is required under normal circumstance to provide adequate subsistence for an adult. Going by Haberd's argument the small farmer category on the average lived below subsistence and the farmers is Tsibiri live barely above subsistence.

The difference between villages and farmer category was not remarkable. Big farmers had higher holding per labour unit equivalent than the Medium and small farmers. Farmers in Kaya and Barde, relatively remote villages, had higher holding per labour unit equivalent. This difference may be a reflection of income difference but size of holding alone may not be the determinant of income. Factors that could determine income may include the use of other inputs, land productivity, types of crops grown and so on. some of these factors were examined in the following sections.

6.1.2 Labour

Land and labour are the two main factors employed in subsistence agriculture. Farm Management survey has shown that in such agriculture, labour requirement in the production process constitute between 50-65% of all farm operations. Elaborating on this, Olayide and Heady (1982) observed that high cost of labour and the unwillingness of young grade school leavers to undertake heavy chores of weeding with primitive tools poses a grave problem to farm labour in developing countries. Norman (1972) in a survey of three (3) villages in the NGS opined that labour and not land is more limited factor of farm production in the study area.

Two types of labour were used for farm operations. Labour was broadly categorized into family and hired labour. Hired labour included those labour paid for in cash and kind. The imputed cost of labour paid for in kind was computed, so was the cost of family labour. A comparison was made between the amount of labour used for maize production and the competing enterprises.

Table 6.3: Labour Use in Selected Enterprises by Farmers in the Study Area

	Labour Use (Hrs)								
				Sorghum	Millet Based[a]				
Operation	Family	Maize Hired	Total	Family	Hired	Total	Family	Hired	Total
Land Preparation	23.7	28.9	52.2b	18.7	44.2	62.8	15.4	35.3	50.7
	(11.6)	(12.9)	(23.6)	(7.0)	(16.6)	(23.8)	(6.4)	(14.6)	(21.0)
Planting	3.5	9.2	12.7	14.7	10.1	24.9	15.0	12.1	27.1
	(1.7)	(4.5)	(6.2)	(5.6)	(2.8)	(9.4)	(6.2)	(5.0)	(11.2)
Fertilizer	5.7	6.0	11.7	6.5	6.9	13.4	4.0	0.7	4.7
Application	(2.8)	(3.0)	(5.8)	(2.4)	(2.6)	(3.1)	(1.7)	(.3)	(2.0)
Weeding	14.2	44.26	58.4	22.4	48.9	71.3	32.5	21.6	54.1
	(7.0)	(21.3)	(29.0	(8.5)	(18.4)	(26.9)	(13.4)	(8.9)	(22.3)
Remoulding	5.3	1.8	7.1	5.9	4.7	10.6	3.1	2.2	5.4
	(2.6)	(.87)	(3.5)	(23.o)	(1.8)	(24.8)	(1.3)	(.9)	(2.2)
Harvesting	20.0	45.0	65.0	55.8	27.5	83.3	32.7	68.8	100.5
	(9.6)	(21.8	(32.0)	(21.0	(10.3)	(32.0)	(13.5)	(28.6)	(42.1)
Total	72.4	135.2	207.1	124.0	142.3	265.3	102.8	139.7	242.5
	(34.8)	(65.2)	(100.0)	(46.5)	(53.5)	(100.0)	(42.4)	(57.6)	(100.0)

Source; Survey data

a. Millet was not grown sole so millet based enterprises were used for the purpose of comparaison.

b. The figures in bracket are percentages.

Table 6.4: The Intensity of Labour Use in Selected Enterprises by the Sampled Farmers

	Labour Use (hr/ha)		
Operation	Maize	Sorghum	Millet Base
Land Preparation	173.32	136.59	174.93
Planting	45.43	54.22	93.48
Fertilizer- Application			
	41.79	29.17	16.31
Weeding	208.61	155.67	186.52
Remoulding	25.14	23.09	18.45
Harvesting	232.23	178.74	346.72
Total	726.52	577.48	826.41

Source: Survey Data

Table 6.3 shows that there was no marked difference in the pattern of labour used. Weeding and harvesting took a larger share of labour used in farm operations. A slightly more hours of labour were used for harvesting than for weeding in all enterprises. This may be attributed to the demand for labour which is high at the time of harvesting and the arduous nature of the task.[1] This was reflected in the price of labour. While labour costed an average of N15/man day for other farm operations, it costed an average of N20/man day for weeding. Hired labour was used relatively more for maize enterprise than other enterprises. This may be a reflection of the importance attached to maize production.

Table 6.4 examined the intensity of labour use. Maize enterprise used more labour than sorghum enterprise but millet based enterprise used much higher labour than the two enterprises. Labour use in millet based enterprises was largely at the time of harvest. While maize and sorghum enterprises used 232.23 and 178.74 labour hours per hectare for harvest operations respectively, millet used 346.72 hours per hectare.

---

1 A farm survey conducted in the study area revealed that there is a very marked peak of farm work between June and July when there is a high demand for labour. The first weeding of most crop enterprises fall within this period. D.W. Norman, 1972, pp. 10-11.

In fact, the respondents explained their preference for maize against millet to the time and the task it takes to bring millet from the field to the table for consumption.[2] But maize as a technology has not addressed the problem faced by farmers in the area instead it has compounded the problem; that of the peak in the demand for labour between June and July.[3]

The pattern and quantity of labour used by households were not markedly different, see table 6.5. Family labour was used more than hired labour. The only exception was Kaya that used greatly a higher amount of labour than the other villages and a substantial part of the labour used was hired labour. May be, the availability of hired labour enable Kaya to have a larger average size of holding than the other villages.

The big farmer category used a higher amount of labour than the other farmer categories. A higher proportion of the labour used by the big farmers category was hired labour. While about 80% of the labour used by big farmer households was hired labour about 24% was hired labour in the small

---

2 Fig. 4.1 in chapter four indicates the drop in millet production with the adoption of maize.

3 Norman in a study in the area found that the total area a household can manage during the labour peak limit total area a household can put into cultivation in a year. Norman, D.W. An Economic Study of 3 Villages in Zaria Province IAR/ABU, 1972, p.38.

farmer category. The medium category used almost a proportionate amount of hired and family labour. This is line with *a priori* expectation because the same level of technology is adopted by the three categories of farmers.

Table 6.5: Average Labour Use by Households in Selected Enterprises in the Sampled Villages[a] (Hours)

	Labour Use (Hours)		
Village	Hired	Family	Total
Barde	200.53	362.51	563.04
Borindawa	339.52	451.71	791.23
Gwanki	139.22	378.32	517.54
Kaya	2,441.83	432.913	2,874.74
Tsibiri	216.28	387.03	603.31

Source: Survey Data.

a. There were many types of enterprises and computation of labour data was cumbersome. So, the dominant enterprises were used for purpose of comparison. The information contained in the table depict the relative labour use not absolute labour use by household per annum in crop production.

Table 6.6: Average Labour Use by Households in Selected Enterprises by Farmer Category (Hrs)

	Big			Medium			Small		
Operation	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total
Land Preparation	813.6	87.3	900.9	117.0	55.6	172.7	13.7	30.0	43.7
Planting	209,5	49.7	259.3	19.3	25.0	44.3	16.1	17.3	33.3
Weeding	303.4	62.9	366.2	64.8	56.4	121.2	17.8	51.8	69.6
Fertilizer Application	99.7	35.4	135.3	4.8	30.6	35.4	2.1	20.0	22.1
Remolding	29.9	113.0	143.0	20.5	24.2	44.6	5.4	12.6	18.0
Harvesting	392.9	133.4	526.3	102.1	185.8	287.9	9.1	66.9	76.0
Total	11849	481.7	2330.7	328.5	377.6	706.9	64.1	198.6	262.7
	(79.3)[a]	(20.7)	(100)	(46.5)	(53.5)	(100)	(24.4)	(75.6)	(100)

Source: Survey Data.

a The figure in bracket are percentage of the total.

Table 6.7: Intensity of Labour Use By Households By Farmer Category (Hrs/ha)

	Big			Intermediate			Small		
Operation	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total
Land Preparation	227.3	24.4	251.7	98.3	46.8	145.1	22.1	48.5	70.5
Planting	58.5	13.9	72.4	16.1	37.1	37.9	25.9	27.9	53.8
Weeding	84.8	17.6	102.4	54.5	47.1	101.6	28.7	23.3	52.0
Fertilizer Application	27.9	9.9	37.8	4.0	25.7	29.7	3.3	32.2	35.5
Remoulding	8.4	3.6	12.0	17.2	20.3	37.5	8.7	20.3	29.0
Harvesting	109.8	37.3	147.0	85.8	156.1	241.9	14.7	107.9	122.6
Total	516.7	106.7	623.3	275.9	317.0	592.9	103.4	260.1	363.5

Source: Survey Data

The intensity of labour use was the same for all farmer categories particularly at the time of weeding when labour is limiting. Labour was used intensively for land preparation by the big and the medium categories and for harvest by the medium category probably because of availability of labour. This was manifested by the preponderance of hired labour hours used as depicted in Table 6.7

6.1.3: Capital

Capital is employed in farm production process in different forms. Capital could be in the form machinery such as tractors and other large equipment. Such high mechanical equipment were not common among the respondents. Only working capital such as fertilizers, seeds, insecticides, which easily transform into farm output and income were considered. Capital utilization was low and was mostly a direct embodiment of labour in the form of land improvement. The tools used were mainly hand tools with no much variation in form and value.

The capital used in production were mainly in the form of seed, fertilizer and chemicals. Table 6.8 examined the amount of capital used by farmers particularly in the production of maize compared with other enterprises. More was spent on capital in maize production than other enterprises. While about N889./ha was spent on maize production N484.38 and N424.2 per hectare were spent on sorghum and millet base enterprises.

The difference in capital use may have implication for cost and consequently the net farm income deriveable from each enterprise. The high capital cost of maize production compared with the other crops may be compensated for by its high productivity but it may be a serious constraint to resource-poor farmers.

Expenditure on capital inputs was almost the same for the sampled villages, but Kaya stood out. Households in Kaya spent a proportionally higher amount on inputs particularly fertilizers, probably because they had higher size of holding (see tale 6.8). The big farmer category spent more on capital inputs than the other categories of farmers (table 6.9). So, the big farmer category are likely to benefit more which may exacerbate income inequality between the farmers.

6.2: Resource Productivity

This section compares resource productivity between maize and the competing enterprises. The value of output per hectare, gross margin per hectare and returns to household labour, management and capital were used as measures of productivity.

Table 6.8: Capital Use in Selected Enterprises Among the Sampled Farmers

	Amount Spent (N/ha)		
Item	Maize	Sorghum	Millet Base
Fertilizer	646.75	369.2	240.0
Seed	186.75	60.33	114.0
Chemicals	0.0	0.0	0.0
Miscellaneous[a]	55.4	54.35	50.20
Total	889.9	483.88	404.2

Source: Survey Data.

a. This include various hand tools used in farm operation like hoe, cutlass, sickle, knife etc. The annual capital flow was computed using straight line depreciation method.

Table 6.9: Average Cost of Inputs by Households in the Sampled Villages

	Cost of Items (N/ha)		
Village	Fertilizers	Seed	Chemicals
Barde	606.58	66.94	39.07
Borindawa	456.34	85.473	37.99
Gwanki	295.78	46.68	18.87
Kaya	1298.54	160.73	34.940
Tsibiri	413.39	51.25	0

Source: Survey Data.

The value of output was considered as the total value of the yield of each crop. Variable cost was made up of the sum of the value of seed, fertilizer, chemicals and hired labour used. Gross margin was defined as gross farm income less total variable cost. Return to family labour, land management was computed by subtracting the imputed value of capital used and divided it by the total number of man-hours used in each enterprise. The return to land and management was found by subtracting the cost of family labour from the net farm income. Family labour was valued at the opportunity cost of using it as hired labour or at the average wage rate in each village.

Table 6.11 indicates that resources were more productive in maize enterprise than the competing enterprises. The average yields were 2,653.750, 1883.004 and 1679.76kg/ha for maize, sorghum and millet respectively. The average value products of labour were N18.21, N16.36 and N10.86 for maize, sorghum and millet enterprises respectively. The implication is that labour employed in maize production generates more income than in sorghum and millet production. Again, the return per unit investment were N3.64, N0.32 and N2.31 for maize, sorghum, and millet respectively. Resource productivity was higher in maize than the competing enterprises and the net return was also higher for maize production.The implication is that maize has a high potential for income generation and may affect income distribution among farmers.

There was no remarkable difference in the structure of production cost.The production of Millet was more labour intensive compare to the other enterprises. This may explain why maize is gradually replacing it in the prevailing cropping system though its production is more profitable than sorghum. Banta *et al*, 1988, in an assessment of the improved sorghum technology in the are concluded that growing sorghum has no positive effect on farm income.

Table 6.10: Average Cost of Inputs Used by Farmer Categories

Farmer Category	Cost of Item (N/ha) Fertilizer	Seed	Chemicals
Big	1030.90	140.40	58.79
Medium	387.42	41.19	3.14
Small	238.14	33.47	10.48

Source: Survey Data.

Table 6.11: A Comparison of Cost and Returns of Maize Production With Other Enterprises in the Sampled Villages

Item	Maize	Sorghum	Millet
Output (kg/ha)	2,653.75	1883.04	1679.76
Value of Output (N/ha)	2,653.75	188304	2015.71
Labour Use (Mandays/ha)			
- Family	51.50	53.30	77.79
- Hired	94.26	61.78	107.74
- Total	145.76	115.08	185.53
Variable Cost (N/ha)			
- Seed	35.85	27.96	29.65
- Fertilizer	256.26	222.63	287.66
- Labour	437.28	345.25	556.59
Gross Margin(N/ha)	1924.36	1287.16	1141.81
Average product of labour (N/manday)	18.21	16.36	10.86
Return per unit cost	3.64	0.32	2.31

Source: Survey Data.1990

6.3: Cropping Pattern

The conventional wisdom is that farmers are guided by a "food first" objective and consequently they allocate land and labour to cash crop production only after their domestic consumption objective have been met. The preceding sections showed that maize was more profitable than the competing crops; millet and sorghum. Since maize is also staple crop farmers are now poised to meet their food requirement with the adoption of improved maize technology and devote more land to cash crop production. In this context the crops grown in the study area were categorized broadly into two; subsistence crops and cash crops. Maize, millet and sorghum were classified as subsistence crops while the others were considered as cash crops. However,it is realized that maize is now a cash crop since a large proportion of the output has to be sold to pay for the purchased inputs in its process.

The prominent feature of agricultural production in the area is the practice of mixed cropping and the adaptive aspect of their sequential management practice. Balcet and Candler (1981) described this process as a two step sequential decision making. As the season progresses and gets established the farmers revises his cropping plans over the season and through replanting (cope) and transplanting (dashe) a set of crop mixtures finally emerge.[4] Mixed cropping is commonly practiced in the area in the form of gicci (cross planting) or relay cropping. Norman (1976), Okigbo and Greenland (1976), and Abalu (1976) have discussed extensively the advantages of mixed cropping system.

The cropping pattern of the respondents was examined. A comparison was also made with the findings of studies which have been conducted in the study area by Norman (1972) and Baclet and Candler (1981). This was to determine if there has been any change with the introduction of the improved maize technology. A new technology follows a new crop calendar and may require changes in cropping pattern and crop rotation.

The improved maize technology emphasize the production of the crop in sole stands. The study also examined the extent to which the crop was grown sole. Norman (1972) in his survey of some villages in the NGS found that there were 25 different crops grown in 200 different crop combinations. Sole crops accounted for only 22 of the 200 crops combinations or 23% per cent of the total cultivated acreage of about 980 acres. Sorghum and millet were the main crop enterprises grown.

---

4 Cope and Dashe are Hausa words for replanting seed and transplanting seedlings respectively occasioned by poor germination.

Baclet and Candler observed 435 different crop mixtures in the former Funtua Agricultural Project. Sole sorghum and millet/sorghum enterprises were the dominant enterprises in 1966/67 production season. Sorghum and millet/sorghum enterprises constituted 22% and 22.9% of the total area cultivated by farmers in that year. In 1980/81 they were still dominant while sorghum constituted 38.40%, millet sorghum constituted 15.4% of the total area put into cultivation.

Ninety eight (98) different types of crop combination or enterprises were observed in the study. Table 6.12 summarize some of the major crop combinations.[5] Maize/sorghum was the most dominant enterprise, it was 16.4% of the total enterprises. There was also a preponderance of sole maize and sorghum enterprises. About 10% and 8% of the enterprises were sole maize and sorghum respectively. About 22% of the total number of enterprises or 86 out of the above 400 enterprises observed were sole crops.

5 Any enterprise that had a frequency of up to 3 and above was considered a major enterprise.

Table 6.12: A summary of the Major Enterprises in the Study Area

Enterprises	Number	%	Average Area (ha)
Maize	42	10.6	0.27
Sorghum	33	2.3	0.46
Cowpea	11	2.8	0.35
Sugar cane	15	3.6	0.19
Rice	15	3.8	0.187
Sweet potato	3	0.8	0.14
Pepper	4	1.0	0.15
Maize/Cotton	11	2.8	0.42
Millet/Groundnut	8	2.0	0.25
Maize/sorghum	65	16.4	0.70
Maize/Rice	4	1.0	0.02
Maize sugar cane	4	1.0	0.08
Maize/compea	4	1.0	0.20
Sorghum.cowpea	9	2.3	0.29
Sorghum/groundnut	4	1.9	0.28
Sorghum/millet	11	2.8	0.34
Sorghum/rice	3	0.8	0.58
Sorghum/yam	3	0.8	0.39
Millet/cowpea	10	2.5	0.32
Cowpea/cotton	6	1.5	0.19
Pepper/cowpea	9	2.3	0.38
Maize/sorghum/cowpea	3	0.8	0.78
Maize/sorghum/rice	9	3.3	0.38
Maize/cowpea/cotton	5	1.3	0.17
Sorghum/cowpea/groundnut	3	0.8	0.25
Sorghum/cowpea/pepper	5	1.3	0.17
Cotton/cowpea/ soybeans	3	0.8	0.07
Maize/sorghum/cotton/rice	3	0.8	0.32

Source: Survey Data.

Table 6.13: Average Area of Maize Production by Farm Category (Ha)

Farmer Category	Adjusted Average Total area put into Maize Production	% of Total	Average Area of Sole Maize	% of Total
Big	1.590	44.41	0.373	10.41
Medium	0.606	51.05	0.423	35.64
Small	0.187	30.16	0.045	7.25

Source: Survey Data.

Table 6.14: Average Area of maize Production in The Sampled Villages

Farmer Village	Adjusted Average Total area put into Maize Production	% of Total	Average Area of Sole Maize	% of Total
Barde	0.269	19.51	0.014	1.01
Borindawa	0.474	31.6	0	0
Gwanki	0.33	44.24	0.33	22.05
Kaya	2.299	48.0	0.54	11.27
Tsibiri	0.628	75.36	0.514	61.93

Source: Survey Data.

Apparently, there was no marked change in the structure of the cropping pattern. Mixed-crops still predominated sole crops. One noticeable feature was that maize seem to have displaced millet as the second most important crop enterprise. This may have to do with the labour intensive nature of its production, particularly the harvest operation. Maize has been extensively adopted, for instance over 43% of the major enterprises observed were maize based enterprises.

The general trend of crop production was still in accord with the "food first" philosophy. Most of the major enterprises were food crops with relatively less proportion of land devoted to cash crops. Maize may have attained its status in the area because it doubles as a cash and food crop and besides, resources were more productive in its production. Maize was produced more in Kaya, Tsibiri and Gwanki. These are villages that either have good access roads or are close to urban centres and so produce for the urban markets. Also maize is now an industrial crop which is used in breweries,poultry production and infant food industry.

The area put into maize production by village and by farmer category were examined as presented in tables 6.8 and 6.9. There was no remarkable difference in the area put into maize production by village and by farmer category. The only noticeable difference was more between villages than farmer categories.

Apparently maize production associated more with closeness to urban areas and ease of accessibility. For instance, Barde which is in a remote area, a smaller percentage of land was devoted to maize production. The highest percentage of area devoted to maize production was in Tsibiri which is close to Shika, and by implication, Zaria. The big and Medium category of farmers devoted a larger share of their farms to maize production than the small category. If resources are more productive in maize production than the competing enterprises, then this may have an adverse effect for farm income distribution.

6.4: Determination of the Impact of the Technology on the Intensity of Farm Resource Use

An attempt was made to determine the effect of the adoption of the improved maize technology on the intensity of farm resource use. The technology is made up of a number of varieties and recommended cultural practices. This may have an effect on the quantity of resource use per unit area of land. It would be important to determine the direction of change in view of the small-holder nature of the production in the area.

Labour use per hectare and the amount spent on capital inputs per hectare were used as measures of the intensity of resource use and were regressed against the area put into maize, sorghum and millet as dependent variables. Table 6.15 presents the result of the regression analysis.

Table 6.15: Relationship Between the Intensity of Resource Use and the Production of Maize and the Selected Crops

Labour Use	Coefficients of Area Put Into Crop Production			
(hrs/ha)	Maize	Sorghum	Millet	R^2
Linear	-347.00	-4.330	5,145.5	0.108
Function	(0.476)[a]	(0.006)	(0.967)	
Logarithm	-0275	0.96	0.148	0.200
Function	(0.256)	(0.259)	(0.343)	
		Capital Input Use N/ha		
Linear	371.79[x]	183.55	3163.37[xx]	0.947[xxx]
Function	(2.784)	(1.365)	(3.247)	
Logarithm	0.618[xx]	0.205	0.039	0.845[xxx]
Function	(4.352)	(1.429)	(0.240)	

a. The figures in parenthesis are t-values

x = Significant at 10% level

xx = Significant at 5% level

xxx = Significant at 1% level

Both the linear and logarithm regression equations for the intensity of labour use were not significant. The implication is that the intensity of labour use is determined by factors than the quantity of crops grown. However, the intensity of labour use had a negative relationship with the quantity of maize and sorghum produced for the linear function, suggesting that the more area that is put into maize and sorghum production the less the intensity of labour use. On the other hand, the linear function for millet was positive which confirms that millet production is labour intensive compared to sorghum and maize. In the logarithm regression equation only maize had a negative relationship with the intensity of labour use, while sorghum and millet had positive relationship.

For the intensity of capital inputs used, both the linear and logarithm regression equations were highly significant. This may be because the three crops are the major crops in the area and farmers are likely to invest more on them compared to the other subsidiary crops. All the coefficients were positive indicating a positive relationship between capital input use and maize, sorghum and millet production in both the linear and logarithm equation. The relationship between maize and millet with capital input use were significant. This may be because millet production is labour intensive and capital like land improvements,is basically labour embodied, in a subsistence agriculture and that the improved tecnology involed the use of more capital inputs like fertilizers and other chemicals. Only maize production had a significant relationship with the intensity of capital use which confirms that maize production invold the use of more capital inputs compared to the other enterprises considered.

CHAPTER SEVEN

THE IMPACT OF THE IMPROVED MAIZE TECHNOLOGY ON FARM INCOME AND INCOME DISTRIBUTION

This chapter examines the impact of the technology on income and on its distribution among households in the sampled villages. As observed in the preceding chapter, resources were more productive in maize enterprises than the selected enterprises with which comparison was made. All the respondents cultivated maize, so for the purpose of comparison, they were categorized small, medium and big farmers. The conventional wisdom is that the big farmers by virtue of their position had more access to the technology than the other categories.[12] This make them poised to benefit more from the improved maize technology, which has the tendency to exacerbate farm income inequality. To this end, the extent to which improved maize production affect farm income was also examined.

---

1 This has been supported by observations in chapter 6, particularly tables 6.10 and 6.13, while the big farmers spent an average of N1,030.90 on fertilizers, the intermediate and small farmer category spent N387.42 and N238.14 respectively. And while the big farmer category devoted an average of 1.59 ha to maize production the small and intermediate categories devoted 0.606 ha and 0.189 ha respectively.

7.1: Income Measures

This section defined and explained the measures used to estimate the income of farmers. These measures include Net Farm Income, Gross Farm Income, Net Farm Income per capita and Net Farm Income per man-equivalent Consumer unit.

7.1.1: Net Farm Income

The study considered the total value of crops produced by each household, less fixed and variable costs incurred in the production process

as the Net Farm Income. Income from Livestock production was not included in the computation because livestock husbandry was not commonly observed among the respondents, only small ruminants in small quantities were kept by the respondents. Crop residues were not valued and included in computation too. This may lead to an under estimation of the values of crops produced.

The annual value of the flow of fixed capital like tools, equipment and so on used in the production process in the production year were determined by a depreciation method. Variable input costs included the cost of fertilizer, other chemical inputs used, hired labour, imputed cost of seeds and family labour. The transportation of farm inputs and farm products were included in the computation. Table 7.1 is a summary of the components of the Net household income.

7.1.2: Gross Farm Income

Gross farm income has been defined as the total value of crop production. Gross Farm Income, like net farm income may not adequately indicate the relative welfare position of households.

7.1.3: Net Farm Income Per Capita

This has been defined as the net farm income per individual member of the household. This measure is necessary because it overcomes the weakness of the net farm per household and the gross farm income measures which do not take into consideration the variation in size and composition of household membership for meaningful interpersonal comparison.

Table 7.1: Components of Net Household Income

ITEM	OPERATION
Value of all crops harvested	+
Value of fixed capital flow[1]	
- Depreciation on tools	-
- Depreciation of equipment	-
Variable cost incurred in farm operations	
Imputed cost of seed	
- Total cost of inorganic fertilizers	-
- Total cost of non-family labour	-
- Total cost of family labour	-
- Total cost of transporting input and output to and from the farm	-

1. A straight line depreciation method was used.

7.1.4: Net Farm Income Per Man-Equivalent Consumer Unit

This measure also takes care of the weakness of net farm income and the gross income measures. It takes into consideration the variation in age and sex composition of household. This involves using a conversion coefficient.[3] The consumer coefficient is specific for each major group of consumer items, income stratum and consumer group.

Since the sampled villages were purposively selected from a relatively homogenous social, and to some extent physical environment, if there is any differences it may be in terms of age and sex. So, the coefficients used in computing the man-equivalent consumer unit per household as contained in Table 7.2 was based on standard calorie requirements for each age and sex group as suggested by Food and Agriculture Organization (FAO)

A detailed information on the conversion coefficient can be found in Matlon, 1979, p. 26 and Kleiman, 1966, pp.37 - 38.

Table 7.2: Coefficients Used in Estimating the Number of Man-Equivalent Consumer Units Per Household.

Sex	Age		
	0 - 6	7 - 14	15+
Male	0.25	0.65	1
Female	0.25	0.65	.75

Source: Olukosi, 1979 p.47 and Matlon, 1979 p.27.

7.2: Mean Income Levels

Disaggregated and aggregated incomes level are presented in Table 7.3. The average net farm income for all villages was N21,976.91 per household. The average net farm income was highest in Kaya with a value of N95,347.93. This may be because most of the farmers in Kaya fall into the big farmer category. Kaya also had the largest size of holding of 6.66 ha per household. The village though easily accessible, is isolated and may have had access to more land than the other villages.

On the other hand Gwanki which is on the Zaria - Kano highway had the least average net farm income of N6,862.93 per household. It also had the least average size of holding of 0.83 ha per household. Surprisingly, farmers in Gwanki devoted about 44 percent of the land they cultivated to maize production as against about 48 percent by farmers in Kaya.

Barde another isolated village had the next highest income to Kaya with N10,850.38 per household, though it devoted only 19.5 percent of its cultivated land to maize production.

Borindawa and Tsibiri which are villages that are close to urban settlements had the least net farm incomes next to

Gwanki. Borindawa had an average net farm income of 8,016.36 while Tsibiri had N8,808.24. While Borindawa devoted about 31% of its cultivated land to maize production, Tsibiri devoted about 75%. The low average net farm income in these two villages may be due to high population pressure on land which may not have allowed households access to adequate size of holdings.

Compared with the result of similar studies by Norman and Matlon in the area and by Olukosi in another part of Nigeria, the average net farm income was high as shown in Table 7.5. This may be attributed to inflation, increased, productivity in the sector or even the improved technology.

7.3: Average Farm Incomes of Households in the sampled Villages.

Village	Income Measure			
	Gross Farm Income	Net Farm Income	Net Farm Income Per Capita	Net Farm Income Per Consumer unit
Barde	13,553.63	10,850.4	1,282.60	2,415.32
	(9343)[a]	(1183.68)	(751.71)	(1407.16)
Borindawa	10,560.49	8,016.36	975.09	1767.96
	(3275.12)	(3194.49)	(306.29)	(737.16)
Gwanki	8,125.95	6,861.63	805.48	1490.0176
	(3255.58)	(3754.53)	(387.31)	(622.95)
Tsibiri	10,645.06	8,808.24	1,206.80	2201.90
	(3995.72)	(4387.8)	(463.32)	(812.43)
Kaya	90030.56	75,347.93	7534.75	7674.23
	(83521.8)	(6839.89)	(5916.6)	(6892.13)
All	26583.18	21,976.91	2360.95	3109.92
	(20,777)	(15,580)	(1577)	(2577.03)

Source: Survey Data.

a. The figures in brackets are the Standard Deviation.

7.4: <u>Average Household Incomes By Farmer Category</u>

Category	Income Measure			
	Gross Income	Net Farm Income	Net Farm Income Per Capita	Net Farm Income Per Consumer
Big	40,890.23	34,000.14	3402.81	5453.25
		(1,5302)	(1,5290)	(1,1572)
	(1,5374)[a]			
	10,024.12	8,230.42	1,117.50	1767.96
Medium		(05123)	(0.5306)	(0.5123)
	(1024.12)			
Small	6,612.08	5,391.47	980.27	1,859.13
	(0.1062)	(0.2238)	(0.2238)	(0.2238)

Source: Survey Data.

a. Figures in bracket are the coefficient of variation.

Table 7.5: A Comparison of the Average Net Farm Income and Income Per Capita Obtained By Other Studies in the Area and Other Parts of Nigeria

Source	Net Farm Income	Net Farm Income Per Capita	Place of Study	Year
Norman (1972)	206(1157)[a]	28(157)	Zaria	1967
Matlon (1977)	350(1966)	52(292)	Kano	1974
Olukosi (1979)	337(1893)	45(253)	Kwara	1969
This Study	21,976(12044)	2258(1293)	Zaria/ Funtua	1990

a. The figures in brackets are deflated values using the consumer price index of food (1987 = 100).

Apparently, the values of net income per capita an the average(Table 7.4) seem too high. This may be due to the large number of big farmers in Kaya which may have skewed the distribution highly to the right. Matlon (1979) had observed that type of distribution is typical of most income distribution and particularly common in a population with mean earnings which do not greatly exceed a minimum subsistence. For instance if the values for Kaya were excluded the average net farm income and the net farm income per capita would be N8,634 and N1,067 respectively.

In order to further examine the relationship between farm income and maize production a budget analysis was done (Table 7.6). The table depict that maize alone on the average contributed about 35 percent to Gross farm income, while sorghum and millet contributed six and two percents respectively.

Other crops contributed an average of fifty seven percent to gross farm income. Table 7.6 shows that maize alone contributed a considerable proportion to farm income.The contribution of maize to farm income was considerably high enough to influence the levels of households farm incomes and income distribution The contribution of other crops combined was high because the crops were mainly cash crops or crops grown mainly for cash.

Table 7.6. Contribution of Maize and other crops to Farm Income(N) per Household in the sample Villages

Item	Value
Gross Income	26583.5
Gross Income from Maize	9388.13(35.32)
Gross Income from Sorghum	1709.50(6.43)
Gross Income from Millet	675.75(2.54)
Gross Income from other crops	15263.13(57.42)
Total cost of production	4606.40
Cost of Maize production	1750.30
Net Farm Income	21976.96
Net Income from Maize	7638.13(34.76)

source; Survey Data,1991.

The figures in brackets are the percentage share of the crops to farm income.

7.3: The Adoption of the Improved Maize Technology and Income Inequality

It is generally believed that there is a positive relationship between the adoption of the improved technology and farm income. So, the adoption of the technology by a category of farmers can lead to a change in farm income inequality depending on the position on the income distribution of the adopters.

If the adopters were on the lower (upper) stratum of the income distribution, it is expected that income inequality will drop (increase). Again, if the adopters were spread over the various strata of income distribution and the increase in the rate of adoption over time is proportionately more in the lower (upper) strata of the distribution then the income inequality will drop (increase) over time. So, depending on the position of the adopters on the income distribution stratum and the rate of adoption, the new technology can affect income distribution negatively or positively.

In this section the results of the size distribution of farm income and the impact of the new technology on farm income distribution were discussed. The measures of income inequality used were the ordinal ranking of the size distribution of income depicted graphically in the form of

Lorenz curve, Gini concentration coefficient, coefficient of variation and logarithm of the coefficient of variation.

Measures of inequality are usually either to rank given populations in order of the degree of incomes concentration or to compare before and after income distribution due to the introduction of a particular policy or sets of policies. The former measure is applicable in a longitudinal study.

In this study the relative positions of income strata on the income distribution spectrum were determined through ordinal ranking. An attempt was also made to compare the result of the study with the findings of similar studies previously carried out in the study area and in other parts of the country to see if there was any difference in inequality among farming households.

Table 7.7: Size Distribution of Net Farm Income in the Sampled Villages

Income Category	% of Total No. of H/hold	Cumulative % of Total No. of Household	Average Net Farm Income	% of Total Income	Cumulative % of Total Income
< 5,000	14.28	14.28	3,277.51	2.20	2.20
5001-7500	33.34	47.62	5,111.11	9.47	11.67
7501-10000	9.53	57.15	8,479.18	3.78	15.45
10001-12500	14.28	71.44	11,505.24	7.70	0
12501-15000	0	71.44	0	0	0
15001-17500	4.76	76.20	15,238.5	3.40	26.55
17501-20000	0	76.20	0	0	26.55
20001-22500	0	76.20	0	0	26.55
22501-25000	0	76.20	0	0	26.55
25001-27500	0	76.20	0	0	26.55
27501-30000	0	76.20	0	0	26.55
27501-30000	14.28	90.48	83,315.46	18.6	45.15
> 30000	9.54	100.00	245,618.55	54.85	100.00

Source: Survey Data.

Table 7.8: Relative Shares of Aggregate Income Received by Various Decile Groups of the Sampled Farmers

Decile	Average Net Farm Income	% of Total Income	Cumulative % of Total
1	5605.15	1.25	1.25
2	9638.68	2.15	3.40
3	11361.27	2.54	5.94
4	12141.69	7.71	8.65
5	13506.15	3.01	11.66
6	16958.36	3.79	15.45
7	22485.13	5.02	20.42
8	27268.50	6.09	26.56
9	83315.45	18.60	45.16
10	245618.55	54.84	100.00

Source: Survey Data.

But, these measure of inequality are sensitive to different types of income distribution. For instance, Champernowne (1974) tested six inequality measures and found that the standard deviation of the logarithm of income was most sensitive for ranking distribution characterized by difference in the extreme low income range. Coefficient of variation was sensitive to variation in distributions with extreme inequality in the high income range. The Gini Coefficient was found to be sensitive to transfers affecting middle income classes. In view of the sensitive nature of these various measures to different types of income distribution a combination of the measures was used.

Table 7.7 is the ranking of households according to the size distribution of net farm income. It was observed that 71.43 percent of the population received only 23.15 percent of the total net farm income. While 23.83 percent of the population of households received 73.45 percent of the total net farm income. The poorest third (which include 57.14 percent of the population in the low stratum of income of the sampled households) received only 15.45 percent of the total net farm income while the third richest (which include 28.32 percent of the sampled population in the high stratum) received 76.85 percent of the total net farm income. Matlon (1979) in a study of income distribution among farmers in Northern Nigeria found that the poorest third of the households earned 18.6 percent of the total household income compared with the richest third which received 46.3 percent. Olukosi (1986) in his survey of farmers in Kwara State found that the poorest third received 19.7 percent of the net family income while the richest third obtained 41.8 percent.[3]

From the foregoing it is apparent that income inequality has increases. Table 7.7 corroborates this observation. While the tenth decile obtained 54.84 percent of the total net farm income the first decile received only 1.25 percent. The ninety decile received 18.6 percent of the net farm income while the second decile received only 2.15 percent.

A more indepth comparison was carried out by comparing the distribution of disaggregated incomes by villages. A summary of measures describing the size distribution of household income by villages is presented in table 7.8.

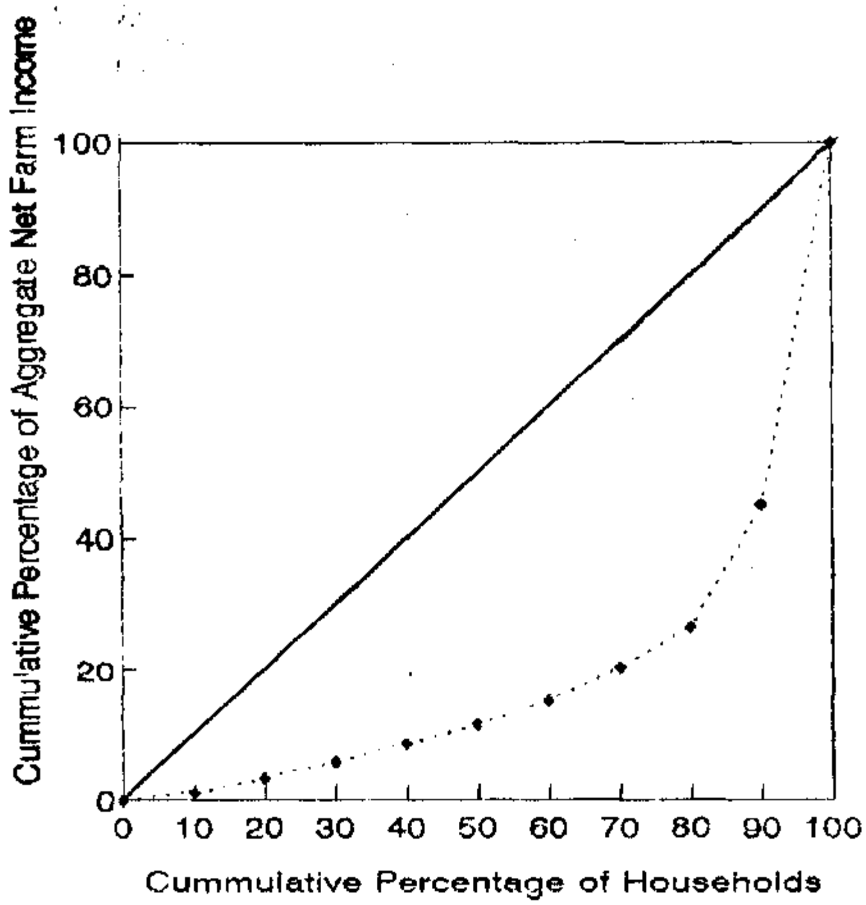
The Gini coefficient for the net farm income per capita was 0.4847. It ranged from 0.1928 in Borindawa to 0.8447 in Kaya, Matlon (1979) reported a Gini coefficient of 0.2823 for his survey villages, while Norman and Payor (1979) reported 0.2990 for Sokoto, 0.3108 for Zaria and 0.3612 for

---

3 For an indept comparison, Chenory, 1974 pp. 8-9 gave the following data for the 1950's and 1960's as the result of surveys conducted in devleoping countries. The average share of income for the poorest 40 percent of the population was only 17.5 percent compared with 16 percent and 75 percent among the developed non-socialist and socialist countries. The following figures were given for African countries, Kenya (1969) 100%; Sierra Leone (1969) 96%; Senegal (1960) 10.0%; Ivory Coast (1970) 10.8% Dahomey (1959) 15.5%; Tanzania (1959) 14.5%; Chad (1958) 18%; Niger (1960) 18.0% and Uganda (1970) 17.1%.

Bauchi in a survey of the three areas. Olukosi (1979) reported a coefficient of 0.3246 for a survey of some villages in Kwara state. The farm income inequality in this study, based on the foregoing may be considered higher than the results of previous studies carried out in the area and in other parts of the country.

The Gini concentration coefficient of 0.4212 was the highest in Kaya followed by Barde which had 0.4132. These two villages are relatively remote and have had more access to cultivatable land compared to the other villages. On the other hand, Borindawa and Tsibiri which are either close to urban settlements or centres of high commercial activities had the two least Gini coefficient of 0.1928 and 0.1981 respectively.



Source: Survey Data

Fig. 7.1 Distribution of Net Farm Income Among Farmers in the Samples Villages.

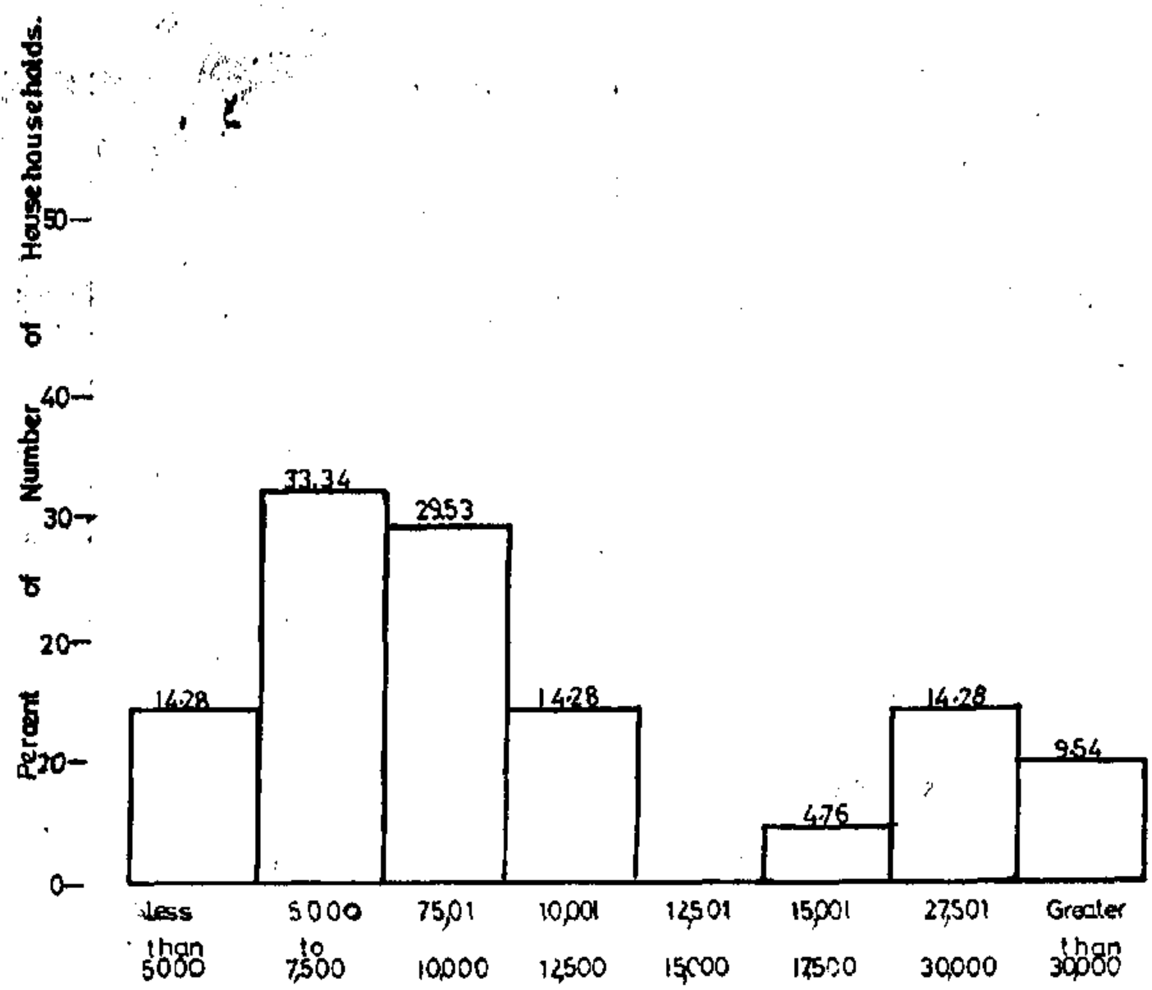


Fig. 7.2 Percentage Share of Income Strata in Income Distribution Among the Sampled Households.

Table 7.9: A Summary of Measures of the Size Distribution of Farm Incomes By Household and Village

		Measure	of	Inequality
Type of Income	Village	Gini Coefficient	Coefficient of Variation	Standard Deviation of the Natural log of Income
Gross Farm Income Per Household	Barde	0.3378	0.8760	0.3390
	Borindawa	0.1730	0.3581	0.1663
	Gwanki	0.2260	0.4479	0.2515
	Kaya	0.4155	0.6923	0.4289
	Tsibiri	0.1866	0.4112	0.1704
	All	0.4590	0.3522	0.2492
Net Farm Income Per household	Barde	0.4132	0.4580	0.4113
	Borindawa	0.1928	0.7172	0.1927
	Gwanki	0.2656	0.5419	0.3173
	Kaya	0.4212	0.1819	0.4110
	Tsibiri	0.1981	0.4981	0.1956
	All	0.4847	0.8301	0.2913
Net Farm Income Per capita	Barde	0.3317	0.7752	0.3124
	Borindawa	0.2309	0.4376	0.2452
	Gwanki	0.4195	0.6013	0.3539
	Kaya	0.4308	0.3407	0.4324
	Tsibiri	0.1915	0.5119	0.2078
	All	0.371	0.4772	0.2885
Net Farm Income Per Consumer	Barde	0.3306	0.6049	0.3113
	Borindawa	0.2208	0.4814	0.3895
	Gwanki	0.4364	0.5571	0.1086
	Kaya	0.4464	0.9281	0.5762
	Tsibiri	0.220	0.4923	0.2039
	All	0.2290	0.9129	0.3395

Source: Calculated from survey Data.

There was no much accumulation of land in these areas due probably to population pressure on land and consequently farm income was more equitably distributed.

The inequality was greater between villages than within village. This may mean that incomes were more equitably distributed within the villages than between villages. This may be due partly to inequality in accessibility to inputs particularly land. Land concentration in the two remote areas may have been due to the availability of cultivatable land leading consequently to a high concentration of income. The reverse was the case for places close to urban centres or areas of high commercial activities. The Gini coefficient for net farm was higher than the other measures, this may imply income was more equitably distributed at individual level than among households.

The other measures of income inequality are also presented in Table 7.8. As mentioned earlier, the coefficient of variation is more sensitive to distributions with inequalities in the relative high range while the standard deviation of the log of income is more sensitive to extreme low income range. This has been reflected as obtained in Table 7.8. The coefficient of variation of the income measures were high for Kaya where a good number of households had extreme high incomes while the value of the coefficients of the natural logs of income were comparatively low.

Another striking feature of these two measures is that, while the coefficient of variation was higher in this study compared with other studies, the standard deviation of the natural log of income was lower. For instance, the standard deviation of the natural log of income and the coefficient of variation for the study were found to be 0.5133 and 0.7089 respectively while Matlon (1979) reported 0.619 and 0.5718 in the same respective order. This probably mean that this study had more households with extreme high incomes compared to the previous studies which may suggest the improved maize technology has increased the farm income of farmers. On a general note, the inequality measures were consistent; there was more inequality between villages than within villages. However, since only net farm income was considered, if non farm income is considered this may give a different picture of income distribution in the area.

CHAPTER EIGHT

SUMMARY AND CONCLUSION

This chapter summarized the findings of this study and drew some conclusions and their policy implications.

8.1: Summary

During the past decades, the Nigerian agriculture has experienced deliberate efforts aimed at arresting the debilitating crisis that has since crept into the sector. The introduction of the improved maize technology into the Northern Guinea Savannah is one of such efforts. The need for the study stemed from the increasing public interest in the income distribution effect of new agricultural technologies and the need to use the much needed scarce resources efficiently.

This interest has been manifested in the increased public expenditure on agricultural research, education, and extension, and the prominence given to the need to reduce income inequalities and Wealth in previous National Development Plans. The knowledge of the effect of new farm technology on pattern of farm income distribution is necessary for all arms of government to formulate appropriate policies to attain the desired goals in agricultural and economic development.

Detailed farm management surveys of the prevailing situation of farms, income distribution and its determinants and resource productivity have been carried out in the study area and in other parts of the country in the past, but a few known attempts have been made to investigate the effect of new agricultural technologies on income distribution and resource use. Thus, a gap in the knowledge of the change in income distribution and resource use that may have taken place since the introduction of improved agricultural technology exist. This study is an attempt to explore if the gap exist and to fill it if possible.

Specifically the main objectives of the study were to describe historical pattern and extent of the adoption of the new technology on farm resource productivity. Third, to see how the new technology may have affected the cropping pattern that existed in the study area before its introduction. Fourth, to determine the effect of the technology on farm incomes. Fifth, to examine if incomes inequality exist among the sampled farmers and to determine to what extent maize production has affected these income levels. Six, to determine the extent to which the pattern of resource use has been affected. This is important because of the resource poor nature of farmers. The knowledge of the foregoing, it is be used to increase agricultural production and equity among farmers in the study area.

The methodological and empirical approaches and tools used by past studies focusing on income distribution and farm resource use were reviewed for possible application to the analysis of this problem. The relevant tools and approaches were modified to suit the circumstances of this study for measuring farm income, size distribution and farm resource use.

Descriptive statistics was used to examine the pattern and trend of the adoption of the improved maize technology. Descriptive analysis was also used to determine the effect of the technology on the cropping pattern in the area and it was complimented by a regression analysis to examine the effect of the technology on the intensity of resource use. Budget analysis was used to determine the productivity of farm resources. The size and size distribution of incomes were measured by means of Lorenz curve, the standard deviation of the natural logarithm of income, coefficient of variation and Gini concentration coefficient. In addition, a regression analysis was used to determine the extent to which the production of maize and some other crops affected farm income.

Different varieties of the improved maize technology of the TZPB and TZB germplasms have been introduced in succession and farmers have been selective in their adoption based on their perceived desired characteristics of the varieties. The improved maize technology has been widely adopted. Maize used to be a subsidiary crop in the Northern Guinea Savannah but it is now a major food and cash crop. Apparently, farmers are widely aware of the technology but it has not been properly understood by them. Being a divisible technology, major components of it have not been adopted and this has not allowed farmers to reap its full benefit.

There has been no well established and specifically mandated institutions to generate/multiply the seed and distribute it and other supporting inputs to farmers. So, farmers used the seeds they acquired several years back continuously, while they are supposed to acquire new seeds every year. The possibility of seed contamination exist, maize being a cross pollinated crop and the fact that different varieties are grown at close fragmented plots. Besides, since different varieties of seed have been introduced, they can easily get mixed up. These factors may conspire to drastically reduce the yield of maize and consequently jeopardize its performance and acceptance by farmers.

The main problems encountered by farmers growing maize were inadequate and untimely availability of fertilizers and drought. The ideal maize to farmers is the one that is less fertilizer demanding, early maturing, drought resistant and has big cobs and seeds.

The average size of holding was found to be 2.17 hectares. There was relatively high degree of land concentration. The difference in the size of holding was more between villages and farmer categories than within village. Apparently, labour limited the size of holding. Big farmers cultivated larger size of holding, probably be because they could afford to hire labour, while farmers in remote villages, Kaya and Barde, cultivated larger size of holding probably due to available labour occasioned by limited secondary employment opportunities.

While the production of maize was capital using, the production of millet was labour using. Labour was used mainly for weeding and harvesting. Crop production in general is still mainly extensive rather than intensive. Resources were more productive in maize production than in the competing entreprises; millet and sorghum.

There has been no marked change in the cropping pattern. The tendency towards the cultivation of crops, particularly maize, sole was observed but mixed-cropping still preponderates. It was also observed that maize is gradually replacing millet in the cropping systems.

The study revealed that farm incomes and income inequality among households have increased. The inequality was more between villages than within villages and it was also more pronounced between households than between individuals. The quality of maize produced was significant in determining the net farm income of households.

8.2: Conclusion

The improved maize technology has been widely adopted in the study area but several factors seem to have conspired and may jeopardize its sustainable use in the area. These factors include the following:

a) The possibility of seed contamination, may vitiate the avowed qualities of the technology.

b) The practice of continuous use of the "improved" seeds year in and year out instead of acquiring new seeds each year may reduce the vigour or yield of the crop.

c) the inadequate and untimely supply of vital components of the technology, like fertilizers, may not allow farmers to fully reap the benefits of the technology. In fact, the inadequate supply of fertilizers is seriously threatening the continued use of the technology. Many farmers regretted that they have reduced the quantity of maize which they produced due to insufficient supply of fertilizer and some indicated their desire to drastically reduce the quantity of maize they produce for the same reasons and the increasing price of fertilizers.

It seems the technology does not suit the socio-economic characteristics of farmers and the bio-physical characteristics of the environment for the following reasons:

a) It involves the use of a lot of external inputs which may not be in accord with the resource-poor nature of the farmers.

b) The pattern of resource used, particularly labour is almost the same. This may compound problems for farmers whose major task is to cope with the peak in the demand for labour at the time of weeding.

c) Its success requires the existence of established functional and co-ordinated institutional infrastructures which were lacking in the area and which may not be easy to come by.

d) The technology involves recommendations which may be too technical for the farmer, most of whom are not literate in western education, to understand and properly apply. This may not allow them to fully exploit the technology.

e) The cropping system is predominantly mixed-cropping but the technology recommended monocropping.

f) The temporary rain cessation or drought that always occur in the area, around May/June, at the beginning of the rains is a serious impediment to maize production.

Again, if planting is delayed for the rains to get well established, the final rain cessation in the production year could be too early for the crop and may lead to total crop failure/loss. There is therefore the need to further improve on the technology in order to make it adequately suit the socio-economic characteristics of farmers and the bio-physical characteristics of the environment.

Great variation in the size of holding existed between villages and farmer category. Labour appeared to be the main constraint to crop production and may not allow some categories of farmers to increase their size of holding. The big farmer category that had the wherewithal were able to increase their size of production, maybe, through the use of hired labour because they used hired labour more than the other categories of farmers. This emphasizes the need for credit facilities to enable farmers, particularly those in the small category, to defray operating costs.

Resources were more productive in maize production than in the competing crops; sorghum, millet. The technology has the potential for increasing farm production and the income of farmers. Though the technology seem to have increased the income of farmers, the potential for it to increase income inequality also exist.

The empirical findings of this study suggest that improved maize technology has been widely adopted in the study area. But, the sustained production of the crop in the area is in question because policy commitment for the generation and the delivery of the improved seed and other complimentary inputs and services is not strong enough. Besides, the characteristics of the technology is not completely in accord with the socio-economic characteristics of the farmers and the bio-physical characteristics of the environment. There is therefore the need for continuous research to develop and produce acceptable varieties to farmers and an effective delivery system which will take into consideration the location and individual difference of farmers for an equitable income distribution.

8.3: Policy Implication

The conclusions suggested in the preceding discussion have the following implication:

First, though the technology has been widely adopted in the study area, its continued use may be in jeopardy for reasons enumerated earlier. There is therefore the need for deliberate policy to address the following:

a) The supply of complimentary inputs to the seed technology like fertilizers, have to be provided to farmers adequately and timely.

b) The need to further research on the technology in order to breed varieties which are not only in accord with the socio-economic characteristics of farmers but also the bio-physical characteristics of the environment.

c) There is also the need to make the farmers clearly understand the technology.

All these policy requirements give weight to the need to establish institutions with the express mandate to produce or multiply the improved seed on yearly basis, a good input delivery system, research and improvement on the seed on a continuous basis and to educate farmers accordingly. This is necessary because this kind of technology, by its nature, is dynamic. These are by no means easy tasks for most developing country to achieve. For future policy aimed at increasing farm production and income, indigenous crop which is well adopted to environment will stand a better chance of sustainable increase in farm production and income.

Second, though farm resource were more productive in maize production, the pattern of resource use particularly labour, was almost the same for the crops for which comparison was made. Norman (1972) had observed that the main problem of agricultural production in the area of study, which limits the area which a household can put into cultivation, is labour and its peak demand at the time of weeding. So, the improved maize technology may compound farmers` problems in this respect. For a technology to be fully embraced by farmers it should be able to ease the production,s pressing problem to some extent.

Third, there was variation in the size of holding and consequently the farm incomes. In fact, some of the respondents live below poverty line level and for a technology that requires the use of external inputs which have to be purchased, there will be a great encumbrance to some which may exacerbate income inequality. so, for an equitable distribution of income there should be a deliberate policy to identify the weaker group and direct specific measures to alleviate their plight. Location seemed to have an effect on size and size distribution of holding and income. This also imply that for an equitable spatial distribution of farm income through the introduction of an improved technology, resource endowment and the characteristics of specific areas should be identified and specific policy measures be applied to specific areas based on their differences.

BIBLIOGRAPHY

Abalu, G.O. (1976). "A Note on Crop Mixtures under Indigenous conditions in Northern Nigeria" Jounrnal of Development Studies, Vol. 12 No.3, p.214.

Abalu, G.O. and B.D. silva (1979). "Socioeconomic Analysis of Existing Farming Practices in Northern Nigeria", Paper presented at the Workshop on Socio-economic Constraints to the Development of Semi-arid Tropical Agriculture, ICRISAT, 19-23 Feb.

Abudy, F. and C. Morris (1972). Personal Income Distribution in Bendel State, (CEWSCE). A Research Report.

Adelman, I and C. Morries (1973). Economic Growth and social Equity in Developing Countries. Stanford; Stanford University Press.

Adesimi, A. (1982). "Resource use and Productivity in Maize Production in Farm settlements of Western Nigeria" Ife Journal of Agriculture, 4 No. pp.118-131.

Ahmed, B. (1985). Scale Economics in Maize Production: A Case of Daudawa Farms in Kaduna State. Unpublished M.Sc. thesis, Department of Agric. Economics and Rural Sociology, ABU, Zaria.

Ahluwaha, M. (1976). "Income Distribution and Development: Some stylized Facts". American Economic Review, 66, pp. 128 - 135.

Annon (1972). Farm Incomes and Resources Management in the Western State of Nigeria, Ministry of Agric. and Natural Resources, Western State Government.

Annon (1981). A socio-economic and Extension Survey of The Funtua Agricultural Development Project, Dept. of Agricultural Economics and Rural Sociology, IAR/ABU, Zaria.

Alao, J.A. (1971). Communication Structure and Modernization of Agriculture: An Analysis of Factors Influencing the Adoption of Farm Practices among Nigerian Farmers. Unpublished Ph.D. Dissertation, Cornell University, New York.

Balcet, J.C. and W. Candler (1981). Farm Technology Adoption

Balcet, J.C. and W. Candler (1981). Farm Technology Adoption in Northern Nigeria, vol.1 (Main Report). A World Bank Research Project Report RPO 071-88.

Baldwin, G.R. and I. Dina (1956). Nigerian Cocoa Farmer, Oxford University Press, London.

Banta, T.A.; J.O. Olukosi and C.e. Ngwabo (1988). "A Socio-economic Evaluation of the Improved Sorghum Technology: The Case of the Guided Change Project Area" Samaru Miscellonous Paper No.144, IAR/ABU Samaru-Zaria.

Basu, A.C. (1969). "The relationship of Farmers Characteristics to the Adoption of recommended farm Practices in Four Villages of Western Nigeria" Bulletin of Rural Economics and Sociology 4 (1) pp. 79 - 87.

Buntjer, B.J. (1969). "The Changing structure of Gandu" IAR/ABU. Samaru-Zaria.

Buting, A.H. (1985). "Science and Technology for Human Needs: Rural Development and the Relief of Poverty" (Ed), steven A. Berth, Essasys on science and Farmers in Developing World, WIIAD Raule 3, Morrition AR 72110, U.S.A.

Champernowne, D.G. (1953). "A Model of Income Distribution", The Economic Journal 63: 318-351.

Cheema, A.A. (1987). "Productivity Trends in the Manufring Industries", The Pakistan Development Review XVII, 44-65.

Chenery, H.B. 1974). Redistribution With Growth, Oxford, Oxford University Press.

Clark, R.C. and Akinbode, A. (1968). Factors Associated with Adoption of three farm practices in the Western State of Nigeria. Research Bulletin I. Faculty of Agriculture University of Ife.

Clayton, E.s. (1960). "Labour use and Farm Planning in enya", Empire Journal of Experimental Agriculture, vol.28 No.110, April.

Cromwell, E. (1990). Seed Diffusion Mechanisms in Small Farmer Communities: Lessons from Asia, Africa and Latin America, ODI Network Paper No.21, Dec. p.10

Edwin, J. A. (1991). A Socio-economic Analysis of Input Availability and Utilization in Hybrid Maize Production in the Northern Guinea Savannah of Nigeria, Unpublished M.Sc. Thesis. Dept. of Agric. econs and Rural Sociology, IAR/ABU, Zaria.

Elliot, C.M., J.E. Bessel, R.A. Roberts and N. Venzerti (1970). Some Determinants of Agricultural Labour Productivity in Zambia", University of Nottignham and Zambia, Agricultural Labour Investigation, UNZAIPI, report No.3, Nov.

Eronini and Ndiomu (sic) (1975). "The Distribution of Inocme in Nigeeria, 1969/70-1971/72". Economic and Financial Review, Central Bank of Nigeria Dec.

Etukudo, A. (1977). "Rural and Urban Household Income Expe nditure in Nigeria" Unpublished Research Bulletin, Human Resources Unit, University of Lagos.

Essang, S.M. (1970). The Distribution of Earnings on the Cocoa Economy of Western Nigeria: Implication for Development, Unpublished Ph.D. Dissertation, Michigen State University, East lasting, Michigan.

Federal Ministry of Science & Technology (1985). The Impact of the National Agricultural System on Agricultural Development in Nigeria,, Skoup and Co. Ltd., associate Business Consultants, Sep. p. 84.

Federal Office of Statistics (1957). Agricultural sample Survey, 1955-1960" Bulletin 2(Revised), Zone B. 1956/57 Lagos, Nigeria p.7.

Griliches, L. (1957). "Hybrid Corn: An Exploration in the Economics of Technological Change", Econometrica, vol.25 No.4, Oct., p. 501-522.

Harberd, L. (1980). Collecting and Analysing Agronomic Data, APMEPU.

Heady, E.O. (1966). Agricultural Problems and Policies of Developed Countries, Bondenas Foriag, 0510.

Hill, P. (1972). Rural Hausa: A Village and A setting, Cambridge, Cambridge University Press.

Hopper, W.D. (1965). "Allocative Efficiency in Traditional Indian Agriculture" Journal of Farm Economics 47:3.

Hopper, W.D. (1975). To Conquer Hunger: Opportunity and Political Will, (Ed) John A. Hamah, International Development Lecture Series, Michigan State University, East Lansing.

International Institute For Tropical Agriculture.(1977). Annual Report and Research Highlights.

Joshona, A. (1985). "Making Improved Seeds Readily Available to Nigerian Farmers", A. Memorandum Submitted Towards Abundant Food Production, National Seed Service, Federal Ministry of Agriculture, Water Resources and Social Development, Iwo Road Ibadan, p. 15.

Kaduna State Agricultural Development project (1990) Annual Report p.10.

Kassam, A.H., J. Kowal, M. Dagg, M.N. Harrison (1975) "Maize in West Africa and its Potentials in Savanna Area", World Crops, 22(2), pp. 75-78.

Kitsopanidis, G.I.and A.D. Psychadakis (1972)."The Economics of Maize Production", Dept. of Agricultural Econs. Research, Aristotelian University of Thesoloniki, the Soloniki, Greece.

Kowal, J.M. and D. Knabe (1972). An Agroclimatological Atlas of the Northern States of Nigeria, Zaria, Nigeria, Ahmadu Bello University.

King, R. (1976). "Earmers' Cooperatives in Northern Nigeria: A Case Study Used to Illustrate the Relationship Between Economic Development and Institutional Change", Ahmadu Bello University, Samaru, Nigeria.

Kleiman, E. (1966). "Age Composition, Size of Household, and The Interpretation of Per Capita Income" Economic Development and Cultural Change, 15: 37-58.

Kuznets S. (1955). "Economic Growth and Income Inequality" American Economic Review, 45: 1-28.

Lageman, J. (1977). Traditional African Farming System in Eastern Nigeria, Munchen, Wellforum Verliag.

Lewis, A. (1954). "Economic Development with Unlimited Supplies of Labor", Manchester School of Economics and Social Studies, Vol.26 pp. 139-191.

Lunning, A.H. (1967). Economic Aspects of Low Labour-Income Farming, Wageningen: Centre for Agricultural Publications and Documentations, Agricultural University.

Matlon, P.J. (1977). The Size Distribution, Structure and Determinants of Personal Income Among Farmers in the North of Nigeria, Unpublished Ph.D. thesis Cornell University.

Matlon, P.J.(1979). "Income Distribution Among Farmers in Northern Nigeria: Empirical Results and Policy Implications" African Rural Employment. Paper No.18, Michigen State University, East Lansing, p.22.

Mellor, J.W. (1975). The Impact of New Agricultural Technology on Empl oyment and Income Distribution - Concepts and Policy, Occasional Paper No.81 Department of Agriculture Economics, Cornell University, New York.

Mijindadi, N.B. (1981). Production Efficiency of Farms in Northern Nigeria, Unpublished Ph.D. thesis, Cornell University, New York.

Mincer, J.N.C., "Labour Supply, Family Income and Consumption" American Economic Review, Vol.1, May, pp. 274-281.

Moji, C.C. (1980). "On Modern Agricultural Technology, its use and Adoption - Some Implication" IRRI Research Bulletin, No.27.

Manu, E.D. (1981). "Transfer of Technology to Small Farmers in Nigeria", East African Journal of Rural Development, Vol.14, pp.3-21.

Nortimore, M.J. and J. Wilson (1965). "Land and People in the Kano Close-Settle Zone", Report to the Greater Kano Planning Authority, Department of Geography Occasional Paper 1, ABU, Zaria.

Norman, D.W. (1972). "An Economic Study of Three Villages in Zaria Province: Input-Output Study 1", Samaru Miscellaneous Paper 37, IAR/ABU, Zaria.

____(1974). "Rationalizing Mixed Cropping Under Indigenous Conditions: The Example of Northern Nigeria", Journal of Development Studies, Vol.II No.2, p.64.

P. Bardon, W.J. Kroder, D.H. Pryor, H.D. Hays and B. Huzinga (1976). "The Feasibility of Improved Maize Crop *Production Technology for the Small Scale Farmers in the* Northern Guines Savanna Zone of Nigeria". Samaru Miscolleanous Paper 188, IAR/ABU, Zaria.

_____ and D.U. Proyor (1979). "Technical Change and The Small Farmer in Hausaland: Northern Nigeria", African Rural Employment Paper No.21; Dept. of Agricultural Economics, Michigen State University, East Lansing.

Ogunfowora, O., S.M. Essang and O.O. Olayide (1974/75). "Resource productivity in Traditional Agriculture: A Case Study of Four Divisions in Kwara State of Nigeria" Journal of Rural Economics and Development 2, pp.119-132.

Ogungbile, A.O. and J.O. Olukosi (1992). "The Feasibility of Hybrid Maize Production Technology for Small-Scale Farmers in Northern Nigeria", Agricultural Farming System, Vol.2, No.1.

Okigbo, B.W. and D.J. Greenland (1976). "Inter-Cropping Systems in Tropical Africa", M.Stelly (Ed), Multiple Cropping ASA Special Publication, No.27, AM Society of Agronomy, Madson, Wl, U.S.A.

Ologunde, O.O. (1987). "Two Decades of Agromic Research on

Yields, Improvement of Sole Crop Maize (Zea Mays) in Savanna Ecological Zones of Nigeria: A Review", Samaru Miscelleanous Paper 188 IAR/ABU, Zaria.

Olukosi, J.O. (1979). The Distribution of Personal Incomes Among African Farmers - A Two Period Analysis, Unpublished Ph.D. thesis, Michigan State University, East Lansing.

_____ (1986). "Income Generation and Distribution: A Case Study of Ipetu and Odo-ore Villages in Omu-aran Area of Kwara State" Samaru Miscelleaneous Paper 112, IAR/ABU, Zaria.

Ranis, G. and J.G. Fei (1961). "A Theory of Economic Development" American Economic Review Vol.51, No.4, Sept. pp.533-565.

Raza, M.R. and J.P. Voh (1986). "The Small holder choice of Technology: A Survival Response in the World Bank Assisted Development Projects (ADPs) in Northern Nigeria", A paper presented at 13th European Congress for Rural Sociology held at Braga/Portugal, 1-4th April.

Ruttan, V.W. (1955). "The Impact of Urban IndustrialDevelopment on Agriculture in the Tennesse Valley and the South-East. Journal of Farm Economics Vol. XXXVII No.1 Feb. p.42.

Shultz, T.W. (1964). Transorming Traditional Agriculture, New Haven, Yale.

_____ (1975). "The Valueof Ability to Deal with Disequillibria". The Journal of Economic Literature Vol. XIII, No.3, Sept.

Singh, R.D. (1982). "Location Effects on the Adoption of New Farm Technology in Northern India", Indian Journal of Agricultural Economics Vol. XXXVII No.4 Oct./Dec. pp.445-502.

Smith, M.C. (1965). "Exchange and Marketing Among the Hausa", R. Bohaman and G. Dalton (Eds), Markets in Africa, Garden City, Anchor Books.

Smith, J. (1990). "Socio-Economic Characterization of Environment and Technologies in Humid and Sub-Humid Regions of West and Central Africa", IITA, Ibadan, May 8 (Draft).

Spencer, D.S.C. (1986). "Agricultural Research: Lessons of the Past Strategies for the Future", R. J. Berg and J.S. Whitsker (Eds), Strategies for Afrcian Development, University of California, Press, pp. 215-244.

_____ and D. Bryelee (1977). "Technical Change Labour Use and Farmer Development: Evidence from Sierra Leone" African Rural Economy Paper, Dept. of Agricultural Economics, Michigan State University, East Lasing.

Tang, A.M. (1956). "Farm Income Differentials in Southern Pledmont, 1860-1940." The Southern Economic Journal, Vol.XXIII, No.1 July.

APPENDIX A: AVERAGE MONTHLY RAINFALL IN THE STUDY AREA 1985-90 (mm)

	Month											
Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1985	0.0	0.0	32.9	0.0	140.7	142.2	313.1	256.3	163.3	3.3	0.0	0.0
1986	0.0	0.0	0.0	5.8	59.1	82.0	293.6	322.1	102.1	42.6	0.0	0.0
1987	0.0	0.0	0.0	0.0	135.7	146.8	276.7	268.3	102.1	42.6	0.0	0.0
1988	0.0	3.5	0.0	34.6	94.4	133.2	181.5	402.5	192.3	114.7	0.0	0.0
1989	0.0	0.0	0.0	15.0	113.0	124.4	158.7	170.4	118.3	52.9	0.0	0.0
1990	0.0	0.0	0.0	0.0	123.3	155.3	221.9	255.3	131.5	0.0	0.0	5.0
Aver	0.0	0.6	5.5	9.2	11.0	130.7	240.9	279.2	152.2	35.6	0.0	0.8

Source: **Agroclimatological** Unit IAR/ABU, Zaria.

APPENDIX B: AVERAGE MONTHLY SUNSHINE IN THE STUDY AREA FROM 1985-90 (Hrs).

	Month											
Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1985	246.9	178.8	173.4	145.4	240.2	224.9	182.1	223.2	216.7	230.6	278.7	186.0
1986	247.6	269.1	214.1	253.1	239.8	234.7	191.1	213.7	235.0	264.3	258.5	215.8
1987	284.8	284.8	196.1	208.8	279.1	228.2	237.0	187.2	240.0	265.4	285.4	255.7
1988	202.1	240.2	217.9	236.0	246.9	220.1	168.4	174.3	176.6	290.3	302.6	225.7
1989	313.8	174.3	271.0	233.4	240.1	218.2	206.4	180.0	194.4	262.8	281.8	248.0
1990	242.7	216.4	240.9	249.1	232.5	217.6	199.5	210.1	222.6	259.7	278.3	379.6
Average	256.3	227.3	268.9	221.0	246.4	224.0	197.4	198.1	214.2	263.2	281.0	251.8

Source: Agroclimatological Unit, IAR/ABU. Zaria.

APPENDIX C: LABOUR USE BY HOUSEHOLDS IN THE SAMPLED VILLAGES (Hrs)

Operation/Type of Labour	Village				
	Barde	Borindawa	Gwanki	Kaya	Tsibiri
Land Preparation					
Hired	41.10	42.69	17.01	175.07	43.31
Family	29.83	53.81	178.30	82.43	40.67
Total	70.93	95.50	192.31	257.50	83.98
Planting					
Hired	92.22	37.19	0.00	274.30	0.00
Family	42.34	44.83	27.25	36.39	19.19
Total	114.56	82.01	27.25	210.69	19.19
Fertilizer Application					
Hired	2.14	29.35	0.00	129.04	0.00
Family	51.86	26.90	17.01	00.53	22.32
Total	54.00	56.25	17.01	189.57	22.32
Weeding					
Hired	38.53	108.22	12.50	60.20	1.97
Family	12.00	203.63	72.01	60.34	130.42
Total	50.53	311.85	84.51	120.54	132.39
Remoulding					
Hired	11.11	3.32	12.31	21.95	0.00
Family	28.91	13.98	15.33	67.67	22.22
Total	40.02	17.30	27.64	89.62	22.22
Haervesting					
Hired	35.43	118.75	99.50	448.83	171.00
Family	174.84	108.56	71.42	125.57	152.21
Total	210.27	227.31	170.92	574.40	323.21

Source: **Survey Data.**

APPENDIX D: INTENSITY OF LABOUR USE BY HOUSEHOLDS IN THE SAMPLED VILLAGES (Hr/ha)

Operation/ Type of Labour	Village				
	Barde	Borindawa	Gwanki	Kaya	Tsibiri
Land Preparation					
Hired	32.83	27.90	20.49	175.07	44.19
Family	29.83	35.17	211.20	12.38	41.50
Total	62.66	63.07	231.69	187.45	85.69
Planting					
Hired	40.12	24.30	0.00	41.19	0.00
Family	23.52	29.30	32.83	5.46	19.58
Total	63.64	53.60	32.83	46.65	19.58
Fertilizer Application					
Hired	1.19	19.18	0.00	19.38	0.00
Family	28.81	17.18	17.01	9.09	22.77
Total	30.00	37.06	17.01	18.47	22.77
Remoulding					
Hired	6.17	2.17	12.31	3.30	0.00
Family	16.06	9.14	18.47	10.16	22.67
Total	22.23	11.31	30.73	13.46	22.67
Harvesting					
Hired	19.68	77.61	119.88	67.39	174.49
Family	97.43	70.95	86.08	18.85	155.32
Total	116.11	147.7.56	194.93	86.24	329.81

Source: Survey Data.

APPENDIX E: CORRELATION COEFFICIENTS OF THE VARIABLES USED IN THE REGRESSION EQUATION TO DETERMINE THE RELATIONSHIPS BETWEEN INTENSITY OF RESOURCE USE AND CROP PRODUCED

	X_1	X_2	X_3	X_4	X_5
Labour Use Per ha(X_1)	1	-	-	-	-
Area put into Maize Production Ha(X_2)	-.1678	1	-	-	-
Area put into Sorghum Production ha(X_3)	-.1028	.9381**	1	-	-
Area put into Millet production ha(X_4)	.1414	.5591**	.6854**	1	-
Value of Capital used per ha(X_5)	-.0916	.9265**	.9481**	.7560**	1

* = Significant at 10% level
** = Significant at 5% level.

APPENDIX F: THE CORRELATION COEFFICIENTS OF THE VARIABLES USED IN THE REGRESSION EQUATION TO DETERMINE THE RELATIONSHIPS BETWEEN THE QUANTITIES OF CROPS PRODUCED AND NET FARM INCOME

	X_1	X_2	X_3	X_4
Net Farm Income (X_1)	1	-	-	-
Quantity of Maize Produced kg (X_2)	.9650**	1	-	-
Quantity of Sorghum Produced kg (X_3)	.6099*	.6988**	1	-
Quantity of Millet Produced kg (X_4)	-.2136	-.1859	-.0188	1

* = Significant at 10% level

** = Significant at 5% level.