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Michael Iyiola Kolawole

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AN ECONOMIC STUDY OF TRACTOR CONTRACTING OPERATIONS
IN WESTERN NIGERIA

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Cornell University, 1972

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The agricultural economy of Western Nigeria is characterized by an overwhelming number of poor, illiterate farmers growing small, scattered acres of crops. The native system of agriculture consists of shifting cultivation, cut and burn without clean-clearing, mixed cropping and planting on the heaps. Various sizes and types of hoe, cutlass and simple knives together make up the farming equipment. Elaborate capital inputs are conspicuously absent. Labor productivity, crop yields, and the use of modern farming practices are on the low side.

Since the 1950's, attempts have been made to introduce the use of tractors. But, there are doubts about the rationale for this production method; not only because of high cost of tractor operation and the "cheap" labor but also because of the different socio-economic environment to which it is imported. Many economists both from developed and developing countries and indeed high Government officials that set up the project doubt the effectiveness of this western sophisticated production technique in peasant agricultural economies.

These doubts and the many question marks concerning farm mechanization prompted the research on which this study was based. The objective of the study was to examine (1) The peasant farmer economic base and ability to use hire service to any significant profit vis-a-vis non-users (2) The utilization of available power and factors that affect usage (3) The impact of tractor use on farm size, labor requirements and farm practices (4) How timely farmers are serviced.

Farm mechanization was introduced in Western Nigeria as a tractor hiring service because farmers lack the financial base to own tractors. The Ministry of Agriculture is the principal agency that operates tractor hire service for farmers. The hire service prepares seed bed for farmers; which consists of plowing, harrowing and ridging/planting for a charge of 82.5 shillings per acre of complete operation. Farmers send applications for service to the Engineering branch through the Extension division of the Ministry.

Primary data were collected by personal interview method during June to October 1971; using the single visit recording approach. Three trained undergraduates of the University of Ife assisted in the survey. Data collected were for the year 1970. Four types of farmers--farm settlers, group farmers, individual users and non-users were interviewed. A sample of 193 farmers and nine private tractor owners were interviewed. Farmers were interviewed concerning crops for which they use hire service such as maize, cotton, tobacco and rice; of which maize is the most important. Fifteen of the sixteen tractor stations were visited.

Analysis of variance technique was used to examine whether net return per acre significantly depends on the number of operations mechanized and use vis-a-vis non-use of tractor. The analysis indicated that there is no significant difference in net return per acre between users and non-users of hire service in maize production. In respect of late maize, net return per acre does not significantly depend on the number of operations mechanized. But in case of early maize, the opposite holds.

Budgeting technique was used to examine the relative profitability of alternative operational procedures open to hirers. The analysis indicates that it is profitable to farmers to skip the harrowing operation. Also, harrowing could be traded for fertilizing with profit, but the

profitibility is very sensitive to fertilizer prices and/or maize response to fertilizer applications. Budgeted results also show that tractor hire use is a very expensive addition to the package of farm practices.

Queuing theory was used to analyze delays and waiting times. The analysis, which used data from Oshogbo hire unit, indicated that with six tractors to go per day, a farmer spent an average of 32 days in the system of which 19 days were spent on the queue. Congestion is a more serious problem in the early season peak period than late crop season peak period.

Annual utilization of available power was generally low. Hours per tractor ranged from 10.8 in Akure to 838.4 in Ijebu-Ode Division. Low tractor usage was due to seasonality of work, high frequency of equipment breakdowns, shortage of tractor operators and irregular fuel supplies. Except in Ibadan/Oyo Circle, tractors are used predominantly for transporting. The ratio of hours of field work to hours of transporting averaged 0.47.

The major conclusion of this study was that overall performance and effectiveness have been below expectations; and that machine technology had been extended to peasant farmers who are not economically viable enough to absorb it. The production technique also finds itself in an environment where the socio-economic arrangement and the basic supporting facilities, both physical and human, for its successful operation are not yet well developed.

BIOGRAPHICAL SKETCH

Michael Iyiola Kolawole was born in Ibokun-Ilesha, Western Nigeria, on September 13, 1940. He was educated at St. Peter's School Ibokun, Baptist Day School, Ibadan and Grammar School, Oshogbo, Nigeria.

He entered the University of Ibadan in October, 1962, obtaining the Bachelor of Science in Economics in June 1966. He taught at Ibokun Grammar School until October 1967 when he was appointed assistant Lecturer in agricultural economics at the University of Ife, Nigeria.

Awarded a scholarship under the UW/USAID project, he entered the Cornell University Graduate School in September 1968. He obtained an M.S. degree in agricultural economics in June 1970, and continued his studies towards the Ph.D. degree with a major in farm management and production economics, and minors in marketing and economics of trade and development. He completed the requirements for the Ph.D. degree in May 1972.

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CHAPTER I

INTRODUCTION

The agricultural economy of Nigeria is characterized by an overwhelming number of poor, illiterate farmers growing small, scattered acres of crops. The native system of agriculture consists of shifting cultivation, cut and burn without clean-clearing, mixed cropping and planting on the heaps. Various sizes and types of hoe, cutlass and simple knives together make up the farming equipment. Elaborate capital inputs are conspicuously absent. Labor productivity, crop yields, and the use of modern farming practices are on the low side.

Arthur Lewis, writing in 1966, called attention to the stagnation of the food producing sector of Nigerian agriculture. According to Lewis, "the growth rate of 2.5 percent assures that food is just slightly ahead of population growth. . . . Currently, what threatens is a reduction in supply of food as young people drift into unemployment in the towns." (1) Elaborating on the issue raised by Lewis, Anthonio observed that the obvious fact "is that the food situation is far from satisfactory." (2)

The food situation, no doubt, stems from the nature of agriculture and the techniques of cultivation. But proposed solutions to the food problem had put more emphasis on the need to create increased effective demand. According to Lewis, "efforts to increase supply faster than demand will come to naught. What one should strive to achieve is pressure on supplies associated with a genuine increase in demand." (1)

Anthonio also argued that the solution "is to restructure the existing components by education and the improvement of the technique of farming. Prior to this, the more urgent problem is that of creating increased effective demand by improving the existing marketing system." (2)

The 1967-70 civil war brought a new dimension into the food picture. The war broke down the existing delicate food-population balance and during and after the civil war Nigeria faced the problem of food shortage. The food shortage was reflected in soaring prices of food stuffs. Between 1969/70-1970/71, prices of food stuffs rose by 36 to 300 percent (3). A tin of rice which could be bought for 40 shillings in July 1971 rose to 70 shillings in August. The price of beans rose from 20 shillings to 60 shillings in the same period. A serious maize shortage caused poultry farmers to import maize. (4)

This new element has contributed to the increased emphasis on increased food production by farm mechanization. In government, universities and press, discussions centered on large scale mechanization. To quote University of Ife statement on agricultural engineering (5)

> . . . In order that Nigeria may be able to feed its population properly, subsistence farming as practiced by over 95 percent of the farmers must give way to mechanized large scale farming employing a relatively smaller percentage of the population. The labor thus released from the farm would then be employed in other sectors of the economy. The length of time spent by peasant farmers working with hand tools is hardly commensurate with the amount of work accomplished. He needs some mechanical aid to amplify his efforts. This calls for application of machinery to agriculture.

In the Nigerian press, the subject also received widespread discussion. The general tone of the discussion was that "only mechanized farming can increase food production" (6). Some felt that the large scale mechanized farms should be operated by agricultural graduates on a cooperative basis. (7)

Modern machine technology should be looked at in the light of past experience and present socio-economic organization. Innovation constitutes a change of what is; but what is, always is affected by what has been. On this premise, an examination of the Nigerian experience in the area of farm mechanization is in order.

The first most significant attempt at mechanization in the country is the popularly known, often quoted and well-documented Mokwa Project. This project was a partnership scheme, started in 1949 and controlled by the Colonial Development Corporation. The objectives of the project were: (i) To increase the production of groundnuts for export and of guinea corn for local consumption, (ii) To demonstrate better methods of farming through mechanization, (iii) To combine modern farming methods with the traditional agricultural system, and (iv) To increase productivity per head and per acre. The Oils Seed Mission which investigated the project contended that mechanical cultivation was essential "if the momentum of economic and agricultural advance was to keep pace with the needs of the people." (8)

The scheme failed because of complex and difficult problems that are bound to arise in such a large and over optimistic approach to mechanize peasant farms. A number of factors have been cited for its failure. These include: (i) lack of adequate initial planning, (ii) problem of selecting the appropriate equipment that will work in the tropics. Problems of cultivation were also faced due to the prolific lateral roots and very tall anthills, and (iii) partial mechanization was found to be of no assistance to the farmer. To prepare the land for cultivation without regard to post-sowing weeding problem only leaves the farmer with an unsurmountable problem.

In 1954, the administration of the scheme passed to the Ministry of Agriculture which continued to run it as a settlement where mechanical cultivations were performed for the settlers on a contract basis. Although Mokwa project was conspicuous enough to dominate all the other mechanized schemes in the North, there were several lowland schemes, dated as far back as 1949, which also made contributions to the progress of farm mechanization. These lowland schemes were mostly for rice production on land inundated by flood water in the rains. The most important of these schemes were: (i) Sokoto mechanized rice cultivation project in Sokoto Province, (ii) Shemankar rice project, (iii) Jahun rice scheme in Kano Province, and (iv) Jere bowl mechanized rich scheme in Bornu Province. All these schemes were under the authority of Northern Region Production Development Board. The objectives of these schemes were two fold: (i) To increase rice production by providing farmers with machinery services and (ii) to bring further land into cultivation.

In 1963, it was reported that none of these schemes "had managed to show a profit." (9) Problems faced on these schemes were: (i) problem of combing the traditional land tenure system with a mechanized system of cultivation, (ii) breakdowns of a number of tractors, and (iii) subsequent operations after ploughing were seldom done owing to inability of farmers to pay for the additional operation. The problems faced by these schemes were summarized in this observation (10)

> . . . bound up with financial factors, the problem of machine selection became quite considerable. Considerable as they might be, machinery and equipment problems are outweighed by problems of agricultural, economic and social nature which are therefore considered more likely to restrict widespread mechanization.

Progress is being made in the use of animal power in agricultural production by mixed farmers. Mixed farming dated back to 1922, although real progress did not come until the 1950's. Between 1945/46, the number of mixed farmers (those having bullocks) increased from 2,400 to 15,000 and in 1963, the number was estimated at 80,000. (9) The mixed farmers own a ridging plough (the emcot plough) and a pair of draught cattle plus an ox-cart for transportation. They usually farm 15-20 acres and are found in Bauchi, Bornu, Kano, Katsina, Sokoto and Zaria areas of Northern Nigeria. It is estimated that there are more than 50,000 teams of bullocks. This process is being speeded up by the establishment of a £55,000 factory by John Holt Company in Zaria. This factory went into production in 1967, manufacturing about 4,000 emcot ploughs per year. Other implements manufactured include ox-carts and tractor trailers. According to Laurent "ridging with bullocks costs less than half the cost of ridging by hand or with tractorts." (11) This seems to be in order but the barriers to expansion of animal power should be borne in mind. These include: (i) The ridging plough has its limitations in the growing of earlier planted grains such as millet, maize and sorghum. Early ploughing is required in order to plant immediately before the early rains come. But the old ridges are then completely dry and very hard. The power required to pull the plough is beyond the capacity of the animals. Thus, the mixed farmer has to wait until much later in the season, when rain has eventually penetrated the ridge before splitting and planting on new ridges. (ii) Animal source of power requires experience in handling of animals which many farmers don't have, and (iii) The use of bullocks is limited to tsetse fly free areas, capital requirements may be considerable and adequate fodder may be a problem.

To overcome the problem of land preparation attendant on animal power, in 1961 a contract hiring scheme was introduced. The farmer paid only 25 percent of the estimated cost. But the scheme suffered a major set back in the number of farmers using the service in 1962 when the subsidy was cut to 50 percent and a two-acre minimum was imposed.

In Western Nigeria, early thoughts of farm mechanization can be traced to the early missionaries when they introduced the programme of "The Bible and the Plough" in the 1840's. But since their primary occupation was evangelization, their model farm did not make much progress.

Mechanization activities actually started in 1950 when the mechanized group farms were introduced. There were about 20 such farms. The distribution of the farms is shown in Table 1.1. By 1955, four of them had been closed. Those not closed did not do well either. They were faced by a number of problems: (i) Shortage of staff and machinery, (ii) Machinery breakdowns could not be quickly repaired; causing delays in planting, (iii) The social problem of how to get the farmers to continue to form into groups and work together, and (iv) High costs, what to grow and market. The marketing problem was aggravated by lack of storage facilities on the group farms. The Department of Agriculture summarized the difficulties of farm mechanization as follows: (12)

> Mechanized group-farming schemes illustrate vividly the waste of time and funds which always results when extension work is started on something quite new with no previous investigations and proving period. The Department did not know how to grow profitable crops under mechanical cultivation. Difficulties of organizing groups of highly individualistic farmers, difficulties of spares and repairs and of final marketing are secondary to the main issue of cultivation know-how and merely emphasize the need for adequate preliminary staff work before attempting to introduce mechanized cultivation to peasant farming.

Table 1.1 MECHANIZED GROUP FARMS
Western Nigeria

Type of Project	Year Established	Acres
Rice Projects*		
Shakki rice scheme	1951	200
Oyo rice scheme	1952	30
Agberi rice scheme	1953	15
Origbo rice scheme	1953	45
Itori rice scheme	1954	25
Arable Projects		
Ikonifin	1951	150
Upper Ogun	1954	120
Ogbomosho	1952	110
Ilaro	1953	30
Ipetumodu	1953	30
Itagunmodi	1953	15
Ipetu-Ijesha	1953	6
Ijeda	1953	6
Pineapple Projects		
Apitipiti	1953	37
Illugun	1953	20
Alabata	1954	100

Source: Inter-African Conference on Agricultural Mechanization, 1955. Conference Paper Number 43.

*These schemes consist of individually owned and cultivated plots.

When farm settlements were established, farm mechanization got a new push. One of the objectives of farm settlement scheme was to bring modern techniques of farming to the educated farmer. But the large scale resignation of settlers and inadequate equipment put limitations on achievements. Nevertheless, the settlements registered notable changes in the landscape. According to Ojo, "The appearance of farms with only few scattered stumps of trees is one of the most striking differences between a farm settlement and a traditional one." (13)

The renewed efforts to push farm mechanization was demonstrated when in 1969, the Federal Government made a grant of £687,000 to the Western State Government to purchase tractors and implements. The current effort to promote farm mechanization in Western State is well brought out in the current development plan. According to the plan document, the objectives of farm mechanization include: (i) To make farming less exerting, more attractive and more lucrative, (ii) To reduce the drudgery caused by the use of cutlass and the hoe in peasant farming, and (iii) To increase food production.

In the plan period 1970/74, about 100 tractors and various agricultural equipment are planned to be purchased for distribution to the tractor hire pools. A total of £1.6 million is allocated for the development of farm mechanization, 42.8 percent of this total is to be contributed by the Federal Government, while 57.2 percent will be provided by the State Government, Table 1.2.

In the plan period, total expenditure allocated to agriculture is 20.2 percent of the total planned expenditure. 10.1 percent of the total expenditure on primary production by the Ministry of Agriculture

Table 1.2. CONTRIBUTIONS TO FARM MECHANIZATION
Western Nigeria, 1970-74

Year	Government	
	Western State Government	Federal Government
	Pounds	
1970/71	58,700	287,000
1971/72	303,350	200,800
1972/73	419,010	200,000
1973/74	138,400	0
Total	919,460	687,000

Source: 1970-74 Development Plan, Ministry of Economic Planning, Ibadan.

is allocated to the farm mechanization project. The expenditure allocated to farm mechanization project is 1.84 percent of the total capital expenditure for the plan period.

The very high emphasis given to farm mechanization is clear from capital expenditure allocation. Compared with other projects in the plan period, farm mechanization stands out as the single most important item of expenditure (Table 1.3).

The previous mechanized farms in the State failed. There is no firm belief that the current mechanization project will be effective either. In an interview with the Permanent Secretary, Ministry of Agriculture, he commented that "Farm mechanization is one project in which there are still doubts in the minds of many people, including myself. It is an area in which we still don't know the reactions of farmers." Yet, there is no known government sponsored economic study to assess the existing status of farm mechanization in the State before it was

Table 1.3. PLANNED PROJECTS IN AGRICULTURE
Western Nigeria, 1970-74

Project	Planned Expenditure in Agriculture
	Percent
Farm mechanization	10.1
Cocoa scheme	8.7
Farm settlement	7.5
Planting material	7.3
Cotton	7.2
Rice	6.7
Kenaf	5.7
Maize	4.3
Fertilizer supply and subsidy	2.5

Source: 1970/74 Development Plan. Ministry of Economic Planning, Ibadan.

decided to put more money into the project. What has been the experience of farmers in and their reactions to the current farm mechanization scheme? What are the implications of farmers' experience for the existing and planned programs of farm mechanization? A study of mechanized farms is needed to answer such questions.

The Problem

Many doubts have been expressed about the desirability and feasibility of mechanizing tropical agriculture. In particular, it is argued that labour is a surplus factor of production, so why mechanize. Its feasibility is doubted because of high costs of mechanization and the problem of combining modern and improved methods of farming with the

traditional system of peasant farming. The Government of Western Nigeria had put into operation a tractor hiring scheme. But there are doubts in the minds of many economists and others, including high Government officials that establish the project, about how it is going to fare. There is, therefore, a need for the analysis of the performance of mechanized farms and the tractor hire service.

Objectives

The objective of the study is to answer the following questions about the tractor hire scheme:

(I) How profitable is the use of tractor hire service to hirers vis-a-vis non-hirers?

(II) What is the impact of tractor use on labor requirements, farm size and farm practices?

(III) What is the relative profitability of the alternative operational procedures open to users of tractor service?

(IV) What use has been made of the available field equipment and what are the constraints on utilization?

(V) How efficiently have the tractor hire units rendered service to their customers?

The Survey Method

Primary data were collected by survey technique. The survey team consisted of three enumerators and the author. Interviews were conducted during the months of June through October 1971. Data collected were for the year 1970, covering both early and late crop seasons.

Three categories of data were collected:

(I) Data concerning the farm operations of farmers using the hire service.

(II) Data concerning the tractor hire units in respect to output, equipment statistics and condition, tractor personnel and work patterns.

(III) Data related to the waiting line problem, equipment breakdowns and repair shops.

For this study, particular types of farmers--machinery users and non-machinery users who grew the same crops and farm in the same ecological area--were sought. The areas selected were those in which tractor hire units[1] are located. A hire unit is identified by area name such as Shaki hire unit. Fifteen of the sixteen hire units belonging to the government of Western Region were visited.

Villages

Village clusters were identified by the name of the hire unit such as Shaki villages or Iseyin villages where Shaki and Iseyin are both locations of hire units. Each hire unit villages were specified by the extension personnel. All specified hire unit villages were visited. Some villages had to be reached on foot, jeep or tractor.

Selection of Farmers

The procedure followed was to visit the hiring unit first, during which a schedule of village visits to farmers using the service was prepared. The schedule usually specified the villages, dates and times of the visits. Advance notices were sent to the farmers by the

[1]A unit has six tractors. A tractor station can have more than six tractors or less. Hire unit and hire station are used interchangeably.

engineering staff, telling them of the dates and times of the visits. On each visit, a member of staff of the extension division and/or the mechanization officer accompanied the survey team. The advance notice was usually sent to the leader of the farmers and this arrangement worked for organized farmers, such as group farmers and young farmers' clubs. On the meeting date, the purpose of the visit was first explained. The presence of the extension man and/or the mechanization officer (either or both of them have been working intimately with the farmers and therefore are well known) was a great help because it allayed any fears the farmers might have. After introductions, the leader of the farmers usually expressed their willingness to co-operate and answer our questions to the best of their ability. Interviewing would then follow. Every reporting farmer that co-operated was interviewed. Where many farmers reported and were willing to co-operate such as at Okaka and Ilero, every other farmer was interviewed. Individual farmers were removed to separate locations before interviewing commenced to ensure that he was interviewed individually. In the case of group farmers, only the president and the secretary of the group were interviewed.

This arrangement worked well for the group farmers. Reporting individual farmers were usually few. In most cases, individual farmers had to be interviewed on their farms and/or in their houses. The tobacco farmers were met at their barn sites and interviewed there. A member of the extension staff always accompanied the team to meet farmers on their farms or houses and the usual procedure of initial introduction was conducted by the extension man.

The co-operation received from farmers in answering the questions was satisfactory. The subject matter was of major help. Apparently,

most farmers had something to say in respect of the hiring set up and so when told the team had come to ask them questions relating to the tractors, every one was ready to co-operate.

Enumerators

Three enumerators, all undergraduates of the University of Ife, assisted the author in the survey. One of the enumerators already had extensive experience in survey work. He was on the field staff of the Department of Agricultural Economics, University of Ibadan, before he was admitted to Ife University.

Recording Approach

Various recording approaches were available in a survey. One approach is a single visit. In investigating peasant farming, it is argued that to obtain accurate information, events should be recorded as they occurred. There was little faith in the ability of peasant farmers to remember, clearly, past transactions. Catt noted that "a single visit soon after harvest seemed to be sufficient to collect details of acreage, yields, family size, capital possessions etc., but it is doubtful if it would be sufficient to collect details of personal expenditure, production, detailed labour use or other events that occurred throughout the year." (14) In contrast, Macarthur (15) found that on return to the farmers after a year data had been collected from them, "the farmers remembered some details of the year's operation. Whilst they would not accurately recall full particulars of some types of events, particularly sales, they appeared to know sufficiently for the gaps to be filled with realistic estimates."

Another approach is to record the data throughout the year. This method was found to be extremely poor. According to Catt, the "technique was not really successful and is not recommended." The main defects were inadequate visits, particularly if the enumerator is not a full time interviewer, and inadequate supervision which result in substantial gaps. Weekly visits have also been used by Catt (14) and Edwards (16). The particular approach used depends on what is practical, the information sought and the time and money available. In this study, a single visit approach was followed, supplemented with call-backs in cases of "not-at-homes" or when gaps needed to be filled.

Field Organization

One type of field organization is quota sampling in which enumerators are spread over the geographic area, each allocated a certain number of clusters to be interviewed. Rather than allocate enumerators among the village clusters, the entire team worked together on one village and then moved to the next. In this way, the author was able to supervise the enumerators directly.

Training of Enumerators

Before going to the field the enumerators were trained in the following areas.

(I) The aim and specific intent of each question. This enabled them to know that the respondent answered in the manner intended.

(II) To translate every question into Yoruba (the native language).

(III) How recordings are to be made on the schedules.

(IV) How to respond to farmers' objections in order to reduce refusal rates.

Pretest

The schedules were pretested. The first pretest was on the author himself. He posed as a farmer and each of the enumerators interviewed him and recorded the answers as he would do in the field. This was of tremendous help because it provided the initial check on recording ability and time per schedule. The enumerators also tried this method, each posing as a farmer for the other. In the process, the recording ability of the enumerators was highly improved. Secondly, the schedules were pretested in the field, in Oyo South Division. This pretest helped to:

(I) Try out the questions.

(II) To try out the field organization.

(III) To try out the recording ability of the enumerators.

(IV) To record missing but relevant questions, points that seemed to cause resistance and if enough space was provided for recording answers.

The schedules were modified after the pretest to take account of the new developments.

After the day's work, the author used to check all the recordings. Farmers were re-visited to clarify certain points where necessary. This immediate check on the field helped to clarify possible sources of error.

Types of Crops and Farmers Selected

Four types of farmers were interviewed--the individual non-users, the individual users, farm settlers and group farmers. The users were interviewed on crops for which hire service was used only. Such crops

include maize, rice, cotton and tobacco. Only non-users who grew the crop(s) for which tractor hire users used the service were interviewed.

Sample Size

Apart from farmers, other groups connected with farm mechanization such as private tractor owners and sales managers of tractor distributing companies were interviewed. The total sample size, including the private owners, was 202. The distribution is shown below:

Type of Farmer	Sample Size
Farm settlers	52
Individual contractors	54
Group farmers	30
Non-contractors	57
Private tractor owners	9
Total	202

Definitions

Cash Receipts. This is the amount received for crop sales. It is a function of quantity sold and price.

Cash Costs. Cash costs are all actual farm cash expenses incurred. The value of inputs furnished by the family or the farmer is not included.

Net Return. Net return is cash receipts less cash costs.

Size of Farm. This is the number of acres under maize in the season.

Mechanization. This means the employment of machines in all operations and in all stages of the production process in crop and livestock husbandaries to replace manual labour.

Partial Mechanization. This means employment of machines to replace manual labour in land preparation operations alone.

Mixed Farming. It is the integration of animal husbandry into the native system of agriculture. A mixed farmer would possess bullocks, animal-drawn plough and cattle.

Settler Users. These are farm settlers who use tractor service on farm settlements.

Group Users. These are group farmers who use tractor service as a group.

Individual Users. These are non-farm settlers who use tractor service on an individual basis.

Mixed Cropping. This is a cultivation practice in which more than one crop is simultaneously grown on the same plot of land.

Thesis Format

Chapter II considers received micro-theory in the areas of costs, production economics and input substitution. Chapter III provides background information. It considers two elements of uncertainty--weather and price variation--that affected the environment in which tractor users operated in the year of study. Chapter IV is devoted to the consideration of the distribution of governmental tractor hire units, the private tractor owners and users of government tractor hire services. Chapter V presents the operating results of tractor users vis-a-vis non-users in growing maize and examines the impact of tractor use on labour and farm practices. In Chapter VI, the relative profitability of alternative operational procedures is examined. Chapter VII considers annual tractor usage and factors affecting it. Chapter VIII

examines the problem of delay in service and Chapter IX presents the problems of farm mechanization in the State. The final chapter contains a summary and recommendations.

CHAPTER II

THEORETICAL CONSIDERATIONS

According to Hicks (17), economic theory is the servant of applied economics. Peter Newman (18) also noted that "we can only hope to observe phenomena systematically if we have a set of instructions that tell us what to look for. These different sets are different theories." These observations underline the fact that economists look at real world through theoretical eye glasses.

In this chapter, some aspects of traditional micro-theory are adapted to the problem at hand. Theoretical considerations concerning the firm, size and scale of business, substitution principle, costs and resource allocation are discussed briefly. The theoretical discussion is based on the following assumptions:

1. Dependence on market exchange, with prices serving as guides in resource allocation both in production and consumption.
2. Perfect competition.
3. A static situation. We abstract from the situation in which variables are dated.
4. Continuous, differentiable functions.
5. Linearly homogeneous production function.
6. Two factors in the production of a product.

7. We abstract from inequalities.

8. A farm firm is the unit of analysis. The operator's objective is to maximize profit. He wants to make the most money by combining the inputs to produce outputs. This implies that he will push production up to the point where marginal revenue is equal to marginal cost.

Some of these assumptions are unrealistic. Although agriculture is usually regarded as a classic case of a perfectly competitive industry, a number of competitive assumptions such as mobility of resources, freedom of action, perfect knowledge and foresight are not met. The marginal analysis fails to take account of resource limitations. In developing countries, the level of dependence on a market economy may be low. Indeed, where there are no markets for farmland and farm labor, resource allocation may be guided by social relationships rather than by prices. The farm operator may be a satisficer rather than a maximizer and a host of other variables may enter into his objective function. However, the truth of the assumptions is really not what matters but the validity of the argument. If the argument is valid, conclusions drawn from it will be valid even if the premises are false (19). It is the predictive powers of theory and not the truth of the premises on which it is based that is of importance. Such is the deductive methodology of economic theory (20).

Cost Considerations

Next to the Marshallian cross in importance are cost considerations in economics. Economic theory makes a distinction among fixed.

variable and opportunity costs. Fixed costs are costs which are positive at zero level of output. Variable costs are those costs which are zero at zero level of output. The opportunity cost of a resource is its value in alternative uses.

Costs represent the nerve center in economics of farm mechanization. The distinction between fixed and variable costs are of particular importance. This is due to the lumpy nature of farm power and machinery. Fixed costs include the depreciation on tractor, implement and buildings, interest on capital, taxes and insurance, while variable costs include the driver's wages, mechanic's wages, spares, fuel and lubricants.

Let the total cost function of producing a product, q, be given by

$$C = a + bq - cq^2 + dq^3$$

Average Fixed Costs,

$$AFC = a/q \text{ with a slope of } -aq^{-2}$$

As q increases, AFC falls

Average Total Costs,

$$ATC = aq^{-1} + b - cq + dq^2$$

$$\frac{dC}{dq} = b - 2cq + 3dq^2 = MC = \text{Marginal cost}$$

$$AVC = b - cq + dq^2 = \text{Average variable costs}$$

AVC, MC and ATC are quadratic functions and AFC + AVC = ATC = AC

The MC is equal to AC when AC is minimum.[1] These relationships are shown geometrically in Figures 2.1 and 2.2. Figure 2.1 shows how

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[1] $C = (AC)\ (q)$

$$\frac{dC}{dq} = MC\ q\ \frac{dAC}{dq} + AC$$

When $\frac{dAC}{dq} < 0$, AC > MC and when $\frac{dAC}{dq} > 0$, MC > AC. At the point where $\frac{dAC}{dq}$ changes from negative to positive, $\frac{dAC}{dq} = 0$.

FIGURE 2.1 DECOMPOSITION OF TOTAL COSTS INTO FIXED AND VARIABLE COSTS

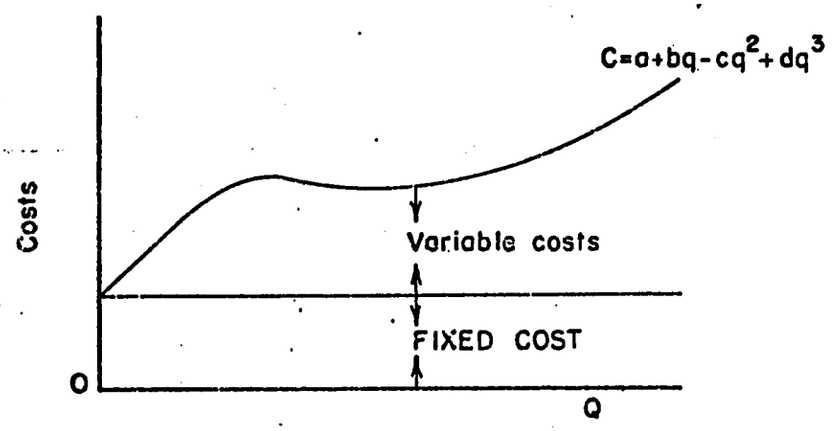
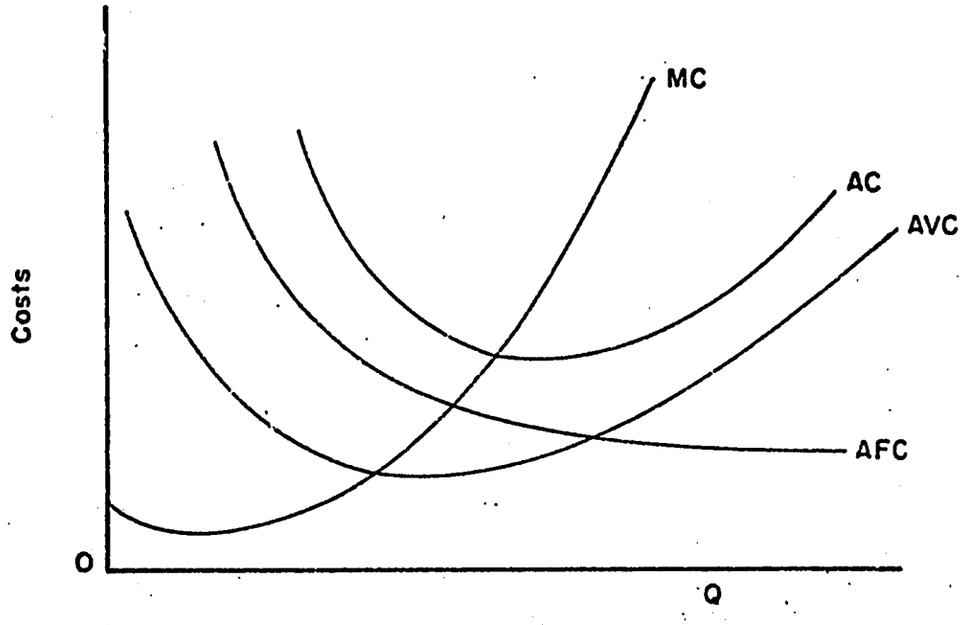


FIGURE 2.2 THE RELATIONSHIP BETWEEN AVERAGE AND MARGINAL COSTS



total cost can be decomposed into fixed and variable costs. Figure 2.2 shows the relationship between AC, AVC, MC and AFC.

Farm Size and Scale

Just as costs are very important in farm mechanization, so also is the size of business. The relationship between costs and size have been of great interest in micro-theory. It is usually couched in terms of economies of size.

The concepts of size and scale are related but not the same. The scale concept is used when both fixed and variable inputs are increased in fixed proportions. If you double acres, you double labor. The concept of scale is much more restrictive, for we are operating on an isocline that goes through the origin. Combined with constant returns to scale, we have a linear production function.

The size concept in which there are fixed inputs with which different levels of variable inputs are combined to achieve economies of size is the more relevant. The study of economies of size has focused on the relationship between the level of output and per unit cost of production (21). Technical economies (Average cost savings) occur as output is increased while keeping plant size fixed. These economies result from fuller utilization of resources--spreading the cost of overhead items and large lumpy inputs over more units of output.

Similarly, it can be shown that MC = AVC when AVC is minimum. This holds since MC is independent of fixed costs. For example,

$MC = b - 2cq + 3dq^2$ . . . (i)

$AVC = b - cq + dq^2$ . . . (ii)

$f'(AVC) = 2dq - c$; $f''(AVC) = 2d$. Therefore, AVC is minimum when $f'(AVC) = 0$

$2dq - c = 0$, $q = c/2d$

This value of q makes equations (i) and (ii) equal.

In farm mechanization program, such technical economies are of central concern owing to the lumpy nature of farm power and machinery. The frequent worry is whether power and machinery are being efficiently utilized or whether the size of business constrained the full utilization of available equipment. Indeed, the central question is the minimum acreage necessary to justify the use of one or more tractors on various types of farms.

The usual method of analysis of this problem is to take hours of machinery use as a measure of size and to plot cost per hour as a function of hours of utilization (22). As hours of utilization increase, the fixed costs are spread over greater output and per unit cost falls, Figure 2.3.

Substitution Principle

This is an important principle in micro-theory. It is of great importance to economists because, assuming rational economic units, substitution should take place either in production or consumption in response to changes in price ratio.

Experience in America and western Europe has indicated the possibility of a high degree of substitutability between labor and farm equipment. In response to rising labor costs, farms in America and western Europe have become more capital intensive by replacing labor with farm equipment.

The introduction of farm equipment, therefore, raises the economic problem of optimum (least cost) combination of labor and farm equipment. Given the production function, input prices and isocost equation, the optimum combination can be specified.

FIGURE 2.3 COST-UTILIZATION RELATIONSHIP

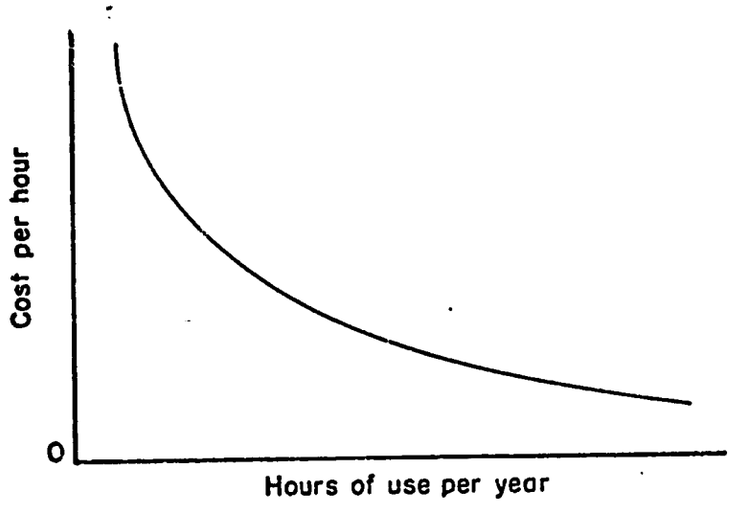
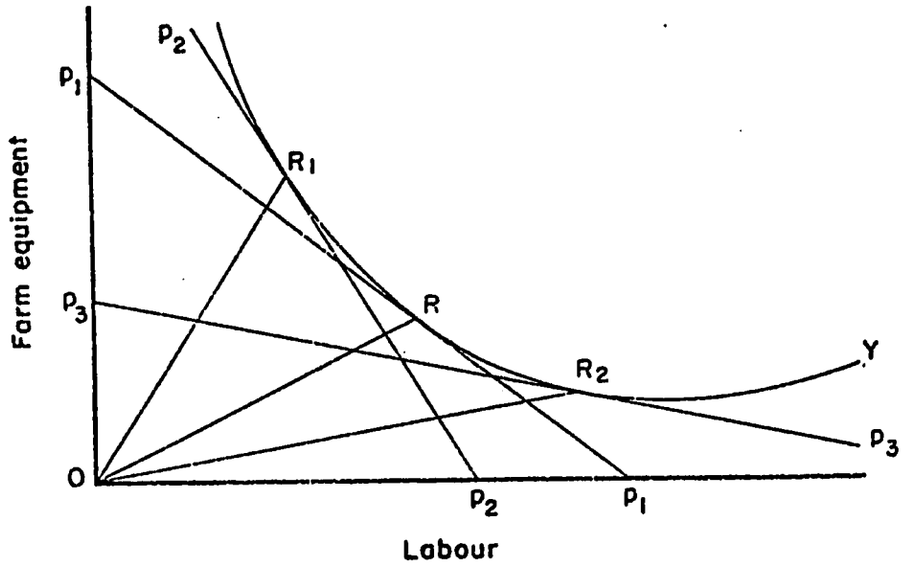


FIGURE 2.4 OPTIMUM COMBINATION OF LABOUR AND FARM EQUIPMENT



Let $Y = f(x_1, x_2)$

Where x_1 = labor

x_2 = farm equipment

Y = output

Isocost equation = $I = p_1 x_1 + p_2 x_2$

Where I = total cost

p_1 = price of labor

p_2 = price of farm equipment services

The objective is to minimize I subject to Y. Form the augmented objective function

$$Z = p_1 x_1 + p_2 x_2 + \lambda (Y - f(x_1, x_2))$$

λ = the undetermined lagrange multiplier

$$\frac{\partial z}{\partial x_1} = p_1 = \lambda f'(x_1) = 0$$

$$\frac{\partial z}{\partial x_2} = p_2 = \lambda f'(x_2) = 0$$

$$\frac{\partial z}{\partial \lambda} = Y - f(x_1, x_2) = 0$$

$p_1 = \lambda f'(x_1) = \lambda mppx_1$ (marginal physical product of x_1)

$p_2 = \lambda f'(x_2) = \lambda mppx_2$ (marginal physical product of x_2)

$$\frac{p_1}{mppx_1} = \frac{p_2}{mppx_2} = \lambda$$

$$mrsx_1 x_2 = \frac{p_1}{p_2} = \frac{mppx_1}{mppx_2}$$ (marginal rate of substitution of x_1 and x_2)

Thus, the fist order condition for least cost combination of labor

and farm equipment requies that the slope of the isoquant[2] is equal to the price ratio.

In geometric terms, the first order condition requires the tangency of the isocost line to the isoquant function. At point R, Figure 2.4, tangency condition is met. At that point labor and farm equipment are optimally combined. Given the production function, and the isoquant derived from it,[3] the elasticity of substitution can be computed. Elasticity of substitution is the percentage change in one factor divided by the percentage change in the other factor in producing a constant output.

Let x_1 = annual cost of machinery services

---

[2]The slope of the isoquant can be shown as follows.
Let $y = f(x_1, x_2)$
Take total differentials
$\Delta y = f'_{x_1} \Delta x_1 + f'_{x_2} \Delta x_2$
Since Δy on the same isoquant curve = 0
$f'_{x_1} \Delta x_1 + f'_{x_2} \Delta x_2 = 0$
$f'_{x_1} \Delta x_1 = -f'_{x_2} \Delta x_2$
$mppx_1 \Delta x_1 = -mppx_2 \Delta x_2$
$\frac{\Delta x_2}{\Delta x_1} = - \frac{mppx_1}{mppx_2} = mrsx_1 x_2$
To be sure that cost is minimized,

$$\left| \bar{H} \right| = \begin{vmatrix} 0 & -\lambda Z x_1 & -\lambda Z x_2 \\ -\lambda Z x_1 & -Z x_1 x_1 & -Z x_1 x_2 \\ -\lambda Z x_2 & -Z x_2 x_1 & -Z x_2 x_2 \end{vmatrix} < 0$$

That is, the bordered Hessian determinant must be negative.

[3]Suppose the production function is given by $y = a + b_1 x_1 + b_2 x_2 + b_3 x_1^2 + b_4 x_2^2$. The isoquant equation will be given by

$$x_1 = \frac{-b_1 \pm [b_1^2 - 4b_3 (b_2 x_2 + b_4 x_2^2 - y + a)]^{.5}}{2b_3}$$

x_2 = annual cost of labor

y = product produced by x_1 and x_2

Elasticity of substitution between x_1 and x_2 will be $\left(\frac{dx_2}{dx_1}\right)\left(\frac{x_1}{x_2}\right)$, from the isoquant equation.

The relative change in factor ratios could be used instead of relative change in marginal rate of substitution in defining elasticity of substitution (23). If this approach is used, we define the elasticity of the ratio with respect to the marginal rate of substitution. That is,

Let $p = x_2/x_1$

$q = \Delta x_2/\Delta x_1$ = MRS = Price ratio

$$Es = \frac{dp}{dq}\frac{q}{p} = \frac{d(x_2/x_1)}{d(\Delta x_2/\Delta x_1)}\frac{(\Delta x_2/\Delta x_1)}{(x_2/x_1)} .$$

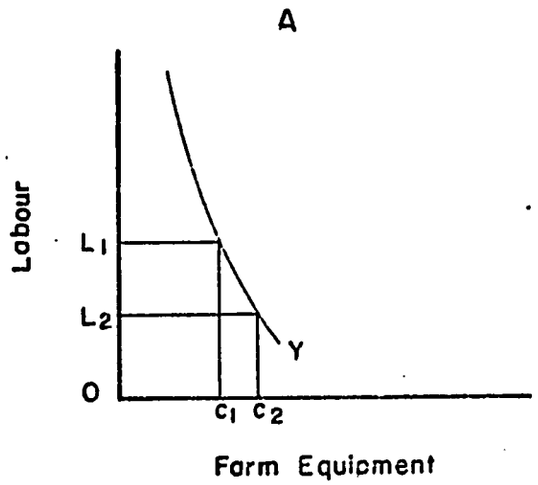
In Figure 2.4, OR is the capital labor ratio, given the price line $p_1\ p_1$. If ratio changes from $p_1\ p_1$ to $p_2\ p_2$, the production of Y will become more capital intensive. If price ratio shifts to $p_3\ p_3$, production will become more labor intensive.

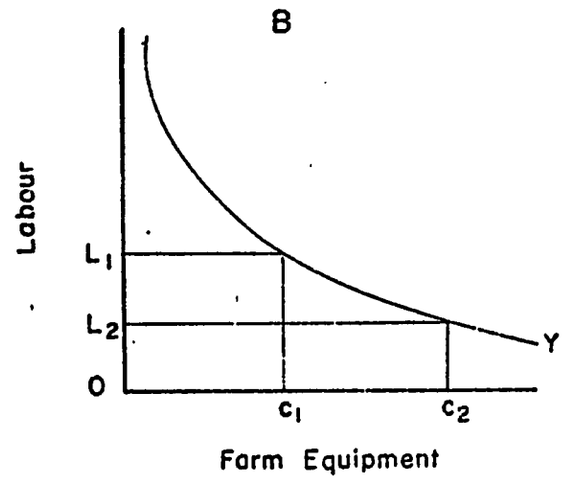
How elastic is the substitution will depend on:

1. The existing system of farming and types of crops grown
2. Soil conditions and climate
3. Topographic conditions
4. Degree of fragmentation of holdings
5. Shape of fields
6. The size of business and quality of farm labor.

Two possible shapes of the isoquant are shown in Figure 2.5.

FIGURE 2.5 ELASTICITY OF SUBSTITUTION BETWEEN LABOUR AND FARM EQUIPMENT





In Figure 2.5a, c_1 c_2 is the required increase in farm equipment to replace L_1 L_2 of labor and still produce the same quantity of Y. In Figure 2.5b, c_1 c_2 is required to replace the L_1 L_2 of labor. In Figure 2.5b, a larger quantity of farm equipment is required than in Figure 2.5a. The situation in Figure 2.5a will stimulate machinery introduction since labor/machinery ratio is higher. If the prevailing isoquant is that in Figure 2.5b, it will be more difficult to replace a substantial amount of labor with farm equipment. On the other hand, production characterized by Figure 2.5a will have severe social problems in terms of unemployment.

Labor Productivity

In labor rich, capital poor agriculture, one of the leading concerns is how to increase labor productivity. Economists have viewed the labor resource in peasant agriculture as having zero or near zero marginal productivity, Figure 2.6. The input of OL_o of labor generates zero labor marginal product. While OL_o is not actually used, perhaps some quantity close to it, OL_1, is being used with a positive but low marginal productivity.

Labor productivity can be increased in two ways. (1) By leftward movement on the same production function. A cutback on labor input could lead to upward movement on the labor productivity curve. The use of non-price instruments such as education and training have been proposed to achieve such a resource adjustment. But this movement could also be at the expense of reductions in total product. (2) By shifting the production function.

FIGURE 2.6 MARGINAL PRODUCTIVITY OF LABOUR IN PEASANT AGRICULTURE

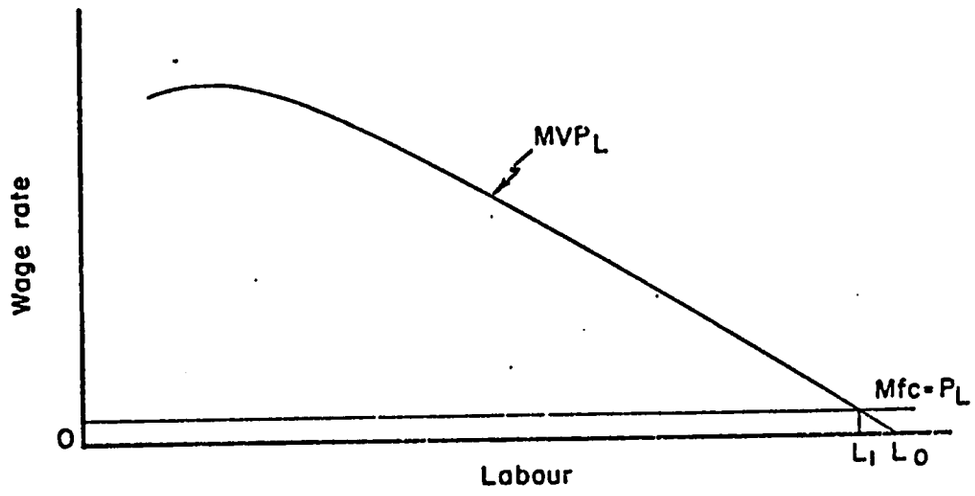
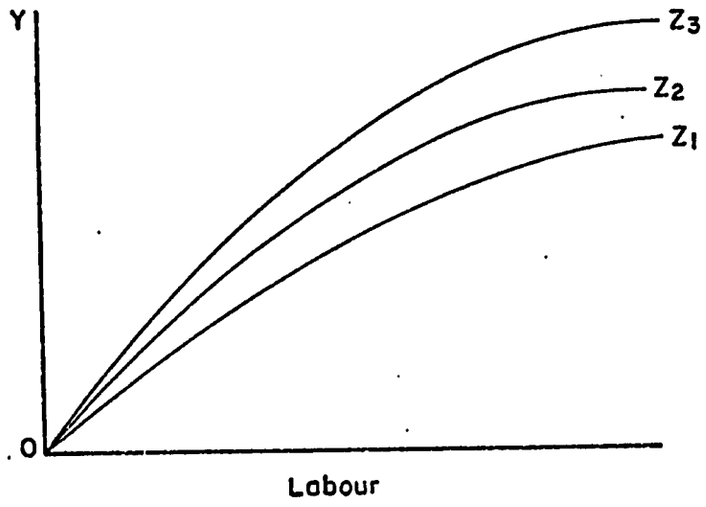


FIGURE 2.7 SHIFTS IN PRODUCTION FUNTION



Let the production function be

$$y = aL^b Z^{1-b}$$

where L = labor

Z = farm equipment

$$\frac{\partial y}{\partial L} = mp_L = abL^{b-1} Z^{1-b}$$

$$= abL^b L^{-1} Z^{1-b}$$

$$mp_L = \frac{abL^b Z^{1-b}}{L} = \frac{b\ y}{L} = abL^{b-1} \frac{Z^{1-b} Z^{b-1}}{Z^{b-1}}$$

$$= \frac{abL^{b-1}}{Z^{b-1}} = ab(k^*)^{b-1},\ k^* = L/Z$$

if Z is held constant at various levels, the production function shifts up for the different levels of Z (Figure 2.7). MP_L, the slope of the production functions, increases as Z is held at various levels. The shifts in labor productivity are shown in Figure 2.8.

Farm mechanization can be an important vehicle for raising the productivity of the peasant farmer. The employment of machines accelerates field work, creates the best possible conditions for the growth of plants and ensures the application of progressive agro-technical methods of production.

Complementary Relationship

It is common to think of labor and machinery as being competitive in agriculture. But, there are possible exceptions to this situation. Assumption four is relaxed to examine this possibility. If we think in terms of numbers of machines, rather than services which flow from

FIGURE 2.8 INCREASES IN MARGINAL PRODUCTIVITY OF LABOUR

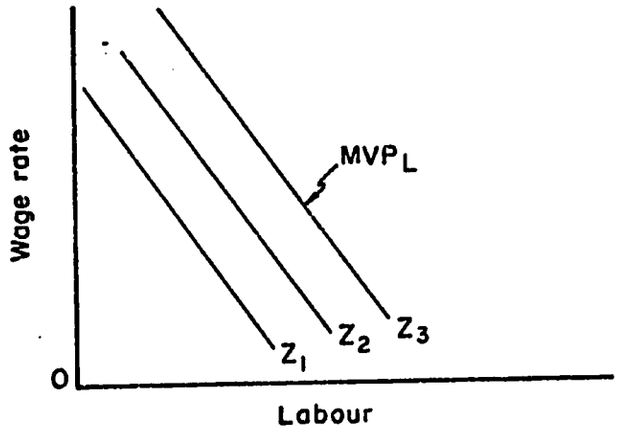
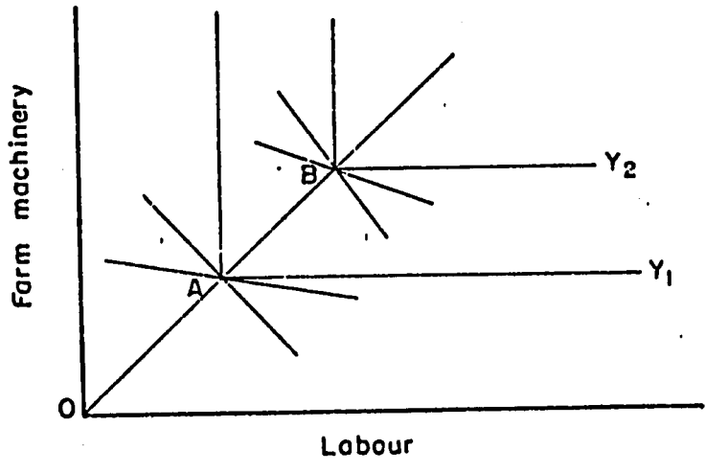


FIGURE 2.9 COMPLEMENTARITIES IN LABOUR AND MACHINERY



machinery, the problem of lumpiness and discontinuities arise. Machinery and labor will be combined in certain fixed proportions, and therefore, complementary, Figure 2.9. For instance, to each farm tractor, at least an operator is required to drive it. At points A and B, Figure 2.9, input combination becomes stable as it is insensitive to changes in price ratio.

Apart from labor, other inputs may also be complementary with farm equipment. A large percentage of suitable agricultural land is unused in Nigeria. It is estimated that some twenty thousand square miles are available for further agricultural expansion (24). This underutilization is not only due to the tenure problems. It is also a reflection of the state of the arts. The lack of co-operant and complementary capital inputs has been largely responsible for large underutilization of land. One of the expected effects of introducing farm equipment is to increase the capacity of the farmer to bring more land under cultivation.

Increasing use of farm machines might reduce labor inputs. The shift of labor from rural to urban employment is not costless. Thus, the costs and benefits of farm mechanization should be taken into account. In this regard, private and social objectives could be in conflict. While the private net benefit of mechanization is expected to be positive, social net benefit might not. These consequences are possible and underline the fact that the social costs of mechanization should not be under-estimated.

CHAPTER III

UNCERTAINTY IN AGRICULTURE

Uncertainty[1] is the usual environment for agricultural production. The kinds of uncertainty in agriculture include (i) Weather, (ii) Price variation, and (iii) technological change. In this chapter only the first two kinds of uncertainty are discussed as they are the types that are of immediate relevance to the study year.

Weather

The weather is a factor to be considered when studying farm business for a specific year. It is an uncontrollable factor in farm business and it introduces an element of uncertainty to farming.

The yearly rainfall pattern allows two cropping seasons--early and late cropping seasons. Rains normally begin from about the middle of March, reach a peak about June/July with a low in August. The second peak is around September/October after which dry season sets in until February. There are, thus, two critical weather periods: (i) the time rains begin (ii) the time rains stop. During the early crop season, farmers rush to plant their maize at the onset of rains during the middle of March to early April. If rains don't start early, planting is delayed. The planting of the late crop is also sensitive to the

[1]Distinction is usually made between risk and uncertainty. Risk has a known probability of occurrence and, therefore, can be insured against. The opposite is the case for uncertainty. Game theoretic models are sometimes used to handle uncertainty.

time rains will stop. If rains stop too early, it means disaster for late crop. This is why it is necessary to plant the late crop early in August.

Weather was ideal in Abeokuta/Ijebu Circle during the second quarter of 1970. But drought set in too early at the latter part of the year. This had adverse effects on arable crops. For the selected weather stations in the Circle, the 1970 figures were all lower than the 1968 figures. Most of the stations also had less rainfall in 1970 than in 1969, Table 3.1.

Table 3.1 RAINFALL FIGURES FOR SELECTED WEATHER STATIONS
Abeokuta/Ijebu Circle, Western Nigeria, 1968-70

Weather Station	Years		
	1968	1969	1970
		Inches	
Abeokuta	59.6	44.7	37.3
Ilaro	80.2	51.6	50.0
Meko	70.6	34.8	34.9
Ipokia	86.2	68.5	60.4
Ijebuode	89.8	73.1	63.4
Shagamu	93.5	58.4	61.9
Odeda	70.6	43.9	44.0
Ikenne	79.9	69.2	62.2

Source: Annual Report, Abeokuta/Ijebu Circle, 1970/71, M.A.N.R., Ibadan.

In Ondo Circle, rainfall was also a problem during the two growing seasons in 1970. Compared with 1969 figures, most of the selected weather stations in the Circle recorded lower rainfall figures (Table 3.2). According to the Circle annual report "Arable crops like maize and rice which were planted very early in the year were adversely affected by poor rainfall. So were those planted in September. The former had not enough moisture during the growth phase while the latter was starved of moisture during the grain-forming period" (25). Rains were late in coming at the beginning of early season. During late crop season, maize stands had to wilt at the early stage of growth as a result of sudden cessation of rains.

Table 3.2 RAINFALL FIGURES FOR SELECTED WEATHER STATIONS
Ondo Circle, Western Nigeria, 1969-71

Weather Station	Years	
	1969/70	1970/71
	Inches	
Akure	60.7	50.8*
Ondo	65.1	51.3
Ado-Ekiti	56.1	56.9
Okitipupa	87.4	86.2
Owo	52.7	44.3
Ife	48.6	50.3
Ilesha	48.0	41.5
Akoko	52.4	49.3

Source: Annual Report, Ondo Circle, 1970/71. M.A.N.R., Ibadan.
*Eleven months only.

In Ibadan/Oyo Circle, rains were inadequate for the early crop and late crops failed owing to early cessation of rains. The growing seasons, April-June and July-September are the critical periods. For most of the selected weather stations of the circle, the growing seasons rainfall figures for 1970/71 were lower than figures for 1969/70 (Table 3.3).

Table 3.3 QUARTERLY RAINFALL FIGURES FOR SELECTED STATIONS
Oyo/Ibadan Circle, Western Nigeria, 1969/70-1970/71

Weather Station	1969/70 Quarter				1970/71 Quarter			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
	Inches							
Ibadan	15.26	17.13	9.10	4.53	22.36	16.86	5.87	9.50
Ilora/Oyo	16.19	14.27	9.44	3.93	17.01	17.50	0.32	3.56
Eruwa	9.1	19.20	4.7	5.73	5.32	16.62	4.64	2.04
Oshogbo	18.53	21.00	9.17	4.84	16.88	13.60	9.52	4.14
Ede	25.63	22.66	9.80	7.30	20.89	15.20	5.10	5.43
Iwo	16.52	17.29	5.6	7.33	21.24	13.72	7.40	3.24
Ikirun	16.14	17.70	8.87	3.36	12.87	3.90	5.72	n.a.
Illa	14.27	22.73	7.42	6.55	7.24	5.14	10.02	3.10

Source: Annual Report, Ibadan/Oyo Circle, 1970/71, M.A.N.R., Ibadan

According to the circle annual report, "Rainfall during the year (1970/71), was generally below average. An average monthly rainfall of 10.08 inches with 19 wet days was recorded for the year as against 11.63 inches with 21 wet days recorded for the corresponding period in 1969/70" (26).

Farmers were also interviewed to ascertain their experience with the rainfall problem. The results point in the same direction of low rainfall and adverse effects on crops in 1970 (Table 3.4).

Table 3.4 DAMAGE CAUSED BY LOW RAINFALL
Western Nigeria, 1970

Type of farmer	Percent of farmers whose crops were damaged by weather	Percent of them that were maize growers	Percent of maize growers with heavy damage
Individual tractor users	67.2	81.4	42.9
Group users	78.8	53.8	71.4
Settler users	87.7	94.0	53.2
Non-tractor users	79.7	80.4	51.2

The important points to note from the above discussions are (1) This study is based on 1970 farm records, a year which, weather-wise, can be regarded as abnormal. It was a year of below average rainfall figures. (2) Most of the farmers interviewed suffered from the drought. Majority of the farmers that suffered were maize farmers, and most of them rated the damage as heavy.

This experience makes a case for more attention to irrigation schemes, particularly in Oyo divisions of Western State. For example, at the International Institute of Tropical Agriculture, Ibadan, attempts are being made to get three crops of maize per year with the help of irrigation. The peasant farmer in Oyo North, for instance, finds it difficult to get one good crop of maize per year due to the uncertainties of weather. The current program of establishing fish ponds for

group farmers by the Western State Government may be broadened to include irrigation works. This will help to overcome the rainfall problem and increase the output of maize in the state. Irrigation considerations should, of course, be based on knowledge of the probability of occurrence of drought years.

Prices Received

In addition to weather, price is another factor of uncertainty in agriculture. The economic climate of a farm business is highly influenced by prices. The relationship of prices received, prices paid and volume sold will determine the level of net incomes for farmers.

The price received by the farmer depends on (I) supply and demand conditions, (II) the time of sale. Most private farmers sell immediately after harvest and at a low price. This is because of (a) the pressure for cash to pay hired laborers, (b) the lack of storage facility to hold the produce until the time he can get a better price. (III) The place of sale. There is a high level of spatial variation of producer prices, (IV) the bargaining strength of the seller vis-a-vis the buyer, (V) administrative decisions. In the Western State, crops whose prices are administered are kenaf, cotton and tobacco. The price of kenaf is set by the Nigerian Fibers Company, that of cotton by the Marketing Board, and that of tobacco by the Nigerian Tobacco Company (NTC). The farmer is a price taker. One way to get higher prices is to produce the higher priced better quality products, Table 3.5.

The price received for maize shows spatial and seasonal variations. Seasonal variation is principally due to supply factor. The late maize price is usually higher than early maize price because the

Table 3.5 PRODUCT PRICES
Western Nigeria, 1970

Product by grades	Price*
Seed Cotton	
Grade I	84
Grade II	56
Grade III	28
Kenaf	
Handstripped	40
Decorticated	30
Retted fiber	70
Tobacco	
Bottom mature	53
Bottom bright	43
Bottom dark	27
Bottom green	20
Top matured	48
Top bright	38
Top dark	23
Top green	12
X	20
J	14
XJ	6

*The price for seed cotton and kenaf is pounds per ton while tobacco is pence/lb.

late maize usually gives a lower yield owing to poor weather conditions. The probability of crop failure is higher for late maize than for early maize.

Maize price also varies with variety. The yellow type maize has virtually no local market. For instance, all the Eleyele Village farmers in Oyo South, who grew yellow maize indicated that they had much difficulty in selling it. Private farmers who grew yellow maize have always sold it at a lower price than the more common, popularly accepted white variety. Farmers who planted the new western white (high lysine) maize variety indicated they had much difficulty in selling the maize. For instance, the Irepodun young farmers club, Eleruwa-Ogbomosho, could not sell their western white maize until the Ministry of Agriculture came to buy it after receiving the report that the maize could not find a market.

The growing of yellow maize has been largely confined to the arable crop settlements. The Ministry of Agriculture and a few poultry farmers constitute the principal market outlets for this type of maize.

The price paid by the Ministry varies from 22 shilling per cwt. to 30 shilling per cwt. (Table 3.6).

Usually, outside prices are higher than the prices paid by the Ministry. A settler, when hard pressed for money to pay his hired labor, sells his maize in the open market. In doing so, he gets a higher price and he also gets the cash on time.[2] If he sells to the Ministry, he does not get paid on time. At Oshun farm settlement, for instance,

[2]Farm settlers are normally not allowed to sell their produce in the open markets. Such sales that take place are conducted secretly.

Table 3.6 PRICE OF MAIZE BY SETTLEMENT
Western Nigeria, 1970

Settlement	Early Maize	Late Maize
	Shillings per cwt.	
Eruwa	25	n.a.
Ogbomosho	22	30
Ilora	30	40
Oshun	25	28
Iresadu	25	n.a.

some settlers in urgent need of cash sold their maize in the open market at the rate of 30 shillings per cwt. for early maize and 50 shillings for late maize. At Iresadu, maize could be sold in the open market at the rate of £35-40 per ton while the Ministry was buying it at £25 per ton. The settler has no problem in selling his yellow maize, but the price paid for availability of market are low price and untimely payments.

Table 3.7 shows the prices received by tractor users. For early maize, the average price is higher in Oyo North than Oyo South, with a higher modal price of 40 as compared with 30 in Oyo South. But the relative dispersion is lower in Oyo South than in Oyo North. Late maize price is higher than early maize price in both divisions. But, the price is higher in Oyo North than in Oyo South and relative disperson is also lower in Oyo South than Oyo North.

In Table 3.8 similar data are presented for non-tractor users. Average price of late maize is also higher in all the divisions than

Table 3.7 PRICES[a] RECEIVED BY TRACTOR USERS[b]
Western Nigeria, 1970

Product	Division	
	Oyo North	Oyo South
Early maize		
Mean	37.7	34.0
Modal	40.0	30.0
Relative dispersion[c]	24.7	15.2
Late maize		
Mean	50.4	37.0
Modal	45.0	30.0
Relative disperson	23.0	20.4

[a]The prices are in shillings/cwt.
[b]Group farmers are not included.
[c]Relative dispersion = $\frac{\sigma}{\bar{x}} \times 100$

for early maize. The modal prices are higher together with lower relative dispersion for late maize in all divisions. For late maize, average price received by non-tractor users is higher than the average price received by tractor users in Oyo divisions. For early maize, average price is higher in Oyo North for tractor users than for non-tractor users, but the reverse holds for Oyo South. So, the variations in price received do not show a consistent pattern between divisions, crop types and type of farmers.

Table 3.8 PRICES[a] RECEIVED BY NON-TRACTOR USERS
Western Nigeria, 1970

Product	Division		
	Oyo North	Oyo South	Oshun
Early maize			
Mean	33.5	43.9	37.0
Modal	35.0	50.0	50.0
Relative dispersion	13.1	28.0	27.6
Late maize			
Mean	52.5	53.0	55.0
Modal	50.0	50.0	60.0
Relative dispersion	11.6	26.2	23.8

[a]The prices are in shillings/cwt.

CHAPTER IV

THE TRACTOR HIRE SCHEME

The tractor hire scheme was established in 1961. The tractor hire unit (T.H.U.) is to bridge the gap between hand labor and self-owned tractors. The hire system was established:

(I) To extend mechanization to farmers--previously, all farm mechanization work was confined to Government farms.

(II) The farmer has not the money to own a tractor.

(III) Because of the increasing scarcity of farm labor.

The operation of the hire unit is a joint responsibility between the extension service division and the engineering division of the Ministry of Agriculture. The extension personnel knows and is in constant contact with the farmer. He persuades the farmer to try out the mechanization of his farm and explains the advantages thereof to the farmer. The engineering staff knows the farmer through the extension staff. So, the amount of work done by the engineering staff depends on the number of farmers the extension staff are able to convince to try out mechanization.

When a farmer wants the hire service, he sends an application to the extension service division. On receipt of the application form, the extension division completes and signs a form giving information about the applicant. The farm is then inspected by the staff of the

division to see if the farm is well stumped and cleared of uprooted trees. Then the engineering staff inspects the farm and gives his report of its condition. If the farm passes, it satisfies the first requirement to get tractor service--a mechanizable, well stumped and clean farm. Other conditions a farmer has to satisfy include:

(I) Grow a crop recommended by the Ministry such as maize, cotton, rice and kenaf. If the farmer is to grow a non-recommended crop such as tobacco, the Nigerian Tobacco Company is involved in the agreement to guarantee that the farmer or Nigerian Tobacco Company (N.T.C.) will pay the balance of tractor expenses.[1]

(II) Not indebted from previous services rendered to him.

(III) Pay one-third of the tractor expenses as deposit.

After all these conditions are met, an agreement is entered into between the creditor (the Ministry) and the hirer in which the hirer agrees to repay the two-thirds balance of the tractor expenses after the sale of produce and the creditor agrees to do the mechanization work. The collection of all tractor expenses is handled by the extension division of the Ministry. After the mechanization work is completed, both parties will sign a completion form that the work had been satisfactorily done.

Each hire unit is supposed to work within a ten-mile radius. If the distance is greater than ten miles, extra charges are supposed to be paid. But that is the theory. In practice, Ogbomosho Hire Unit has, for instance, serviced farmers at Oko (16 miles), Eleruwa (12 miles),

[1]The collection of two-thirds balance of the tractor expense has been lowest for recommended crops, particularly maize.

Ahorodada (21 miles) and Iresadu (16 miles). Similarly, Oshogbo Hire Unit has serviced farmers at Illa (33 miles), Ikirun (14 miles) and Iwo (30 miles). Ibadan tractor hire unit has serviced farmers at Ijaiye-Orile (25 miles). In fact, the more common practice in all the hire units is to operate beyond the ten-mile radius with no extra charge.

Distribution of Government Hire Units

Most of the tractor hire units are concentrated in Ibadan/Oyo Circle. This is followed by Egba/Ijebu Circle (Table 4.1).

Table 4.1 TRACTOR HIRE UNITS BY CIRCLE
Western Nigeria, 1970

Circle	Tractor hire units
	Percent
Ibadan/Oyo	56.2
Ekiti	12.5
Akure	12.5
Egba/Ijebu	18.8
Total	100.0

Fifty-six percent of the hire units in Ibadan/Oyo Circle are concentrated in Oyo Divisions of the Circle. The single largest area of concentration in the State is in Oyo South Division with 18.75 percent of the hire units. Oyo North alone has 12.5 percent of the hire units, as compared to 12.5 percent in all Oshun Divisions (Table 4.2).

Table 4.2 TRACTOR HIRE UNITS BY DIVISION
Western Nigeria, 1970

Division	Tractor hire units, in percent
Oyo South	18.75
Oyo North	12.50
Oshun	12.50
Ibarapa	6.25
Egbado	6.25
Egba	6.25
Remo	6.25
Ibadan	6.25
Akure	6.25
Akoko	6.25
Ife/Ilesha	6.25
Ekiti	6.25
Total	100.00

The locations of the tractor hire units are shown in Figure 4.1. The heavy concentration of THUs in Oyo Divisions of the State is due to:

(I) There is a good topography in the Divisions. Most of the land is flat which facilitates the use of tractors.

(II) Mechanization had long been introduced in the area, particularly at Fashola where mechanization has been introduced for the past 25 years. Fashola has been the nucleus of farm mechanization in the State. Originally, it was the Government mechanized farm before it was converted to a livestock center. From Fashola, mechanization spread

FIGURE 4.1: LOCATION OF TRACTOR HIRING UNITS IN WESTERN STATE OF NIGERIA

---- Divisional boundary

● Location of tractor hiring unit

◉ Tractor hiring unit with an agricultural engineer

to other parts of Oyo Divisions. It is only of recent that mechanization is spreading from Oyo Divisions to other parts of the State.

(III) Oyo Divisions are suitable for arable crops which are easily mechanizable such as maize and rice. In normal years, rainfall is adequate to grow these crops.

(IV) Oyo Divisions are open, mostly savanna country. The grassland is dotted with few and small trees. This is a very important advantage because it is the forested nature of the southern part of the State that restricts the extent of mechanization. The farther south, the greater is rainfall, the thicker is the bush, the more forested and the larger are the trees. The luxuriant and thick vegetation of the south presents the formidable task of clearing and uprooting stumps in order to use the tractor. This problem is not as serious in the Oyo Divisions of the State. Figure 4.2 shows the vegetation of the State and the distribution pattern of the tractor hire units.

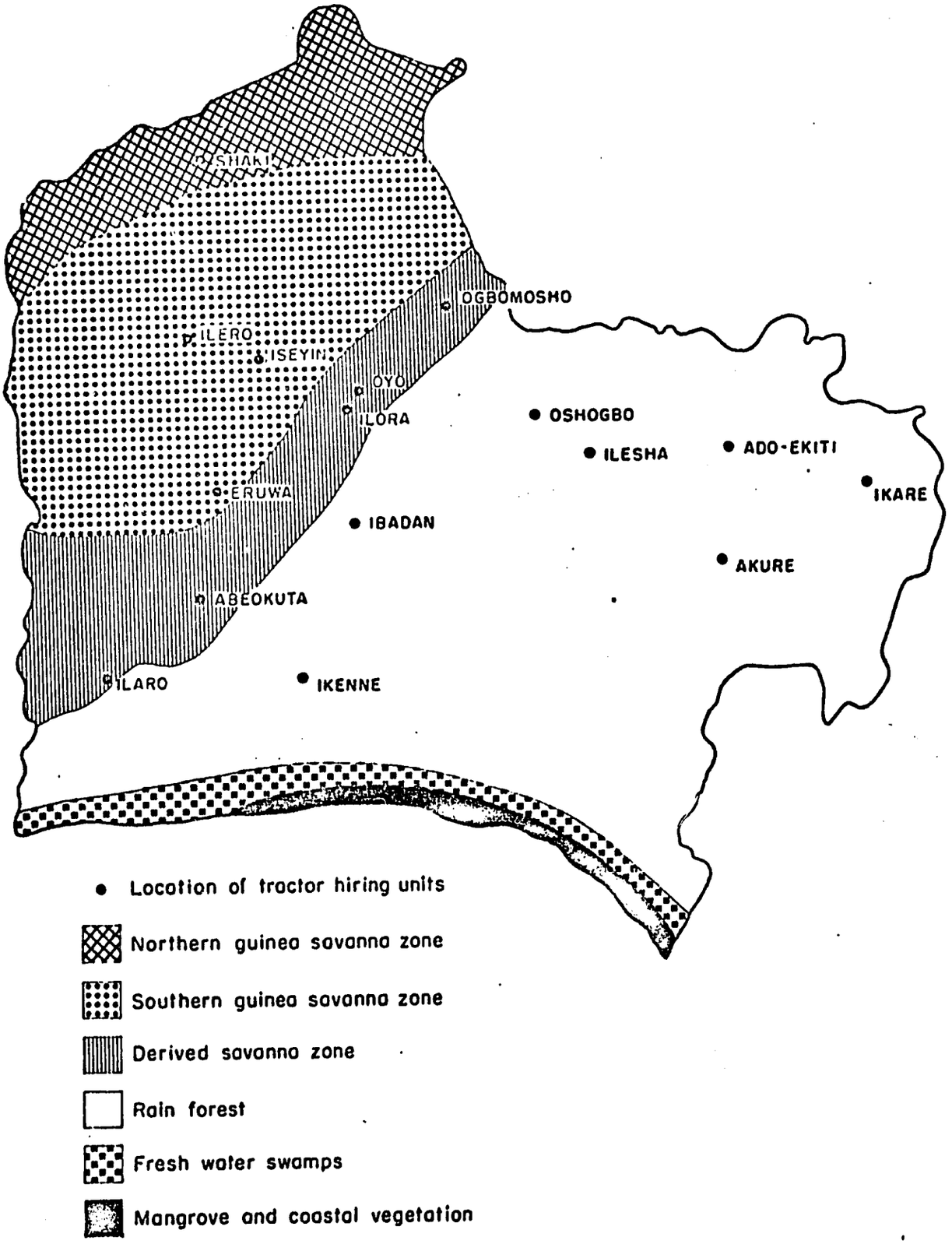
The Users of Tractor Hire Service

The users of tractor hire service can be divided into two categories, (I) Government (II) Private. Under the Government farms are demonstration plots, multiplication plots, extension work stations, livestock investigation centers, tree crop farm settlements and research stations. Under the private users are:

(I) Farm settlers on arable crop settlements.

(II) Group farmers.

FIGURE 4.2: VEGETATION AND LOCATION OF TRACTOR HIRING UNITS IN WESTERN STATE OF NIGERIA



(III) Individual, non-settler farmers.

(IV) Retired civil servants, part-time and absentee farmers.

Private Users

The private users use the service in growing a variety of crops such as maize, rice, tobacco, kenaf, cassava, and cotton. But the most important crop for which tractor service is extensively used is maize, Table 4.3.

Table 4.3 TRACTOR USERS BY CROPS GROWN
Western Nigeria, 1970

Crop	Type of User		
	Individual users	Group users	Settler users
		Percent	
Early maize	38.4	32.7	57.1
Late maize	36.4	19.2	34.5
Cotton	11.1	13.5	0
Tobacco	10.1	15.4	8.4
Rice	4.0	19.2	0
Total	100.0	100.0	100.0

A larger number of the users grew maize. Tobacco and rice production are more important among group farmers, while farm settlers concentrate on the growing of maize.

A recent addition to tractor hirers are the Ghana refugees, particularly in Oshun Divisions. These people contributed a significant increase to the number of people who wanted to use the service in 1971. A large number of them, having nothing to do, returned to farming.

The number of private tractor users in Oyo Divisions continues to show an increase, as Table 4.4 indicates.

Table 4.4 GROWTH IN REQUESTS FOR TRACTOR HIRE SERVICE
Oyo South Division, Western Nigeria, 1969-71

Crop grown	Period 1969/70	Period 1970/71
	Number of farmers	
Maize	85	134
Kenaf	5	10

Source: Annual Report, Ibadan/Oyo Circle, 1970/71. M.A.N.R. Ibadan.

The retired civil servants and absentee farmers are concentrated mostly in Oyo South. They command more money and grow larger acres, averaging about 50 acres. It is common among principals and proprietors of high schools to use the hire service to grow maize and rice to feed students.

Mechanization of land preparation is important on food crop settlements only. Of particular importance in this regard are Ilora and Ogbomosho farm settlements. The farm settlers have an advantage over other private users because they are not faced with the problem of initial stumping. This has been done by the Government. The only possible exception is the Oshun farm settlement. Originally, it was a tree crop settlement, but it is being converted to a food crop settlement with only a small stumped land available for distribution to settlers. This accounts for the small acreage of settlers on this settlement.

The encouragement and formation of group and grouped farmers received greater impetus with the development of farm mechanization. At the end of 1970/71, there were about 30 group farmers in Oyo South, Table 4.5.

Table 4.5 GROUP FARMERS BY LOCATION
Oyo South Division, Western Nigeria, 1970

Location	Number of group farmers
Awe	4
Fiditi	4
Ado-Awaye	4
Fashola	4
Ipapo	4
Ilora	2
Imini	2
Ikoyi	2
Akinmorin	1
Oluwatedo	1
Ajagba	1
Olo	1

Source: Annual Report, Ibadan/Oyo Circle, 1970/71. M.A.N.R. Ibadan.

Grouped farmers such as Ilu-Omoba rice grouped farmers and Igbo-Ora Grouped farmers, has no common purse. The farm is not jointly owned. There are only contiguous plots of farms belonging to each individual. The unifying factors are:

(I) The farm is usually ploughed together as one.

(II) In case of rice farmers, there is the advantage of scaring away birds from all the farms by any one present on the farm.

Expenditures, maintenance and sales are done by individual operator for his own plot. Grouped farmers are much more individualistic than group farmers. But it presents a block of land in one location which facilitates mechanization.

Group farmers have a common purse. The farm is jointly owned. The expenditure and net income are shared among members. A very large proportion of the labor input is group labor.

Group farmers are the most common type. Its formation is encouraged by the Government for a number of reasons:

(I) To facilitate mechanization. It allows larger size of farms, located in one place.

(II) It acts as a vehicle for demonstration purposes. For instance, a number of farmers started to use fertilizer and to harrow their farms after they have seen these practiced on group farms. The Government usually makes it possible for members of the group to visit other demonstration plots in the State to improve their knowledge and understanding of modern farming methods.

According to the group farmers, the benefits derived from being together include:

(I) Raising of capital from member contributions.

(II) The group gets priority over individual users in receiving tractor service.

(III) If the group name is registered, it is possible to borrow money to finance their farm business.

(IV) The farm work can still be done even when a member or two are sick.

(V) It makes possible the stumping of larger acres of land than individual farmers.

(VI) It facilitates the growing of crops such as tobacco and rice, both of which are labor intensive.

(VII) It facilitates government assistance. For instance, the Are rice group farmers obtained financial assistance to purchase rice and maize mills. The Eleruwa farmers club had the tractor costs of their first farm of ten acres paid by the Government. In 1970, the Government paid the tractor cost of five acres out of 15 acres cultivated.

In spite of these possible benefits, group farming has not been a success in the State. It has been difficult to get illiterate farmers to work together co-operatively and successfully. Petty quarrels are frequent. The result has been the disintegration of a large number of group farmers. The larger the size the greater the probability of a quick break up. It is unfortunate that this important vehicle, which could promote the spread of mechanization, both in terms of individual tractor ownership and the expansion of farm size, has met with utter failure. Some of the problems faced by the group farmers are:

(I) Lack of stability and a high frequency of break up. This instability has been due to very low or no net income to share at the end of the season's work. Many rice and maize group farms failed in Shakki District and the group

broke up because of this factor. A lot of cotton group farmers also broke up when they incurred losses in 1970. In fact, most of the 1970 cotton group farmers were either non-existent again in 1971 or have shifted to growing maize with a heavy depletion of membership.

(II) Lack of adequate tractor supply is another big problem faced by group farmers. There were several cases of group farmers that stumped their land but got no tractor to do the ploughing. Such farms were abandoned and the group members deserted, unable to endure the labor lost.

(III) Some of the group farmers are too big. There is irregular attendance at group work, complaints of laziness on the part of some members and general lack of co-operation among them.

(IV) Other contributory factors are embezzlement of group money, group politics, particularly over the selection of chairman and lack of a sense of joint responsibility. Since the farm belongs to the group and not to an individual, if it is successful it is fine but if it fails no one feels responsible for the setback. There was the case of a group in Egbado Division which failed to harvest their crop because of quarrel that erupted among them. The efforts and expenses were to no benefit and the mechanization cost remained unpaid.

(V) To get sufficient large land in one location for the group farmers is also a problem. The second farm may be two

miles from the first since the members of the group who contribute the land do not have land in the same location.

Personal Characteristics of Private Users

Table 4.6 indicates that the level of formal education is not an important decision factor in the use of hire service.

Table 4.6 TRACTOR USERS BY EDUCATION
Western Nigeria, 1970

Education level	Type of User: Individual users	Type of User: Settler users
	Percent	
No formal education	69.6	1.9
Did not finish primary school	6.5	7.7
Finished primary school	13.0	36.5
Did not finish modern school	0.0	9.6
Finished modern school	6.5	38.5
Attended secondary school	4.4	5.8
Total	100.0	100.0

The majority of individual users had no formal education, but a majority of the farm settlers finished modern III or completed primary school.

Among the individual users, both young and old people are well represented (Table 4.7). But the older people, above 40, are slightly larger than the young ones, 26-30 years old. The farm settlers are

Table 4.7 TRACTOR HIRE USERS BY AGE
Western Nigeria, 1970

Age in years	Type of User			
	Individual users		Settler users	
	Number	Percent	Number	Percent
Less than 20	2	4.9	0	0
20-25	3	7.3	11	22.9
26-30	12	29.3	26	54.2
31-35	6	14.6	10	20.8
36-40	5	12.2	1	2.1
Above 40	13	31.7	0	0
Total	41	100.0	48	100.0

mostly young people, in the 20-30 year class. While the farm settlers are much younger than the other users, age does not seem to be a determining factor.

Length and Consistency of Use

A good number of the users have long been making use of the hire service, Table 4.8. There are more recent users among the individual users than among the farm settlers. A large part of the farm settlers have been using tractors for a long time. This is not unexpected because the mechanization project got its initial boost from the farm settlements.

But it should be noted that a farmer does not consistently use the service for four, five or nine years consecutively. Within year

Table 4.8 TRACTOR USERS BY LENGTH OF USE
Western Nigeria, 1970

Length of use in years	Type of User	
	Individual users	Settler users
	Percent	
Less than 2	17.3	5.8
2-3	17.3	23.1
4-5	23.1	13.5
6-7	11.5	26.9
8-9	21.2	11.5
Above 9	9.6	19.2
Total	100.0	100.0

and year-to-year use are very irregular. Some farmers may be off the users' list for two or more years before coming back again. The reasons for this irregularity include:

(I) Inability to pay the one-third deposit required. The farmer will use the service the year or season he can pay the deposit and fail to use it when he cannot.

(II) Inability to stump new land after the first land is put into other crop.

(III) On farm settlements, the settler may not obtain a stumped land. This is true among a number of farm settlers at Oshun farm settlement.

(IV) Crop failure. This is particularly true among cotton and rice group farmers. The tractor is usually not used the year following a crop failure and low income to share.

For instance, Temidayo cotton group farmers in Eruwa used hire service in 1969 but did not use in 1970 because the cotton failed. Okolo cotton group farmers used in 1969 but not in 1970 because the crop failed. Both groups started to use in 1971, but the first group shifted to kenaf cultivation while the latter group shifted to maize.

A number of reasons prevent the non-users from using the hire service. The various reasons given include:

(I) Lack of money to pay the expenses.

(II) Inability to stump the land.

(III) Inadequacy of tractors available. The tractors available did not go round all the farmers wishing to hire service.

(IV) Inaccessibility of some farmers because of rivers without bridges. In addition, tractors cannot even reach some farms except when heavy equipment is used to make some form of road.

(V) Sheer inertia and desire to see the results on other farms before trying it out. Risk aversion might be an important factor.

The Level of Farm Mechanization

The tractor hire service is provided to do land preparation such as ploughing, harrowing and ridging. A complete operation consists of doing all these three operations. There is no subsequent use of tractor beyond the stage of land preparation.[2] To this extent, this

[2]Planting on the flat is common only among farm settlers and on Government stations. The private farmers usually ridge with machines and plant with hand on ridges.

is not "mechanization" in the sense in which full mechanization of all growing operations is understood. Mechanization in Western Nigeria, on the aggregate, is still largely partial.

Although overall level of mechanization is partial, not all farmers do the three seed bed preparations with tractors. A farmer may do one or two of the three land preparation operations. The only thing that is certain is that any farmer who uses the hire service does ploughing. The difference lies in whether he will harrow, ridge/plant. Ridging and planting are mutually exclusive.

One practice is double ploughing. It is done by some farmers because:

(I) The farm was ploughed too early before the onset of rains and so the soil was not well penetrated.

(II) In majority of cases, it is because after the first ploughing, harrowing was not done on time. The farm becomesweedy again and needs to be reploughed.

(III) It is also done to replace harrowing operation. The advantage of double ploughing is to make the job of weeding easier.

After the ploughing operation, the farmer is faced with the decision of which of the remaining operations he will do.

His decision depends on:

(I) The timely availability of service.

(II) His financial position.

(III) The prospects of the crop in relation to his estimates of weather. That is, his estimate of the degree of uncertainty involved.

(IV) Availability of labor.

(V) The size of the farm.

Among the two subsequent operations of harrowing and ridging, harrowing operation has the greater probability of being skipped. The practice of skipping harrowing operation is more common among the non-settler farmers, Table 4.9.

Table 4.9 OMISSION OF HARROWING BY CROP AND TYPE OF TRACTOR USER
Western Nigeria, 1970

Type of tractor user	Early maize	Late maize
	Percent of Growers	
Settler users	25.0	27.5
Group users	52.9	60.0
Individual users	68.0	69.0

From this table, it is clear that:

(I) For both early and late crops, more of the individual users omit the harrowing operations than the other type farmers.

(II) A larger percent of farmers omit it in late crop season than in early crop season.

The questions that are pertinent in this regard are:

(I) Why does a farmer want to skip the harrowing operation?

(II) Why does a farmer not carry complete operation in land preparation? The farmers interviewed indicated that they omitted harrowing because:

(I) Lack of availability of harrows.

(II) Untimely provision of service, so that this operation is omitted to avoid late planting.

(III) To minimize costs.

If the farmer omits harrowing to minimize his costs, he needs to balance the reduced cost with the loss in yield resulting from lack of harrowing. Whether the net effect will be positive or negative will depend on the percentage yield lost relative to percentage cost reduction.[3] It is important to note, however, that majority of farmers cited the first two reasons as being responsible for omission of harrowing operation instead of the desire to reduce tractor expenses. Reasons for not carrying complete operation are the same as above; with a larger proportion of farmers citing non-availability of tractors and untimely servicing as being principally responsible.

The degree of farm mechanization can be regarded as the proportion of the total acreage of the operation done by machine (27). This is similar to the approach of Tolpekin (28) who measures the level of mechanization by the [illegible]ation of the volume of mechanized operation to the overall volume of operations of the given type.

Following Tolpekin,

$$L = \frac{Vm}{Vo} \times 100$$

L = The level of mechanization

Vm = Volume of mechanized operation

Vo = Overall volume of operations of the given type

This measurement is designed for a situation of full mechanization. But in the case of partial mechanization with which the study is

[3]Alternative operational procedures are examined in greater detail in Chapter VI.

concerned, it needs to be modified. There is only one mechanized operation and there is a maximum of three parts of this operation that can be mechanically performed. The proportion of this maximum a farmer does mechanically should also be weighted by his acreage. Thus[4]

$$L_i = W_i \left(\frac{V_i}{M_i}\right) \times 100$$

Where V_i = Parts of the operation mechanically performed

M_i = Maximum parts that can be mechanically performed

W_i = Weights = $\frac{A_i}{\sum_{i=1}^{n} A_i}$ $i = 1, 2, \ldots n$ farmers

L_i = Level of machine use for land preparation by the ith farmer

Table 4.10 shows the results, which are:

(I) For early crop, settlers use the hire service more than other type farmers while for late crop, the group farmers use it more than other type farmers.

(II) For both early and late crops, the settlers and group farmers use the service more than the individual farmers. This is because farm settlers and group farmers usually grow more acres and do more parts of the land preparation with machines than the individual users.

(III) Except for settlers, the farmers use the service for late crop more than for early crop. This is largely due to the number of operations mechanically done rather than size factor. The number of farmers wishing to use the hire service in the late crop is smaller, on the aggregate, than the early crop and thus allows more operations to be done in land preparation for the late crop.

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[4]Double ploughing is treated as a single part.

Table 4.10 THE LEVEL OF TRACTOR USE BY TYPE OF USER AND CROPS GROWN
Western Nigeria, 1970

Type of tractor use	Early Maize		Late Maize	
	Average	Range	Average	Range
	Percent			
Settler users	2.8	29.4	2.4	13.2
Individual users	1.7	5.3	1.9	14.1
Group users	2.6	8.7	5.9	12.0

Changes in Aggregate Use of Tractor Services

Temporal changes in the use of hire services was examined at the aggregate level. Is the use of tractors growing, and if so at what rate? The period covered was 1965-1966-1969/70 and 1965/66-1970/71 in case of transporting for Ondo and Abeokuta Circles. The time unit is a year.

Both linear[5] and exponential[6] trends were fitted, using the ordinary least squares estimator. The models were run for three circles (Ibadan, Ondo and Abeokuta) and five different types of operations (ploughing, harrowing, ridging, planting and transporting).

Table 4.11 shows the results. During the period, the use of tractors was on the increase. As expected, the absolute annual increase is greatest in Ibadan Circle for all field work operations. The annual increase in hours of transporting is highest in Ondo Circle. The percentage annual rate of growth of hours of transporting is also highest in the Circle.

[5]The linear trend model is $Y = a + bT$

[6]The exponential trend model is $Y = ab^T$, when linearized, it becomes $\log Y = A + BT$
where $A = \log a$
$B = \log b$

Table 4.11 RATES OF CHANGE IN AGGREGATE USE OF TRACTOR SERVICES
Western Nigeria, 1965/66-1969/70

Operation	Ibadan Circle		Ondo Circle*		Abeokuta Circle	
	Annual % rate of growth	Annual rate of change	Annual % rate of growth	Annual rate of change	Annual % rate of growth	Annual Rate of change
Ploughing (acres)	0.61 (2223)	8062.5 (-2600.3)	0.39 (191.5)	1132.7 (-219.1)	0.22 (179.7)	127.6 (279.2)
Harrowing (acres)	0.08 (2386)	530.4 (6044.6)	0.25 (15.46)	32 (63)	0.26 (175.6)	132.7 (205.3)
Ridging (acres)	0.19 (2057)	388.7 (1215.7)	0.15 (167.9)	37.6 (164.8)	0.27 (163)	64.1 (102.1)
Planting (acres)	0.24 (2093)	710.2 (1084.6)	0.38 (13.03)	12.8 (3.2)	0	0
Transporting (hours)	0.25 (2219)	1268.8 (2295.6)	0.45 (2142)	1678.9 (3938)	0.24 (2135)	1051.9 (944.2)

*Includes Ekiti Circle.
Figures in parentheses are the intercepts.

In both Ibadan and Abeokuta Circles, ridging operation showed the smallest rate of change. In all circles, the increase in the use of tractors for ploughing is higher than for any other operation.

The Private Tractor Owners

Apart from the Government Hire Units, there are other mechanization schemes under different types of organization. There are private, Nigerian Tobacco Company (N.T.C.) and Nigerian Fiber Industries Company (N.I.F.I.N.C.) mechanization schemes. The few private tractor owners are found in Oyo, Ibarapa Division, Ibadan and on farm settlements such as Oshun, Ilora and Ogbomosho farm settlements. Most of the non-settler private owners are concentrated in Eruwa/Igbo-Ora areas of the State. Rev. Macbee and Chief Olaniyan have their own tractors while three other tractor owners have government tractors on trial special hire scheme. All the five tractor owners hire out to private farmers. But most of their work is done for tobacco farmers.

Rev. Macbee at Igbo-Ora ploughs twice for tobacco farmers and he gets paid by the Nigerian Tobacco Company. No deposit is required. He does no planting nor harrowing operations. He only does ploughing and ridging. His rates are set out in Appendix Table A-2.

His tractor repairs are carried out at the Ministry's repair shop. He has been having troubles with the Ford tractor tires. He has experienced an average of two punctures per month.

He maintains two tractor operators. He pays a basic salary of £N12 per month, £N1 extra for taking good care of the tractors and each day a tractor operator does a good job, he pays him an additional

ten shillings. His customers are very happy with his services, so also are his tractor operators.

Chief Olaniyan at new Eruwa, hires out his tractors to N.T.C. when he has less work for the equipment on his farm. He charges 45 shillings per acre for ploughing and 37.5 shillings per acre for ridging.

He maintains three tractor operators. Their pay range from £10- 13 per month and he feedseach of them everyday they work.

At Ibadan Mr. Latunde Laosun, a kenaf farmer, also bought his own tractors.

Chief Akinriade at Oyo, a retired N.T.C. worker, went back to farming on a large scale. He does no hire service and has no plans to do it. He feels that the equipment available is just enough to cope with the volume of work on his farm.

He has one operator since only one tractor is active. He is paid £132 per year. All his repair work is done at Fashola workshop.

On farm settlements, tractors are not owned by individuals but by groups of settlers. There are two groups of settlers that own tractors on Ogbomosho farm settlement and one group on Oshun farm settlement. At Ilora farm settlement, there are four groups of settlers that own tractors.

The first group, the Omolanwa Group, is composed of two settlers. Their main crops are maize and mellon. Together, they operate about 100 acres of land.

The plough and the tractor were given to the group by the Ministry. The cost is paid installmentally over a period of time. The harrow, ridger and trailer were bought by the group members.

The group does custom work when they are less busy on their farm. They charge Government rates for tractor services. If they charge less, the group leader said the Government can seize the tractor. This group has faced the following problems in operating their equipment:

(I) Frequent breakdown. Over £100 was spent on repairs between 1970/71. One reason for this is that the equipment given by the Government is already old. To have spent £100 on tractor repairs within a year meant that no money is left to meet any other expense for a peasant farmer.

(II) Repairs are delayed for too long. Usually, repairs are done at the Fashola workshop. The main cause of delay is lack of spare parts.

(III) The difficulties of recovering payments for tractor services rendered. The amount of debt showed sharp increase in 1970 owing to the crop failures.

(IV) Inadequate amount of land. The group indicated their desire to operate a larger farm, but since each settler is allowed only 50 acres on the settlement, it is difficult to expand their size of operation.

The second group, the Upper Ogun Group, is composed of three members. Their main crops are maize, cassava and pepper. Together they operate 150 acres of land. Two tractors were given to them by the Government on payment of £100 as deposit.

The group also does custom work and charges Government rates. Initially, settlers were asked to deposit a proportion of the total tractor expenses. But owing to the difficulties of recovery of the

balance, all the tractor expenses were required to be paid before service is rendered.

In addition to the problem of recovering tractor expenses, the group also indicated that their size of holding is inadequate for the equipment at their disposal.

The third group, Ogunleye Group, is made up of three members. They own one tractor and one plough. The equipment was given to them by the Government in May, 1971. The cost will be paid installmentally over a period of time. They also do custom work, charge Government rates and accept a deposit of half the tractor expenses. The problems they faced were:

(I) Lack of adequate financial base to do repairs on the tractor.

(II) Out of the three members, only one has holding yet which means that there are only 50 acres of land available.

(III) Lack of cash to buy fertilizer and the fertilizer credit facility was scrapped by the Government.

The fourth group, the Oniosun Group, is composed of three members. They have one tractor and one trailer. A deposit of £100 was paid to the Government before they were given the tractor and the trailer. The problems faced by this group were:

(I) The tractor given by the Government is already very old and there was no battery in it when it was given to them.

(II) The trailer had no tires when given to them by the Government.

(III) The group members know nothing about tractor handling and maintenance.

(IV) Together the three operated only 60 acres because there is no money to maintain a larger farm. The available money was spent on fixing the trailer and the tractor.

(V) There were no implements to work the tractor. They were not given a plough, no harrow and no ridger and they have no money to buy these. So, they hire a plough from fellow settlers who have tractors. This procedure caused a lot of delay in their farm operations.

The experience of these group tractor owners had been examined in some detail because it provides a point of departure from the Government hire service and moves in the direction that could be a solution to mechanization problem in the state. The group tractor owners indicated that they decided to own tractors because:

(I) The charges of Government Hire Units are too expensive.[7]

(II) The lateness in obtaining service from the hire unit causing late planting and crop failure. Some felt that by owning their tractors seed bed preparations will be done earlier and so be able to plant on time. But the circumstances of tractor acquisition and maintenance expenses still represent serious limitations to overcoming these problems.

Sponsored Private Hire Units

Because the Government has limited amount of tractors and the

[7]The groups also continue to charge the Government rates they considered high. It is not certain whether they could have been able to hire out their equipment at rates less than that of the Government, if allowed. The Government rate itself is subsidized.

few available are not all in good condition, the N.T.C. considered the Government Hire Units rather unreliable for land preparation work for their tobacco leaf suppliers. Therefore, the N.T.C. sponsored three men (one is already defunct) to get advance purchase of tractors and implements and render private hire services to tobacco farmers. These men are to repay in three yearly installments. One man is based at Iseyin while the other is based at Ago Are. These people operate in the N.F.C. area (the Nigerian flue-cured tobacco area comprising Ago Are, Otu, Igbo-Ora and Iseyin areas). The two active N.T.C. private tractor hire units are normally supplemented by other private tractor owners, particularly in Eruwa/Igbo-Ora areas. These are not N.T.C. Hire Units. They are only N.T.C. sponsored in the sense that the N.T.C. gave them loans to establish the business. Owing to the increasing number of tobacco farmers, the available hire services are not adequate. Therefore, Government Hire Units are still used to supplement.

Experience in tractor handling and ploughing are the requirements to get sponsored by the N.T.C. The two active N.T.C.-sponsored private tractor hire units have long experience in ploughing. One was an N.T.C. driver, doing ploughing for the company while the other was a tractor driver ploughing for the Ministry. They are mechanics and can do maintenance work on their tractors. But major repairs to the Fashola workshop or the dealer.

To get service from these types of hire units, a farmer must:

(I) Be a tobacco grower.

(II) Should stump his farm and make sure the farm is in a mechanizable state.

The charges are the same as Government rates. Planting is done with hand and harrowing is not a common practice. No deposit is required. The N.T.C. pays the tractor expenses and debits the account of the tobacco grower. This is then deducted from his total sales at the end of the season.

The problems faced by these sponsored private hire units are:

(I) Farmers do not stump and clear their farms on time.

(II) The growers require the tractor service about the same time.

(III) Inadequate supply of tractors.

The N.I.F.I.N.C. Hire Scheme

The Nigerian Fiber Industries Company is the sole organization handling the production of kenaf in the State. The agricultural arm of the company handles the production of kenaf. The company has kenaf estates at Wasimi, Iseyin, Shaki and Oshogbo. Most of the production is on plantation basis. Private farmers are just being encouraged to plant kenaf. So far, the spread among farmers has been slow. The company has its own tractors and implements entrusted to its fleet of agricultural officers instead of allowing the Government Hire Units to do the operations. When the equipment is not enough to cope with their work, the company usually hires tractor services from the Ministry. A farmer is qualified for service only if he plans to plant kenaf. On receipt of his application, the agricultural staff of the company will arrange to plough, harrow, plant and fertilize. No deposit is required. All tractor, seed and fertilizer expenses are deducted after sale of produce. The recovery of debt is easy because it is the company alone that buys the fiber.

CHAPTER V

THE USE OF TRACTOR HIRE SERVICE IN GROWING MAIZE

Maize is the most important crop for which farmers used tractor hire service. There are usually two maize crops per year--the early and the late crops. In this chapter, both crops are analyzed to examine (i) user versus non-user operating results, (ii) tractor hire cost relative to other costs, (iii) the profitability of tractor hire in maize production, (iv) the impact of tractor use on farm size, farm practices and labor inputs.

Early Maize Growers

Early maize is the main crop for the year, planted at the onset of rains in March/April. Land preparations in readiness for rain start from late February. The size of farm is low for all farmers but the impact of tractor use can be noticed between the users and non-users, Table 5.1. The big farmers are concentrated among the group farmers and farm settlers. Most of the small farmers are among the non-tractor users. The fact that tractor users grew more acres than non-tractor users shows the increasing contribution of farm mechanization to enlarged farm sizes.

Cash Expenses

The expense items include hired labor, fertilizer, seed,

Table 5.1 ACRES OF MAIZE GROWN
166 Early Maize Growers, Western Nigeria, 1970

Size in acres	Type of Farmer			
	Individual users	Group users	Settler users	Non-users
	Percent			
Less than 3	31.6	17.7	6.3	39.7
3-4	23.7	35.3	6.3	25.4
5-6	23.7	5.9	31.2	15.9
7-8	5.3	11.8	18.8	11.1
9-10	2.6	5.8	4.1	6.4
Above 10	13.1	23.5	33.3	1.5
Total	100.0	100.0	100.0	100.0

chemical, transportation and machine hire. For the majority of tractor users, machine hire costs dominate the expenditure. For non-users, labor costs dominate, Table 5.2.

The group farmers use less hired labor since group labor is used mostly. But the share of machine hire cost is highest among them. Machine hire and labor costs constitute about the same percentage of total costs per acre among the individual users. Fertilizer, seed and chemicals constitute a very small percentage of total costs.

Cash Receipts

Total cash receipts per acre are low for all the farmers, but farm settlers have the smallest percentage of low income earners, Table 5.3.

Table 5.2 THE STRUCTURE OF CASH EXPENSES PER ACRE
166 Early Maize Growers, Western Nigeria, 1970

Type of farmer	Machine Hire		Hired Labor		Fertilizer		Other	
	Average	Range	Average	Range	Average	Range	Average	Range
				Percent				
Individual users	42.3	54.3	43.1	61.2	13.8	28.7	5.5	15.1
Group users	56.8	60.7	36.7	62.0	14.0	22.3	5.7	11.9
Settler users	43.6	53.3	38.9	59.4	15.1	20.0	4.6	11.3
Non-users	0	0	90.7	40.2	16.4	39.1	5.8	13.7

Table 5.3 CASH RECEIPTS AND EXPENSES PER ACRE
166 Early Maize Growers, Western Nigeria, 1970

Receipts and expenses in shillings	Individual users		Group users		Settler users		Non-users	
	Expenses	Receipts	Expenses	Receipts	Expenses	Receipts	Expenses	Receipts
				Percent of Farmers				
0-100	23.7	15.8	41.2	58.8	2.1	18.8	71.4	30.1
101-200	44.7	31.6	52.9	23.5	77.0	25.0	20.6	42.9
201-300	26.3	26.3	5.9	5.9	16.7	27.0	4.8	12.7
301-400	5.3	15.8	0	5.9	4.2	18.8	1.6	7.9
401-500	0	5.3	0	0	0	10.4	1.6	3.2
501-600	0	2.6	0	0	0	0	0	0
Above 600	0	2.6	0	5.9	0	0	0	3.2

More than 80 percent of group farmers did not earn more than 200 shillings, followed by non-users with 73 percent of them not earning more than 200 shillings. These two groups constitute the largest low income earners. Large income earners are among the farm settlers and individual users. Eleven percent of individual users and 10 percent of farm settlers earn above 400 shillings per acre.

Net Return Per Acre

The failure to cover variable costs in early maize production is shown in Table 5.4.

Table 5.4 NET RETURN FROM GROWING MAIZE BY TYPE OF FARMER
166 Early Maize Growers, Western Nigeria, 1970

Net returns in shillings per acre	Type of Farmer			
	Individual users	Group users	Settler users	Non-users
	Percent			
Below 0	34.2	52.9	35.4	14.3
0-40	7.9	23.5	8.3	23.8
41-80	10.5	5.9	18.8	19.1
81-120	13.2	5.9	14.6	20.6
121-160	15.8	0	4.2	4.8
161-200	5.2	0	2.0	7.9
Above 200	13.2	11.8	16.7	9.5
Total	100.0	100.0	100.0	100.0

More than 50 percent of the group farmers did not cover their variable costs. A smaller percent of non-users suffered loss but only

10 percent of them realized net return above 200 shillings in contrast to 13 percent for individual users, 12 percent for group farmers and 17 percent for farm settlers.

Level of Performance

The distribution of performance factors is shown in Table 5.5. This table indicates that:

(I) Labor-machine cost ratio is high for all farmers, but highest among the individual users and lower among the group farmers.

(II) Labor and machine efficiencies are highest among the individual tractor users and worst among the group farmers.

Labor and machine inefficiences and inadequate labor-machine combination constitute the economic sources of low level of operating results. Machine costs are higher than labor costs for group farmers and farm settlers. The opposite holds for the individual users. The results of calculated level of use of tractor for land preparation shows that individual users were the lowest users. This is reflected in the lower machine costs vis-a-vis the farm settlers and group farmers.

Analysis of Variance

Analysis of variance is a technique "for partitioning a total sum of squares into components associated with recognized sources of variation" (29, p. 99). Analysis of variance may be one-way or multi-way classification depending on the number of factors. The model can

Table 5.5 PERFORMANCE FACTORS BY TYPE OF TRACTOR USER
166 Early Maize Growers, Western Nigeria, 1970

Type of tractor user	Labor-machine cost ratio per acre		Machine cost per shilling of crop sold		Labor cost per shilling of crop sold	
	Average	Range	Average	Range	Average	Range
Individual users	1.3	4.1	0.4	1.3	0.5	3.5
Group users	0.7	1.9	0.9	4.3	0.8	5.6
Settler users	0.9	2.9	0.6	4.2	0.5	3.5
Non-users	0	0	0	0	0.8	4.3

be fixed or random. Fixed analysis of variance is appropriate if inferences are to be made only to the treatments included in the experiment. Random model is appropriate if inferences are to be made to a whole population of treatments. Alternatively, the models can be differentiated by asking the question: If the experiment were conducted again, what treatments would be included? If the same treatments would be included, fixed model is appropriate. If a new set of treatments would be included, the random model is appropriate.

Whatever model or classification is employed, the central purpose of the technique is to test whether there are differences in the response of interest due to the treatments. The assumptions of the technique are spelled out in Steel and Torrie (29, p. 128).

Fixed Model, One-way Analysis of Variance

Discussions of farm mechanization in peasant agricultural economies have always emphasized the need to be selective, particularly in terms of degree of mechanization, location of mechanization activities, type of farmers that can profit from mechanization and what crop to mechanize. In addition, it is of interest to compare mechanized farming with the native system of farming since it is expected, a priori, that mechanization would afford the farmers higher returns in the form of cash than the native system of cultivation.

To examine these issues, the sample was classified by type of farmer, number of operations mechanized by type of tractor user, location, settlement, type of users and user versus non-users. The variability was studied using analysis of variance with net return per acre as the dependent variable.

Number of Operations Mechanically Performed

The mean of net return for different numbers of mechanized operations is shown in Table 5.6 for farm settlers.

Table 5.6 MEAN NET RETURN BY NUMBER OF OPERATIONS MECHANICALLY PERFORMED
48 Settler Users, Western Nigeria, 1970

Number of operations mechanically performed	Mean net return in shillings per acre	Standard deviation
One	19.7	69.7
Two	-44.5	99.6
Complete operation	79.5	105.6

The mean net income is highest for complete operation. Two operations show the lowest mean net return per acre. The analysis of variance is shown in Table 5.7.

Table 5.7 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY NUMBER OF OPERATIONS MECHANICALLY PERFORMED
48 Settler Users, Western Nigeria, 1970

	Sum of squares	D.F.	Mean squares	F ratio
Between groups	80338.4	2	40169.2	3.9
Within groups	452880.8	45	10064.0	
Total	5332119.2			

The hypothesis of equal mean was tested at 5 percent level.

$F(2,45) = 3.20$

The null hypothesis is rejected. Net return per acre is significantly different among the number of operations mechanically performed among early maize settler growers. The honestly significant difference (H.S.D.)[1] procedure (29) was employed to separate the means.

$$H.S.D. = q_a\ (p,\ n_2)\ S\ [1/2(\frac{1}{ri} + \frac{1}{rj})]^{.5}$$

Where q is indexed by a, the error rate, n_2, the error degrees of freedom and p, the number of treatments. S is the square root of error mean square. At 5 percent level of significance, the following are the calculated H.S.D. values:

$H.S.D._{12} = 138.7$

$H.S.D._{13} = 95.17$

$H.S.D._{23} = 116.16$

These values are used for judging the significance of all observed differences.

Number of operations mechanized	1	2	3
Means	19.74	-44.52	79.49

The difference lies between two operations and complete operation.

The mean net return for different number of operations mechanized among individual tractor users is shown in Table 5.8.

As in the case of farm settlers, three operations showed the highest mean net return and two operations, the lowest. The significance of this factor among individual users was tested at the 5 percent

[1]H.S.D. is used in judging all possible pairwise comparisons.

Table 5.8 MEAN NET RETURN PER ACRE BY NUMBER OF OPERATIONS MECHANICALLY PERFORMED
37 Individual Users, Western Nigeria, 1970

Number of operations mechanized	Mean net return	Standard deviation
One	75.6	95.7
Two	72.2	145.8
Complete operation	109.1	262.4

level. F (2,34) = 3.3, but the calculated F ratio is 0.15. In the case of individual early maize growers, mean net return per acre does not significantly depend on number of operations mechanized.

Location

Three locations were identified, Oyo South, Oyo North and Oshun Divisions. The mean net return among the locations is shown in Table 5.9.

Table 5.9 MEAN NET RETURN PER ACRE BY LOCATION
71 Early Maize Growers, Western Nigeria, 1970

Location	Mean net return in shillings	Standard deviation
Oyo South	-0.05	108.5
Oyo North	105.2	128.1
Oshun	79.9	96.3

Mean net return is highest in Oyo North, followed by Oshun. The analysis of variance is shown in Table 5.10.

Table 5.10 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY LOCATION
71 Early Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean squares	F ratio
Between groups	136175.75	2	68087.87	5.75
Within groups	804904.75	68	11836.83	
Total	941080.50			

The null hypothesis of equal mean was tested at the 5 percent level. F (2,68) = 3.13. The null hypothesis is rejected. Net return is significantly different among the locations.

Tractor User Versus Non-User

Whether there is a difference in net return between users and non-users was also analyzed. The mean values are shown in Table 5.11.

Table 5.11 MEAN NET RETURN PER ACRE BETWEEN USER AND NON-USER
167 Early Maize Growers, Western Nigeria, 1970

Type of farmer	Mean	Standard deviation
User	58.0	150.8
Non-user	90.7	133.9

The non-users show a higher mean net return than the tractor users. The analysis of variance is shown in Table 5.12.

The null hypothesis of equal mean was tested at the 5 percent level. F (1, 165) = 3.80. The null hypothesis is accepted. There is no significant difference in net return per acre between users and non-users of hire service for early maize.

Table 5.12 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BETWEEN USER AND NON-USER OF TRACTOR SERVICE
167 Early Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	42290.3	1	42290.3	2.0
Within groups	3452851.0	165	20926.3	
Total	3495141.0			

Settlements

The mean of net return among farm settlements is shown in Table 5.13.

Table 5.13 MEAN NET RETURN PER ACRE BY SETTLEMENT
45 Farm Settlers, Western Nigeria, 1970

Settlement	Number	Mean	Standard deviation
Oshun	6	37.3	72.3
Ogbomosho	23	91.1	100.0
Ilora	9	-41.9	91.5
Eruwa	7	101.7	116.9

Mean net return is high at Eruwa and Ogbomosho farm settlements. It is negative at Ilora farm settlement. The analysis of variance is shown in Table 5.14.

The null hypothesis of equal means was tested at the 5 percent level. $F(3, 41) = 2.83$. The null hypothesis is rejected. Net return per acre is significantly different among farm settlements.

Table 5.14 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY SETTLEMENT
45 Farm Settlers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean squares	F ratio
Between groups	132843.5	3	44281.1	4.59
Within groups	395169.0	41	9638.2	
Total	528012.5			

Type of Farmer

Four types of farmers were considered--farm settler contractor, individual private contractor, group contractor and non-contractor.

The distribution of means of net return per acre is shown in Table 5.15.

Table 5.15 MEAN NET RETURN PER ACRE BY TYPE OF FARMER
167 Early Maize Growers, Western Nigeria, 1970

Type of farmer	Number	Mean	Standard deviation
Farm settler	48	52.1	124.8
Individual contractor	38	80.5	161.4
Group farms	17	24.1	191.2
Non-users	64	90.7	133.9

The non-users have the highest mean net return followed by the individual contractors. Group farmers experienced the lowest mean net return. The analysis of variance is shown in Table 5.16. The hypothesis of equal means was tested at the 5 percent level. $F(3,163) = 2.6$.

Table 5.16 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY TYPE OF FARMER
167 Early Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	82856.43	3	27618.81	1.32
Within groups	3412303	163	20934.37	
Total	3495159			

The null hypothesis is accepted. Net return per acre is not significantly different among the farmers.

Type of Tractor Users

There are three types of tractor users--group users, individual users and settler users. The mean net return per acre is higher among the individual users than either of the other type users, Table 5.17.

Table 5.17 MEAN NET RETURN PER ACRE AMONG USERS
102 Early Maize Growers, Western Nigeria, 1970

Type of tractor user	Mean net return	Standard deviation
Individual users	77.8	165.9
Settler users	56.6	106.5
Group users	36.6	190.1

Whether there is a significant difference in net return among the users was tested at the 5 percent level. F (2,99) = 3.08, but the calculated F ratio = 0.49. Mean net return does not significantly depend on the type of user.

Late Maize Growers

Late maize is grown as a second group, usually on all or part of the early crop plot. The distribution of acres of late maize grown is shown in Table 5.18.

Table 5.18 ACRES OF MAIZE GROWN
128 Late Maize Growers, Western Nigeria, 1970

Size in acres	Type of Farmer			
	Individual users	Group users	Settler users	Non-users
	Percent			
Less than 3	44.4	10.0	44.8	39.6
3-4	25.0	40.0	10.6	28.3
5-6	16.6	10.0	13.7	15.1
7-8	0.0	10.0	6.9	5.7
9-10	5.7	20.0	13.7	9.4
Above 10	8.3	10.0	10.3	1.9
Total	100.0	100.0	100.0	100.0

The majority of farm settlers, non-users and individual users grew less than three acres. But non-users growing less than three acres are fewer than the settlers and individual users growing less than three acres. At the same time, the large farms are concentrated among the tractor users. Thus, while there are still small size farmers among users, the use of the tractor has enabled a good number to increase their size of operation. Group farmers and farm settlers grew larger acres than the individual users.

Cash Receipts

Cash receipts were calculated in shillings per acre. The distribution is shown in Table 5.19. The majority of the growers earn very little. About 14 percent of the individual users earned more than 400 shillings per acre compared with 6 percent among non-users. The non-users showed the largest proportion of low income earners. Among the users, 53 percent of individual users earned less than 200 shillings per acre in contrast to 80 percent and 76 percent among group farmers and farm settlers respectively. Thirty-three percent of individual users earn above 200 shillings per acre in contrast to 10 percent and 21 percent among group farmers and farm settlers respectively.

Cost Structure

The structure of costs is shown in Table 5.20. The important points indicated by this table are:

(I) The dominating nature of the machine hire in the cost of production. For machine users, the cost of machine hire is higher than cost of labor. Among the non-users, cost of labor is the highest.

(II) The low level of purchased fertilizer, seeds, and chemicals.

Net Return

The distribution of net return on a per acre basis is indicated in Table 5.21.

Many farmers had negative net return. But they are much more concentrated among users than non-users of hire service. Only 15 percent of non-users suffered loss as compared with 66 percent, 60 percent and

Table 5.19 CASH RECEIPTS AND EXPENSES PER ACRE
128 Late Maize Growers, Western Nigeria, 1970

Cash receipts and expenses in shillings	Individual users		Group users		Settler users		Non-users	
	Expenses	Receipts	Expenses	Receipts	Expenses	Receipts	Expenses	Receipts
				Percent of Farmers				
0-100	25.0	27.7	30.0	60.0	24.1	58.6	75.5	50.9
101-200	52.8	25.0	70.0	20.0	55.2	17.2	24.5	30.2
201-300	22.2	27.7	0	0	17.2	10.4	0	9.4
301-400	0	5.6	0	10.0	3.5	10.4	0	3.8
401-500	0	5.6	0	10.0	0	3.4	0	1.9
501-600	0	2.8	0	0	0	0	0	1.9
Above 600	0	5.6	0	0	0	0	0	1.9

Table 5.20 THE STRUCTURE OF CASH EXPENSES PER ACRE
128 Late Maize Growers, Western Nigeria, 1970

Type of farmer	Hired Labor		Machine Hire		Fertilizer		Other*	
	Average	Range	Average	Range	Average	Range	Average	Range
				Percent				
Individual users	39.9	58.5	49.4	78.4	14.7	29.4	5.4	13.2
Settler users	37.1	71.5	49.3	56.9	13.4	22.2	3.6	5.1
Group users	33.0	37.6	56.3	43.2	11.6	23.8	9.0	14.3
Non-users	89.5	39.6	0	0	20.8	37.5	6.6	17.2

*Includes seed, chemicals and transportation.

Table 5.21. NET RETURN FROM GROWING MAIZE BY TYPE OF FARMER
128 Late Maize Growers, Western Nigeria, 1970

Net return in shillings per acre	Type of Farmer			
	Individual users	Group users	Settler users	Non-users
	Percent			
Less than 0	30.5	60.0	65.5	15.1
0-40	16.7	10.0	13.7	28.3
41-80	11.1	10.0	0	22.6
81-120	13.9	0	3.5	15.1
121-160	5.7	0	3.5	5.7
161-200	2.7	10.0	10.3	3.8
Above 200	19.4	10.0	3.5	9.4
Total	100.0	100.0	100.0	100.0

31 percent among settlers, group farmers and individual users respectively. Farm settlers and group farmers have the greatest proportion of farmers that failed to recover their variable costs.

The causes of negative net returns can be traced to the physical factors of drought, already mentioned. But there are also economic explanations of the situation shown in Table 5.22. This table gives some indication of the economic basis for the poor operating results of late maize growers. The sources of the problem lie in poor cost control and inefficient labor-machinery combination. The use of machine services has only contributed to increase aggregate costs. The reason for this situation is the partial nature of farm mechanization. After the land

Table 5.22 PERFORMANCE FACTORS BY TYPE OF TRACTOR USER
128 Late Maize Growers, Western Nigeria, 1970

Type of farm	Labor-machine cost ratio per acre		Machine cost per shilling of crop sold		Labor cost per shilling of crop sold	
	Average	Range	Average	Range	Average	Range
Individual users	1.1	2.9	0.7	8.0	0.6	3.9
Group users	0.7	1.3	2.4	12.9	0.8	3.3
Settler users	0.9	4.2	1.5	5.9	1.3	14.6
Non-users	0.0	0.0	0.0	0.0	0.8	7.4

preparation operation, major cost items such as weeding and harvesting are still done by hired labor.

Analysis of Variance

The sample was classified by type of farmer, location, number of operations mechanized, settlement and tractor user versus non-tractor user. The variability was studied using analysis of variance on the basis of net return in shillings per acre. It is assumed that there is no reason to doubt the basic analysis of variance assumptions (29).

Type of Farmer

The sample was classified into four types of farmers. The distribution of mean net return per acre is shown in Table 5.23.

Table 5.23 MEAN NET INCOME PER ACRE BY TYPE OF FARMER
128 Late Maize Growers, Western Nigeria, 1970

Type of Farmer	Number	Mean net income per acre	Standard deviation
Farm settlers	29	-20.3	117.0
Individual contractors	36	83.3	196.0
Group farmers	10	15.6	175.9
Non-users	53	76.0	127.1

Both the farmer settlers and group farmers have low mean net return in contrast to the high mean net return secured by the individual and non-contracting farmers. The analysis of variance of net return per acre is shown in Table 5.24.

Table 5.24 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY TYPE OF FARMER
128 Late Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean Square	F ratio
Between groups	231175.12	3	77058.37	3.35
Within groups	2848676	124	22973.19	
Total	3079851			

The hypothesis of equal means was tested at the 5 percent level of significance. F (3,124) = 2.6. The calculated F ratio is 3.35 which is greater than 2.6 and therefore the hypothesis of equal means is rejected. The net return per acre significantly depends on the type of farmers.

The separation of means technique was employed to detect where the difference lies. The non-contracting farmers are used as control. Interest centers on comparing the other means with the non-contracting farmers. For this purpose, the Dunnett's significance difference procedure (D.S.D.[2]) is employed (29).

$$D.S.D. = t_{a,p} s \left(\left(\frac{1}{ri} + \frac{1}{rj}\right) \right)^{.5}$$

Where T is from Dunnett's table. It is indexed by a, the error rate, error degrees of freedom and P, the number of treatments minus the control.

S = the square root of error mean square. At the 5 percent level of significance, the following are the calculated D.S.D. values.

[2]D.S.D. is used for paired comparisons where one mean is for the control.

$D.S.D._{14} = 72.04$

$D.S.D._{24} = 67.45$

$D.S.D._{34} = 107.57$

These values are employed for judging the significance of observed differences for one-sided comparisons. The hypothesis that groups one and three means are less than group four mean is accepted while the hypothesis that group two mean is greater than group four mean is rejected.

Group	1	2	3	4
Means	-20.3665	15.6419	76.0367	83.3980

The means that are different are indicated with the arrows, otherwise there is no difference. This analysis suggests that the tractor hiring farmers have not performed better than non-tractor hiring farmers.

Location

The farmers were also classified according to location since spatial distribution of the tractor hiring units is an important factor for consideration. Three location points were identified and their distribution of mean net return per acre is shown in Table 5.25.

Mean net return in Oyo North is appreciably higher than mean net return in Oshun and Oyo South. The analysis of variance of net return per acre is shown in Table 5.26.

The hypothesis of equal means was tested at the 5 percent level of significance. $F(2,50) = 3.19$. The calculated F ratio is 6.21

Table 5.25 MEAN NET RETURN PER ACRE BY LOCATION
53 Late Maize Growers, Western Nigeria, 1970

Location	Number	Mean net income per acre	Standard deviation
Oyo South	16	-45.5	135.3
Oyo North	18	117.7	169.1
Oshun	19	3.7	109.3

Table 5.26 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY LOCATION
53 Late Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	242449.81	2	121224.87	6.21
Within groups	976543.68	50	19530.87	
Total	1218993			

which is greater than 3.19 and therefore the hypothesis of equal means is rejected. Net return per acre significantly depends on location.

The separation of means technique was employed to detect where the difference lies. The honestly significant difference procedure (H.S.D.) was employed.

$$H.S.D. = q_a\ (p,\ n_2)\ S\ \left[1/2\left(\frac{1}{ri} + \frac{1}{rj}\right)\right]^{.5}$$

Where q is indexed by a, the error rate, n_2, the error degrees of freedom and P, the number of treatments. S is the square root of

error mean square. At the 5 percent level of significance, the following are the calculated H.S.D. values:

$H.S.D._{13} = 114.65$

$H.S.D._{12} = 116.14$

$H.S.D._{32} = 111.12$

These values are used for judging the significance of all observed differences.

Location	Oyo South	Oyo North	Oshun
Mean	-45.5081	3.7921	117.7122

There is difference between Oyo North and Oshun.

Farm Settlements

The hypothesis that there is no difference among farm settlements was also examined. For this purpose, four predominantly arable farm settlements were identified. The means of net return per acre among the settlements are shown in Table 5.27.

Mean net return per acre is low for all the settlements, but much better in Ogbomosho than other settlements. The analysis of variance of net return per acre is shown in Table 5.28.

The hypothesis of equal means was tested at the 5 percent level of significance. $F(3,25) = 3.00$. The calculated F ratio is 2.29 which is less than 3.00 and therefore the hypothesis is accepted. Net return per acre is not significantly different among the settlements.

Table 5.27 MEAN NET RETURN PER ACRE BY SETTLEMENT
29 Late Maize Growers, Western Nigeria, 1970

Settlement	Number	Mean net return per acre	Standard deviation
Oshun	7	0.5	64.9
Ogbomosho	12	5.7	131.4
Ilora	3	-174.9	122.6
Eruwa	7	-19.6	96.1

Table 5.28 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY SETTLEMENT
29 Late Maize Growers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F Ratio
Between groups	82936.50	3	27645.50	2.29
Within groups	300729.50	25	12029.15	
Total	383665.50			

Tractor Contracting Versus Non-Contracting Farmers

The mean net return per acre among users and non-users is shown in Table 5.29. The mean net return among non-users is greater than the mean net return among users of tractor service. The analysis of variance is shown in Table 5.30.

The hypothesis of equal means was tested at the 5 percent level of significance. F (1, 126) = 3.8. The calculated F ratio is 2.26 and therefore the hypothesis is accepted. There is no significant difference in net return per acre between contracting and non-contracting late maize farmers.

Table 5.29 MEAN NET RETURN PER ACRE BETWEEN USER AND NON-USER
128 Late Maize Growers, Western Nigeria, 1970

Type of farmer	Number	Mean net return per acre	Standard deviation
User	75	34.2	171.8
Non-user	53	76.0	127.2

Table 5.30 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BETWEEN USERS AND NON-USERS
128 Late Maize Growers, WesternNigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	54247.34	1	54247.34	2.26
Within groups	3025592	126	24012.63	
Total	3079839			

Tractor Users

There is no significant difference between users and non-users of tractor service. But, is there a significant difference among users? The mean net return per acre among users is shown in Table 5.31.

Table 5.31 MEAN NET RETURN PER ACRE AMONG USERS
75 Late Maize Growers, Western Nigeria, 1970

Type of user	Mean net return per acre	Standard deviation
Individual users	83.4	196.0
Group users	15.6	175.9
Settler users	-20.4	117.1

The mean net return per acre was highest among the individual tractor users. Whether there is a significant difference among the users was tested at the 5 percent level of significance. F (2,72) = 3.13 and calculated F ratio is 3.17. The null hypothesis of equal means among users is rejected. The net return per acre significantly depends on the type of tractor user among the late maize growers.

Number of Operations Mechanically Performed

It has been noted that users tend to skip certain operations, particularly harrowing operation. Some farmers trade harrowing for fertilizing. What difference, if any, the number of operations done makes to operating results was analyzed. The mean net return is shown in Table 5.32.

Table 5.32 MEAN NET RETURN PER ACRE BY NUMBER OF OPERATIONS MECHANIZED
36 Individual Tractor Users, Western Nigeria, 1970

Number of operations	Number	Mean	Standard deviation
One	9	109.1	154.4
Two	20	46.9	170.4
Complete	7	154.6	298.3

Complete operation--plough, harrow and ridge--gives higher mean return per acre. Two operations, plough and harrow or plough and ridge give the smallest net return. This suggests that it is better to do either ploughing operation alone or complete operation. The analysis of variance is shown in Table 5.33.

Table 5.33 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY OPERATIONS MECHANICALLY PERFORMED
36 Individual Tractor Users, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	67963.4	2	33981.7	0.878
Within groups	1277070	33	38699.1	
Total	1345030			

The hypothesis of equal means was tested at the 5 percent level of significance. F (2,33) = 3.30. The hypothesis was accepted. Net return per acre does not significantly depend on the number of operations mechanized among late maize individual tractor users.

Among settler users, mean net return was negative for all numbers of operations mechanized, but the loss was smallest for complete operation, Table 5.34.

Table 5.34 MEAN NET RETURN PER ACRE BY NUMBER OF OPERATIONS MECHANIZED
29 Late Maize Growers, Western Nigeria, 1970

Number of operations mechanized	Mean net return	Standard deviation
One	-21.1	33.9
Two	-34.1	160.2
Complete operation	-12.8	118.3

Whether there is a significant difference among the number of operations mechanized among settler users was tested at the 5 percent level of significance. F (2,26) = 3.39, but the calculated F ratio is 0.08.

The hypothesis of equal means is accepted. Mean net return does not significantly depend on number of operations mechanized among late maize settler growers.

Early and Late Maize Compared

It has been noted that late maize tends to command higher price than early maize, but that there is greater uncertainty in respect of late maize yield than early maize. What difference, if any, the type of crop makes to net return was therefore analyzed.

For group farmers, the mean net return is shown in Table 5.35.

Table 5.35 MEAN NET RETURN PER ACRE BY TYPE OF CROP
27 Group Farmers, Western Nigeria, 1970

Type of crop	Mean net return in shillings	Standard deviation
Early maize	24.1	191.2
Late maize	15.6	175.9

The early maize shows a higher mean net return than late maize. The analysis of variance is presented in Table 5.36. $F(1,25) = 4.25$ at the 5 percent level of significance. The null hypothesis of equal means is accepted. Net return per acre is not significantly different between the crop types.

Among individual tractor users the distribution of mean net return is shown in Table 5.37. Mean net return per acre is greater for late maize among individual users. The analysis of variance is presented in Table 5.38. $F(1,72) = 3.90$ at the 5 percent level of significance.

Table 5.36 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY TYPE OF CROP
27 Group Farmers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	447.6	1	447.6	0.013
Within groups	863617.87	25	34544.71	
Total	864065.43			

Table 5.37 MEAN NET RETURN PER ACRE BY TYPE OF CROP
74 Individual Tractor Users, Western Nigeria, 1970

Type of crop	Mean net return in shillings	Standard deviation
Early maize	80.6	161.4
Late maize	83.4	196.0

Table 5.38 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY TYPE OF CROP
74 Individual Tractor Users, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	147.18	1	147.18	0.004
Within groups	2309259	72	32073.03	
Total	2309406			

The null hypothesis of equal means is accepted. Net return per acre is not significantly different between crop types.

For farm settlers, the distribution of mean net return per acre by crop type is shown in Table 5.39.

Table 5.39 MEAN NET RETURN PER ACRE BY TYPE OF CROP
77 Farm Settlers, Western Nigeria, 1970

Crop type	Mean net return in shillings	Standard deviation
Early maize	58.5	105.5
Late maize	-20.4	117.1

Mean net return is negative for late crop among farm settlers. The analysis of variance is presented in Table 5.40.

Table 5.40 ANALYSIS OF VARIANCE OF NET RETURN PER ACRE BY TYPE OF CROP
77 Farm Settlers, Western Nigeria, 1970

	Sum of squares	D.F.	Mean square	F ratio
Between groups	112340.31	1	112340.31	9.29
Within groups	906540.56	75	12087.20	
Total	1018880.87			

F (1,75) = 3.98 at the 5 percent level of significance. The null hypothesis of equal means is rejected. In the case of farm settlers, net return per acre is significantly different between the crop types.

Tractor users incurred greater cash expenses in early maize production than non-tractor users. Forty-seven percent of individual users, 50 percent of group farmers, 12.5 percent of farm settlers and 81 percent of non-users incurred less than 500 shillings in cash expenses for early maize growing. None of the non-tractor users incurred above 1500 shillings in cash expenses while 19 percent of group farmers, 21 percent of individual users, 46 percent of farm settlers incurred cash expenses above 1500 shillings in early maize production, Table 5.41. For late maize the pattern of cash expenses was the same. Between early and late maize crops, cash expenses in growing late maize were smaller than the expenses in growing early maize among all type farmers. This fact underscores the fact that late maize acreage and maintenance operations are generally smaller than early maize acreage and maintenance operations.

Tractor users secured higher gross receipts from early maize than non-tractor users. Fifty-nine percent of non-tractor users secured less than 500 shillings as compared with 21 percent, 56 percent and 35 percent among settler users, group users and individual users respectively. Only about 2 percent of non-tractor users secured gross receipts above 1500 shillings in growing early maize as compared with 31 percent of individual users, 19 percent of group farmers and 52 percent of farm settlers. The farm settlers obtained more gross receipts than other type farmers in growing early maize. Cash expenses in growing early maize were also higher among the farm settlers than any other type farmer. This reflects the fact that farm settlers grow more acres, have a higher index of tractor use and carry out much larger maintenance operations which involve expenditure. In addition, the farm settlers transport

Table 5.41 CASH EXPENSES PER FARMER BY TYPE OF CROP AND FARMER
Western Nigeria, 1970

Cash expenses in shillings	Individual users		Group Farmers		Settlers		Non-users	
	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize
				Percent of Farmers				
Less than 500	47.4	61.1	50.0	40.0	12.5	50.0	81.3	89.8
500-1000	21.1	19.5	31.4	30.0	20.8	25.0	15.3	10.2
1001-1500	10.5	8.3	0	10.0	20.8	14.3	3.4	0
1501-2000	2.6	2.8	0	10.0	12.5	7.1	0	0
2001-2500	7.9	0	6.2	10.0	10.4	3.6	0	0
2501-3000	2.6	0	6.2	0	6.3	0	0	0
Above 3000	7.9	8.3	6.2	0	16.7	0	0	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

their maize with trailers for which they are charged while in most cases the other type farmers use family labor for transportation which do not enter into cash cost calculations. Between crops, gross receipts from late maize were lower than gross receipts from early maize for all type farmers. Over 50 percent of all the farmers obtained less than 500 shillings from growing late maize, Table 5.42.

Although tractor users secured greater gross receipts from early maize than non-tractor users, the net return per farmer or per acre was higher among non-users. The proportion of farmers that failed to break even was greater among tractor users than non-tractor users, Table 5.43. Only 14 percent of non-users incurred a loss in early maize growing as compared with 34 percent of individual users, 50 percent of group farmers and 35 percent of farm settlers. For late maize, the pattern was the same but the percentages of farmers that suffered loss rose compared with early maize, except for individual tractor users. A similar picture is indicated by Table 5.44. The receipts per shilling of cash expenses were smaller among tractor users than non-tractor users.

The lower level of net returns obtained by tractor users vis-a-vis non-users are due to the following factors (i) the tractor users incurred higher cash expenses, (ii) there was a high degree of untimeliness in tractor service so that a large percent of tractor users planted their crops late (see Chapter VIII), (iii) the drought problem of 1970 coupled with late planting of crops caused greater adverse financial effects on tractor users vis-a-vis non-users.

Notwithstanding the above financial picture, many farmers are still using the tractor service and it is expected that many more will use the service. A conclusive inference concerning the profitability

Table 5.42 GROSS RECEIPTS PER FARMER BY TYPE OF FARMER AND CROP
Early and Late Maize Growers, Western Nigeria, 1970

Grops receipts in shillings	Individual Users		Group Farmers		Farm Settlers		Non-users	
	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize
	Percent of Farmers							
Less than 500	35.1	52.7	56.1	70.0	20.8	68.9	58.7	67.9
500-1000	29.8	19.4	18.7	0	16.7	17.2	31.8	26.4
1000-1500	5.4	11.1	6.3	10.0	10.4	3.5	7.9	3.8
1501-2000	10.8	2.8	0	10.0	10.4	6.9	0	0
2001-2500	2.7	2.8	6.3	0	12.5	0	0	0
2501-3000	5.4	5.6	6.3	0	0	3.5	1.6	1.9
Above 3000	10.8	5.6	6.3	10.0	29.2	0	0	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.43 NET CASH RETURNS PER FARMER BY TYPE OF FARMER
Early and Late Maize Growers, Western Nigeria, 1970

Net cash returns in shillings	Individual Users		Group Farmers		Farm Settlers		Non-users	
	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize	Early Maize	Late Maize
	Percent of Farmers							
Less than 0	34.2	30.6	50.0	60.0	35.4	65.5	14.3	17.8
0-500	42.1	55.6	31.3	20.0	16.7	31.0	65.1	64.4
501-1000	13.2	2.8	0	0	16.7	3.5	19.1	13.4
1001-1500	5.3	5.5	0	20.0	14.5	0	0	2.2
1501-2000	2.6	0	12.5	0	10.4	0	0	0
Above 2000	2.6	5.5	6.2	0	6.3	0	1.5	2.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.44 RECEIPTS PER SHILLING OF EXPENSES BY TYPE OF FARMER AND CROP
Western Nigeria, 1970

Receipts per shilling of expenses	Early Maize				Late Maize			
	Individual Users	Group Users	Farm Settlers	Non-users	Individual Users	Group Users	Farm Settlers	Non users
	Percent							
Less than 1	34.2	56.3	37.5	22.0	30.6	60.0	65.4	16.3
1-1.5	23.6	25.0	33.3	20.3	30.6	20.0	20.7	24.5
1.6-2	13.2	6.2	12.5	15.3	11.1	20.0	6.9	16.3
2.1-2.5	10.5	0	16.7	13.6	8.3	0	3.5	12.2
2.6-3	5.3	0	0	6.8	5.5	0	3.5	0
Above 3	13.2	12.5	0	22.0	13.9	0	0	30.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

of the hire service to private farmers cannot be made from these results because:

(I) The study is based on cross-sectional data. Operating results for a period of years will have to be examined to see the trend in operating results.

(II) There was the drought problem in 1970, a natural factor beyond the control of farmers. This factor also beclouded the picture of the operating results.

(III) The study used the farmer and not the farm as a unit of analysis. Only crops for which tractor service was used were treated and among those the most important crop, maize, alone was finally analyzed. It is possible that the use of tractor service has increased the net income per farm, since the farmers grow a variety of other crops apart from maize. Net income from the farm as a whole might be the decision variable of the user rather than net income from a single enterprise.

The preceding analyses, for both early and late maize crops, were run using net return per farmer instead of net return per acre as the dependent variable. The results of tests and mean net returns are summarized in Tables 5.45 and 5.46 respectively.

Table 5.45 SUMMARIZED RESULTS OF TESTS
Tractor Use, Western Nigeria, 1970

	Net return per acre as dependent variable*		Net return per farmer as dependent variable*	
Specified factors	Early Maize	Late Maize	Early Maize	Late Maize
Number of operations mechanized (farm settlers)	_/	X	X	X
Number of operations mechanized (individual users)	X	X	X	_/
Location	_/	_/	_/	_/
Tractor user vis-a-vis non-user	X	X	X	X
Among tractor users	X	_/	X	X
Type of farmer (includes non-users)	X	_/	X	_/
Farm settlements	_/	X	_/	X

*X = Not significant at the 5 percent level.
_/ = Significant at the 5 percent level.

The Impact of Tractor Use on Farm Practices and Labor Inputs

The introduction of tractor use is expected, inter alia, to increase farmer involvement and integration into the wider economy. In

Table 5.46 MEAN NET RETURNS PER ACRE AND PER FARMER
Early and Late Maize Growers, Western Nigeria, 1970

Specified factors	Net Return per Acre		Net Return per Farmer	
	Early maize	Late maize	Early maize	Late maize
	Shillings			
Number of operations mechanized (individual users)				
One operation	75.6	109.1	146.0	202.9
Two operations	72.2	46.9	269.2	42.4
Complete operation	109.1	154.6	318.1	1227.3
Tractor user vis-a-vis non-user				
Tractor users	58.0	34.2	331.2	26.6
Non-tractor users	90.8	76.0	273.9	219.3
Type of tractor users				
Farm settlers	56.6	-20.4	514.1	-222.8
Group settlers	36.6	15.6	35.2	-116.9
Individual users	77.8	83.4	182.7	267.5
Location				
Oyo South	-0.05	-45.5	-211.4	-484.1
Oyo North	105.2	117.7	242.3	333.8
Oshun	79.8	3.8	673.7	-151.4
Settlement				
Oshun	37.3	0.48	381.9	-106.9
Ogbomosho	91.1	5.7	1030.5	-92.1
Ilora	-42.9	-174.9	-711.5	n.a.

particular, increased purchase of factor inputs produced outside the farm is expected in this process of greater involvement and integration. At the same time, the level of technology and modernization is expected to be improved. The technological variable is usually seen along two lines:

(I) It is reflected in the implements used in production such as hoe, cutlass, plow, tractor.

(II) It is also reflected in the farm practices used. It is this second part that is examined here. The degree of input commercialization was examined by type of farmer and crops. The distribution of farmers by fertilizer use is presented in Table 5.47.

Table 5.47 FERTILIZER APPLICATION BY TYPE OF FARMER
Western Nigeria, 1970

Type of farmer	Type of Crop	
	Early Maize	Late Maize
	Percent	
Group tractor users	73.7	61.1
Settler users	90.6	91.5
Individual users	75.0	66.7
Non-users	38.3	32.8

A greater percent of all tractor service users used fertilizer than the non-users for both early and late maize. The use of tractor service has provided an encouragement for increased commercialization of input in respect of fertilizer.

The farm settlers have by far, accepted the use of fertilizer than other type farmers. Notice, too, the fall in fertilizer use for

late maize vis-a-vis early maize. Among all farmers, except the settlers, the percentage of farmers that applied fertilizer to late maize fell.

Similar information is presented in Table 5.48 for seeds.

Table 5.48 SEED PURCHASE BY TYPE OF FARMER
Western Nigeria, 1970

Type of farmer	Type of Crop	
	Early maize	Late maize
	Percent	
Group tractor users	68.5	44.4
Settler users	71.7	37.5
Individual users	66.7	50.0
Non-users	41.7	34.4

For all type farmers, the percent that purchased seed for early maize is greater than the percent that purchased seed for late maize. A smaller percent of non-users purchased seeds for both crops. The proportion of farmers that purchased fertilizer and seed was higher among users than non-users. Also, the proportion of farmers that purchased these inputs is higher for early maize than for late maize.

Some of the reasons given by farmers who did not use fertilizer include:

(I) Land is virgin and needs no fertilizer.

(II) Fertilizer is not available when wanted.

(III) Drought set in early and therefore refused to maintain the farm any further.

(IV) There is no cash to buy fertilizer.

(V) Did not know about fertilizer. This response was received from among the non-tractor users.

The level of technology in respect of crop varieties planted was also examined. This is presented in Table 5.49.

Table 5.49 THE GROWING OF IMPROVED VARIETY OF CROPS BY TYPE OF FARMER
Western Nigeria, 1970

Type of farmer*	Type of Crop			
	Early maize	Late maize	Cotton	Rice
	Percent			
Group tractor users	55.6	35.3	100.0	100.0
Individual users	43.3	40.5	75.0	100.0
Non-users	16.0	16.7	91.9	0

*Excludes farm settlers. All of them grew the improved maize variety

Rice and cotton farmers grow the improved variety. For maize, a greater percent of the tractor users grew improved variety than non-tractor users.

Mixed Cropping

This is a practice among peasant farmers whereby more than one crop is raised on the same plot of land. Farmers mix crop because:

(I) It is a kind of insurance. If one crop fails, the other may do well.

(II) To get the most out of the inputs that went into the land preparation, particularly where stumping and clearing are involved.

(III) Inability to prepare more land to allow separation of the crops, particularly if further uprooting of trees is required.

(IV) Separation of the crops means increased maintenance work, particularly weeding. For instance, if late maize is mixed with cassava, a usual practice, the farmer weeds for cassava as he weeds for maize. If both crops were separated, he will have to weed two separate farms. The price the farmer pays for mixed cropping is lower yields for each crop but combined yield per acre might be higher

Table 5.50 gives the picture of mixed cropping by farmers.

Table 5.50 THE PRACTICE OF MIXED CROPPING BY TYPE OF FARMER Western Nigeria, 1970

Type of farmer	Type of Crop	
	Early maize	Late maize
	Percent	
Group tractor users	13.3	6.7
Settler users	4.0	6.0
Individual users	6.3	9.5
Non-users	22.8	28.1

There is a higher percentage of farmers who practiced mixed cropping among non-tractor users than among the tra users. The problem of stumping is the principal cause of mixed cropping among the users. Between the two crops, there is a higher percentage of farmers that practiced mixed cropping for late maize than for early maize.

Labor-Saving Technology

Tractor technology is a labor-saving technology. The unemployment and social problems that go with its introduction have been the leading factors used against farm mechanization, particularly in the labor rich, capital poor countries. The level of mechanization is inversely proportional to manual labor outlays.

Only one operation, the land preparation, is mechanized. The impact of tractor use on labor inputs is examined only at this micro level. For this purpose, land preparation is regarded as the sum total of those operations that are performed to bring the land into the required condition for seeding. These operations are different depending on whether a farmer will make use of the tractor or not.

Tractor users employ both labor and machine time for land preparation operations. The farmer uses labor to bring the field into an acceptable, mechanizable condition. This operation requires a substantial labor input. After the farm is in a mechanizable condition, he employs tractor to do ploughing, harrowing and ridging. While the use of tractor may reduce labor inputs after the field is brought to mechanizable state, the need to use tractor increases labor input to bring the land into a mechanizable state. The net effect on labor will depend on the reduction in labor time due to tractor use in relation to the increase in labor time. If the reduction in time is greater than the increase in time, there will be net savings in time due to the use of tractor.

The following assumptions are made:

(I) There is no clearing of tall grasses before ploughing. This is a common practice among farmers.

(II) The average conditions for Oyo Division are used. That is, a predominantly grass land area with dotted trees.

(III) The farmer did a complete operation--plough, harrow and ridge.

(IV) An eight-hour working day is used.

If the farmer wants to use tractor, he will have to do stumping operation and clear the trees and roots. If he is not going to use tractor, he needs not stump his farm. Operations he will perform are:

(I) Cutlass the bush.

(II) Burn and clear the debris.

Operation	Average man days per acre
1. Stump to use tractor	6.5
2. Cutlass, burn and clear (not going to use tractor)	5.75
3. Increase in time	0.75

If he is not going to use tractor, the next operation before planting is ridging. On the other hand, if he will use tractor service after stumping his land, the operations he will do are:

(I) Plough

(II) Harrow

(III) Ridge

Operation	Average man days per acre
1. Plough, harrow and ridge (will use tractor)	0.480
2. Ridge (will not use tractor)	6
3. Reduction in time	5.52

The increase due to the use of tractor is 0.75 man days per acre. But the reduction in time due to tractor use is 5.52 man days per acre. The net savings in time is at least 4.77 man days per acre. This represents a significant savings in time. If working time per day is eight hours and tractor charges per acre is 82.5 shillings, the cost of time released to the farmer is at least 2.2 shillings per hour. But the problem the farmer has to face to enjoy such savings is how to get labor to do the initial stumping, a pre-condition for tractor use.

A related question is what the farmer does with the time saved by hiring tractor services. Among those who engaged in other activities, petty trading seems to be more important, Table 5.51.

Petty trading and carpentry are the principal extra activities in which the farmers engage. Most of the farmers go into activities not related to intensification and expansion of agricultural operation. Only 12 percent expand into livestock farming. This suggests a strong tendency for displacement from agriculture to non-agricultural occupation.

Tractor users were also asked what they were doing when the tractor is ploughing for them. The farmers are generally present with the tractor operation. In case of group farmers, a delegation is usually sent with the tractor operator. The classification of response is shown in Table 5.52.

Table 5.51 DISTRIBUTION OF FARMERS BY EXTRA ACTIVITIES MENTIONED
Tractor Users, Western Nigeria, 1970

Extra activity	Percent of farmers
Tailoring	12.5
Construction	12.5
Carpentry	18.7
Corn milling	6.2
Bakery	6.2
Raising pigs	12.5
Petty trading	31.2

Table 5.52 DISTRIBUTION OF FARMERS BY WHAT THEY ARE DOING AT PLOUGHING TIME
Tractor Users, Western Nigeria, 1970

What the farmer is doing	Percent of farmers
Doing nothing, but looks on at the operation which to me appears mysterious	1.8
Doing some other work on the farm, such as weeding	1.8
Busy plastering a house in the town	1.8
Removing the weeds.	1.8
Present to help remove obstructions such as stones and stumps on the path of the tractor and to help if the tractor gets stuck.	92.4

CHAPTER VI

BUDGETING AND FARM ADJUSTMENTS

Budgeting technique has been used as a tool of analysis in farm management for many years. There are two classes of budgets--partial and complete budgets. Both are forward looking, used to examine the profitability of proposed changes on paper before money is committed to the change. Partial budget deals with part and not all the costs and returns. It lists only those costs and those returns which would actually be affected by a change or adopting a practice. It is, thus, commonly employed on problems associated with specific operational problems which affect only a segment of the total business. In contrast, complete budget lists all costs and all returns. This type of budget is used in a situation where a contemplated adjustment affects all or nearly all inputs and outputs.

The first step is to select the alternatives for which budgets should be constructed. Figure 6.1 shows the identified alternative operational procedures for tractor hirers.

Branches	Flows
1. A-B	Initial stumping of field
2. B-C	Clearing of stumped trees
3. C-D	Clear grass before ploughing
4. C-E	Ploughing

5.	D-E	Ploughing
6.	E-F	Harrowing
7.	E-G	Ridging
8.	E-H	Harrowing
9.	G-I	Planting (with hand)
10.	H-I	Planting (with machine)
11.	F-G	Ridging

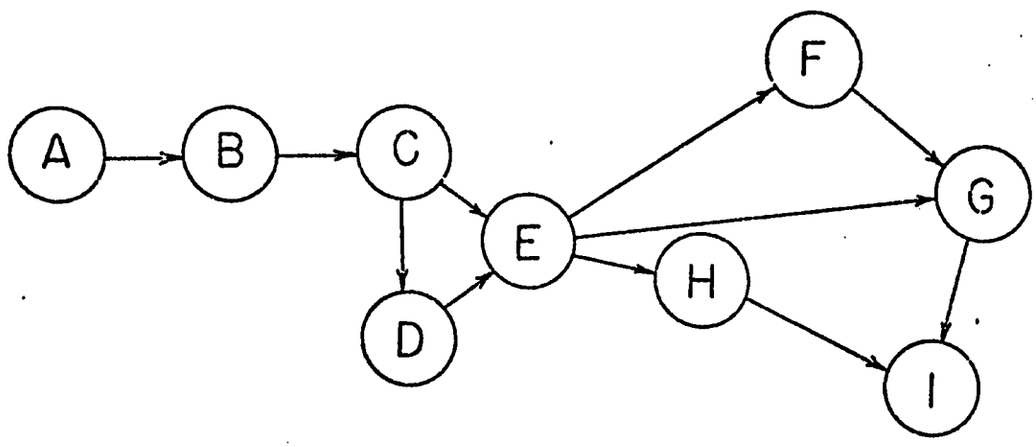
The farmer has options at two points. At C, he has to decide whether to go straight to E or to go to E via D. Secondly, at E, there are three alternatives open to him. He has to decide what combination of operations he has to do after ploughing before getting to the stage of planting his crops.

Nine alternative farm practices are synthesized in all. These are:

(I) A → B → C → E → F → G → I

(II) A → B → C → D → E → F → G → I

FIGURE 6.1 SYSTEM FLOW PLAN FOR TRACTOR HIRE USERS



(III) A → B → C → E → G → I

(IV) A → B → C → E → H → I

(V) A → B → C → D → E → G → I

(VI) A → B → C → D → E → H → I

(VII) Trade harrowing for double ploughing

(VIII) Trade harrowing for fertilizing

(IX) Add tractor hire service.

For each event (A to I), activities leading into it should be completed before activities leading out from it are started. These events are, therefore, sequential. The budgeting technique is employed to examine the profitability of the alternative operational procedures open to the tractor user. It is assumed that:

(I) The omission of harrowing operation causes a 2.5 percent reduction in yield.

(II) Failure to clear tall grasses before ploughing operation starts causes a reduction of one percent in yield.

(III) Tractor service is on time.

The prices and yields used in the budgets are shown in Table 6.1.

Hand Planting With Omission of Clearing Before Ploughing

Should a farmer trade grass clearing before ploughing for hand planting? The partial budget of this operational procedure is shown in Table 6.2.

This operational procedure causes a small reduction in net income per acre. A comparison of this practice with practice three indicates the rôle of harrowing operation. The introduction of

Table 6.1 REQUIRED MAN-DAYS PER ACRE FOR GROWING MAIZE[a]
Budgeted Data, Western Nigeria, 1970

Type of operation	Average man-days per acre	Daily wage in shillings[b]
Hand planting	2	3.5
Weeding	4	5.0
Fertilizing	2	3.5
Clearing, burning and packing	5.75	5.0
Grass clearing	2.5	3.5
Ridging	6	5.0

[a]Maize price of 0.33 shillings/lb and yield of 800 lbs per acre are used.

[b]Prices of mechanically performed operations and different types of fertilizer are contained in Appendix Tables A-1 and A-3.

Table 6.2 CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HAND PLANTING FOR GRASS CLEARING
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Cost of hand planting.		
Reduced Receipts		
Omission of grass clearing (1% of yield)	2.64	
Total added costs and reduced receipts		9.64
Added Receipts	--	
Reduced Costs		
Cost of grass clearing	8.75	
Total added receipts and reduced costs		8.75
Loss in Net Income		-0.89

harrowing operation turns a net gain in income of 10.01 shillings to a loss of 0.89 shillings in net income.

The sensitivity of the budget is tested by varying the assumptions on price and production. Daily wage rate for planting was first decreased by 0.5 shillings and then increased by 0.5 shillings. The loss in yield due to omission of grass clearing was first decreased by 0.5 percent and then increased by 0.5 percent. The results are shown in Table 6.3

Table 6.3 SENSITIVITY OF CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HAND PLANTING FOR GRASS CLEARING
Budgeted Data, Western Nigeria, 1970

Wage rate in shillings	Yield loss in percent	Change in net income in shillings
3	1	0.11
4	1	-1.89
3.5	0.5	0.43
3.5	1.5	-2.21

Clear Tall Grasses Before Ploughing and Hand Plant

Should a farmer combine both hand planting and clearing of grasses before ploughing? The result of the budgeting is indicated by Table 6.4

The combination of the two practices led to a high loss in net income.

Table 6.4 CHANGE IN NET INCOME FROM GROWING MAIZE BY CLEARING GRASS AND PLANTING WITH HAND
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Clearing of grass	8.75	
Planting with hand	7.00	
Reduced Receipts	--	
Total added costs and reduced receipts		15.75
Added Receipts		
Clearing of grass (1% of yield)	2.64	
Reduced Costs	--	
Total added receipts and reduced costs		2.64
Lost in Net Income		-13.11

Omit Harrowing And Clearing of Tall Grasses Before Ploughing Plus Hand Planting

Should a farmer trade harrowing and clearing of grass for hand planting? The result of the budget for this operational procedure is shown in Table 6.5

This is a profitable operational procedure. It is due to the reduced cost of harrowing relative to the loss caused by its omission. The reduced cost is far greater than the lost revenue. This is the benefit farmers want to enjoy when many of them adopted the practice of skipping the harrowing operation.

Table 6.5 CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HARROWING AND GRASS CLEARING FOR HAND PLANTING
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Planting with hand	7	
Reduced Receipts		
Omission of harrowing (2.5% of yield)	6.6	
Omission of grass clearing (1% of yield)	2.64	
Total added costs and reduced receipts		16.24
Added Receipts	--	
Reduced Costs		
Harrowing (Government rate)	17.5	
Grass clearing	8.75	
Total added costs and reduced costs		26.25
Change in Net Income		10.01

The sensitivity of the above results was tested for different values of product price, yield loss and rates of production. The result is shown in Table 6.6.

Change in net income is most sensitive to changes in product price and yield. It can be profitable to omit the harrowing operation if yields and/or product price are low. But otherwise, it may be costly to omit the harrowing operation. The influence of omission of grass clearing before ploughing depends on the size of the grasses. If the grasses are not full grown, perhaps the farmer can omit this operation

Table 6.6 SENSITIVITY OF CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HARROWING AND GRASS CLEARING FOR HAND PLANTING
Budgeted Data, Western Nigeria, 1970

Wage rate in shillings	Yield loss in percent (harrowing)	Yield in lbs. per acre	Maize price per lbs. (shillings)	Change in net income (shillings)
3	2.5	800	0.33	11.02
4	2.5	800	0.33	9.01
3.5	2.5	800	0.25	12.25
3.5	2.5	800	0.42	7.49
3.5	2.5	700	0.33	11.16
3.5	2.5	900	0.33	8.85
3.5	2.0	800	0.33	11.33
3.5	3.0	800	0.33	8.69

without damage. But it is usual to find the tractors ploughing inside very tall grasses. In such cases, the omission of this operation will:

(I) Delay the decay of the trash.

(II) Not allow complete soil inversion.

(III) Delay harrowing operation while waiting for the trash to decay or if done early, will not be thorough.

Omit Grass Clearing and Ridging Operations

Should a farmer plant on the flat, whether with hand or with machine? Planting on the flat is not a common operational procedure. It is only common on Government stations and on farm settlements. The result of the budget is shown in Table 6.7

Table 6.7 CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING GRASS CLEARING FOR PLANTING ON THE FLAT
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Planting (Government rate)	20.0	
Reduced Receipts		
Omission of grass clearing (1% of yield)	2.64	
Total added costs and reduced receipts		22.64
Added Receipts	--	
Reduced Costs		
Grass clearing	8.75	
Machine ridging (Government rate)	20.00	
Total added receipts and reduced costs		28.75
Change in Net Income		6.11

There is a gain in net income. The reduced cost from omission of grass clearing is greater than the lost revenue. A variation of this practice is to plant with hand on the flat. If this is done, there will be a gain of 19.11 shillings in net income. The added cost of hand planting is smaller than reduced cost of tractor planting.

The problems of planting on the flat include:

(I) Shortage of planters. For instance, there were only two planters in Oyo South Division and the two have broken down with no spare parts to repair them.

(II) Tractors and operators are not enough to cope with the increasing number of farmers who want service. In such circumstances, farmers decide it is better to ridge and plant with hand.

(III) Hand weeding is easier when planting is done on ridges than on the flat.

(IV) Since harrowing operation is uncertain and may be completely omitted, ridging allows some of the weeds to be covered up.

Clear Grass, Omit Harrowing and Plant with Hand

Should a farmer trade harrowing operation for clearing grass before ploughing? The result of budget for this operational procedure is shown in Table 6.8.

The introduction of grass clearing before ploughing operation turns a gain in net income of 10.01 to a loss in net income of 2.21. The loss in net income from introducing harrowing operation is less than the loss generated by introducing grass clearing before ploughing.

Should a farmer trade harrowing operation for ploughing? Instead of harrowing, double ploughing is done. This practice allows greater inversion of the soil and weed infestation is considerably reduced. It is assumed that because of the double ploughing, at least one weeding is eliminated. The result of the budget is shown in Table 6.9.

A variation of the above farm practice is to double plough because harrowing was not done on time. This costs the farmer a loss of 45 shillings in net return. This is a greater loss than the

Table 6.8 CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HARROWING FOR GRASS CLEARING
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Grass clearing	8.75	
Planting with hand	7.0	
Reduced Receipts		
Omission of harrowing (2.5% of yield)	6.6	
Total added costs and reduced receipts		22.35
Added Receipts		
Clear tall grass (1% of yield)	2.64	
Reduced Costs		
Harrowing (Government rate)	17.5	
Total added receipts and reduced costs		20.14
Change in Net Income		-2.21

Table 6.9 CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HARROWING FOR DOUBLE PLOUGHING
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Ploughing (Government rate)	45	
Reduced Receipts	--	
Total added costs and reduced receipts		45
Added Receipts	--	
Reduced Costs		
Weeding	20	
Harrowing (Government rate)	17.50	
Total added receipts and reduced costs		37.50
Change in Net Income		-7.50

situation above, yet this is the more common cause of double ploughing. Late harrowing is, in most cases, due to breakdown of the harrow.

Should a farmer fertilize instead of harrowing? Under ideal conditions, there is no choice between the two. But because cash is a serious limiting factor for the farmer, he often ponders on this question and some do trade one for the other. The result of the budget to test the profitability of this operational procedure is shown in Table 6.10

The sensitivity of the above result was tested by varying the product price, fertilizer type and production coefficient. The result is shown in Table 6.11.

Table 6.10 CHANGE IN NET INCOME FROM MAIZE GROWING BY TRADING HARROWING FOR FERTILIZING
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Fertilizer (sulphate at 1 bag/acre)	15.67	
Application	7.00	
Reduced Receipts		
Omission of harrowing (2.5% of yield)	6.6	
Total added costs and reduced receipts		29.27
Added Receipts		
Contribution of fertilizer to yield (on basis of assumed 0.5 coefficient)	18.67	
Reduced Costs		
Harrowing (Government rate)	17.5	
Total added receipts and reduced costs		36.17
Change in Net Income		6.90

Table 6.11 SENSITIVITY OF CHANGE IN NET INCOME FROM GROWING MAIZE BY TRADING HARROWING FOR FERTILIZING
Budgeted Data, Western Nigeria, 1970

Fertilizer Type	Input-output coefficient	Maize price in shillings per lb.	Change in net income in shillings
15-15-15	0.5	0.33	-0.43
25-10-0	0.5	0.33	1.82
Sulphate	0.3	0.33	-0.68
Sulphate	0.7	0.33	14.10
Sulphate	0.5	0.25	2.23
Sulphate	0.5	0.42	11.75

Change in net income is highly sensitive to fertilizer price and input-output coefficient. The operational procedure will be more profitable the lower is fertilizer price and/or the higher is the maize response to fertilizer applications.

Comparison of Alternative Operational Procedures for Tractor Hires

Budgets illustrating changes in net income for alternative operational procedures have been presented. These alternatives are ranked on the basis of relative profitability, Table 6.12.

These budgets indicate that it profits the farmers to skip harrowing operation and/or grass clearing before ploughing. The harrowing omitted can be replaced by fertilizing his farm with profit.

The analysis has so far dealt with alternative practices open to tractor users. But while the number of farmers using the hire service has been increasing, there are still many farmers, in fact

Table 6.12 COMPARISON OF CHANGES IN NET INCOME FOR ALTERNATIVE OPERATIONAL PROCEDURES AMONG TRACTOR USERS
Budgeted Data, Western Nigeria, 1970

Operational procedure	Change in net income (shillings)	Rank
1. Hand planting with omission of grass clearing	-0.8	4
2. Hand planting with clearing of grasses	-13.1	7
3. Omit harrowing and clearing of grass and hand plant	10.0	1
4. Omit grass clearing and plant on the flat	6.1	3
5. Clear grass, omit harrowing and hand plant	-2.2	5
6. Double plough instead of harrowing	-7.5	6
7. Fertilize instead of harrowing	6.9	2

still a majority, who are still sitting on the fence. The basic question is: should a farmer add the use of tractor hire to his package of farm practices?

A budget is prepared to examine this question. The assumptions used in addition to price and production assumptions specified earlier are:

(I) Hiring service ends after the ridging operation.

(II) The farmer does not clear grasses before ploughing.

(III) Ridges call for greater quantity of seeds than heaps.

(IV) There is an increase in yield attributable to the use of machine services.

(V) Complete operation is done.

The result of the budget is shown in Table 6.13. Stumping cost is 59 percent of added costs in the first year. Assuming stumping cost is zero in the second year,[1] the loss in net income will reduce to 19.92 shillings.

Table 6.13 CHANGE IN NET INCOME FROM GROWING MAIZE BY ADDITION OF TRACTOR HIRE TO FARM PRACTICE
Budgeted Data, Western Nigeria, 1970

Change in costs and returns	Shillings per acre	
Added Costs		
Stumping and clearing (Government rate)	120	
Machine hire (complete operation)	82.5	
Seeds (25% increase)[a]	1.50	
Reduced Receipts	---	
Total added costs and reduced receipts		204
Added Receipts		
Yield (2% increase)	5.33	
Reduced Costs		
Clearing, burning and packing	28.75	
Ridging	30	
Total added receipts and reduced costs		64.08
Change in Net Income		-139.92

[a]Assumes 24 lbs/acre at 3 pence/lb.

This result indicates that the tractor hire costs (the added costs) are very high relative to costs eliminated when mahine hire is added to

[1]Stumping cost can be regarded as an investment, an addition to capital stock, since after the initial stumping the land is available for use many years after that.

farm practices. There are three areas of attack:

(I) The stumping cost.

(II) The hire cost.

(III) Rates of production.

With stumping cost at zero level, yield will have to increase by at least 9.6 percent or tractor hire costs reduced by at least 24.2 percent for the change in net income to be positive.

Three alternative approaches to the problem of stumping are:

(I) Government to bring in heavy equipment to stump the land for farmers and subsidize the charges. The problem with this approach is the lost top soil. If stumping is mechanized, ways of reducing damage to top soil have to be deviced.

(II) The farmer to do the stumping with hired labor but Government to help pay part of the labor expenses (this was done for Eleruwa Young Farmers' Club at Ogbomosho). The problem with this approach is that apart from expenses, hired labor is usually not prepared to do stumping work. They prefer weeding and ridging operations. The wage rate will have to be very high to induce laborers to do stumping work.

(III) Farmers should not mechanize in the first year the land is opened up. It is felt that if a farm is tilled for about two years and then mechanized in the third year, the cost of stumping will be reduced and the possibilities of damage

to implements are also reduced. This approach will call for greater input of fertilizer since by the third year much of the mineral nutrients have been utilized by a hand tilled first and second year crop.

Size of Farm and Tractor Hire Service

It has been pointed out that three sources of low profit in tractor hire by peasant farmers are cost of initial stumping, cost of tractor hire and low yield. A fourth possible source is the size of business.

The modal size of business among users is three acres. A minimum of five acres is regarded the required size to justify the use of tractor hire service. What then, if any, is the impact of expanding size of business on net income? Will a five-acre farm pay? The problem is examined with the help of a budget. It is assumed that a stumped, cleared mechanizable land is made available to the farmer by gift.

The major items of variable costs are seeds, fertilizer, tractor service and labor. Labor is required for planting, fertilizing, thinning, weeding (2-3 times), harvesting and transporting. For these operations, the labor requirements have been variously estimated. According to Olayide and Ogunfowora (30) it averaged 19.25 man-days per acre while Oluwasanmi and Fayemi (31) estimates averaged 26 man-days.

The cash expenses are shown in Table 6.14.

Rate of production under peasant conditions is very low, even when weather is favorable. That much is generally agreed upon. But the actual figure has been variously estimated by different research workers. Various yield estimates are shown in Appendix Table A-9.

Table 6.14 CASH EXPENSES PER ACRE FOR GROWING MAIZE
Budgeted Data, Western Nigeria, 1970

Expense Item	Shillings per acre	
Post-ridging labor[a]	100	
Machine hire (complete operation)	82.5	
Fertilizer (sulphate)	15.67	
Seed[b]	6	
Total Cash Expenses		204.17

[a]20 man-days/acre at five shillings/day.
[b]24 lbs/acre at three pence/lb.

The modal yield per acre among farmers is three bags/ acre. At this yield level and price of 3.75 pence per pound, total receipts per acre is 208.3 shillings per acre. For a three-acre maize farm, total receipts is 624.96 shillings. The net return per acre for different fertilizer types is shown in Table 6.15.

Table 6.15 NET RETURN PER ACRE FROM GROWING MAIZE
Budgeted Data, Western Nigeria, 1970

	Fertilizer Types[a]		
Cost and returns	Sulphate of ammonia	25-10-0	15-15-15
	Shillings per acre		
Total cash costs	204.17	209.25	211.50
Total cash receipts	208.32	208.32	208.32
Net return	4.15	-0.93	-3.18

[a]Prices of the different fertilizer types are contained in Appendix Table A-3.

The sensitivity of the budget to tractor hire cost and yields was tested. The tractor hire cost was reduced by 9 percent and yield increased by the same percentage. The result is shown in Table 6.16.

Table 6.16 SENSITIVITY OF NET RETURN PER ACRE FROM GROWING MAIZE
Budgeted Data, Western Nigeria, 1970

Fertilizer types	Nine percent reduction in machine hire cost	Nine percent increase in maize yield
	Shillings per acre	
Sulphate of ammonia	12	22.89
25-10-0	6.57	17.81
15-15-15	4.32	15.56

A 9 percent increase in yield increases net return per acre more than the same percentage reduction in hire cost. To increase net return per acre to the same level, hire cost will have to be reduced by 23 percent, that is, to 63.7 shillings per acre. This indicates that there will be greater dividends to work on the low yield problem than on the high machine cost if the farmer wants to continue to use hire service to profit.

Should a three-acre farm be expanded to a five or more acre farm when:

(I) The additional acres are stumped free.

(II) No change in price relationships.

(III) Additional labor would be required.

(IV) Costs and yields would increase in direct proportion to

the number of acres. These include fertilizer cost, seed cost, machine hire cost and maize yields.

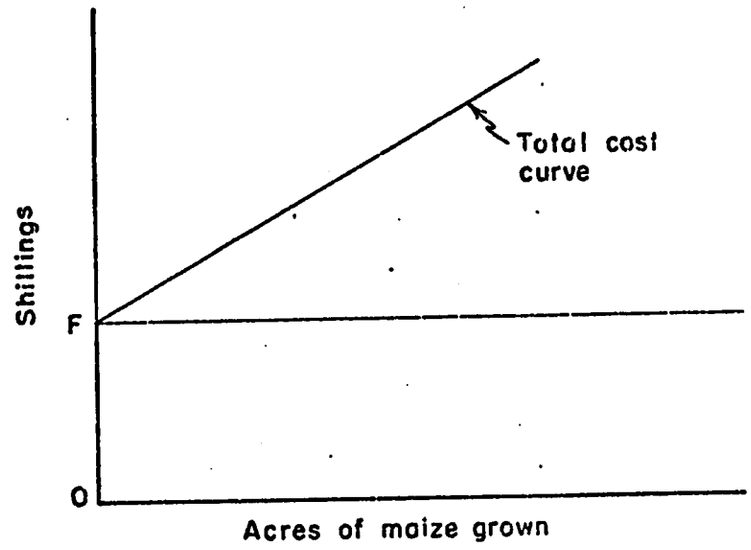
(V) The only possible cost item that might not increase in direct proportion to the number of acres is labor cost, if it is assumed that work is given to the laborers on a bulk rather than per acre basis. The savings here, if any, is going to be moderate.

The situation faced by the farmer is shown in Figure 6.2. Given that the farmer is faced with this type of total cost curve, profit will depend on the position of revenue curve. The revenue curve depends on yield and price. The farmer is a price taker. He is left to work on the yield variable if his total revenue curve is to be above the total cost curve. This analysis suggests two hypotheses:

(I) The salvation of a tractor hirer lies in using the modern, yield increasing technologies to boost his production if machine hire is to be used to profit.

(II) Expansion of size of his farm will make the farmer worse off except mechanization is carried a little further. According to the senior Agricultural Engineer, "many farms have failed because of lack of weeding services."

FIGURE 6.2 THE COST-SIZE RELATIONSHIP FACED BY TRACTOR HIRERS



CHAPTER VII

THE OUTPUT OF TRACTOR HIRE UNITS

Organization of Tractor Hire Units

As of 1971, there were 16 tractor hire units in Western Nigeria. The tractor hire units (THUs) are organized on the bases of pools, sub-pools and workshop group of pools. A pool is where there is an Agricultural Engineer and a sub-pool has no Agricultural Engineer. The activities of a sub-pool are co-ordinated by the Agricultural Engineer at the head of a pool. For instance, there is Akure pool and under it are Okitipupa, Ile-Oluji and Onisere sub-pools. The sub-pool is concerned with the jobs in its respective section. It can also move to other jobs in the pool area on completion of jobs in its section. But such across-the-board performance of jobs has been very infrequent.

Each pool or sub-pool works for three broad categories of people--the farm settlements, the agricultural officer (Extension Division) and private farmers. A THU may have one, two or all three categories of customers. For instance, Akure pool had no farm settlements and no private farmers. While Ondo sub-pool (Okitipupa, Ile-Oluji and Onisere) had no private farmers. The proportion of work done for these categories of customers varies from THU to THU.

Pools and sub-pools are organized around a workshop on a circle and semi-circle basis. All the pools and sub-pools in Oyo and Oshun

divisions are organized around Fashola workshop, all the pools and sub-pools in Ondo and Ekiti circles are organized around Akure workshop, all pools and sub-pools in Egba/Egbado/Ijebu circle are organized around Abeokuta workshop. Ibadan workshop acts as the State head-quarters and caters for Ibarapa and Ibadan Divisions.

Tractors and Suppliers

All tractors available are four-wheel riding tractors. There are three principal makes--Ford, David Brown (D.B.) and Massey-Ferguson (M.F.). Different types are also used, Table 7.1.

Table 7.1 MAKE AND TYPES OF AVAILABLE TRACTORS
Western Nigeria, 1970

Make	Types Available
Ford	3000, 4000
M.F.	35, 135, 165
D.B.	990 Selectmatic
	880 Implematic

Few of the 35 type M.F. tractors are now in use, having been replaced by the new 135 type. D.B. implematic has also been largely replaced by D.B. 990 selectmatic. This proliferation of tractors is a serious source of problem. It reduces output because of the limited substitutability between spare parts. The proliferation of implements is even greater than the proliferation among tractors, and there is almost zero substitutability between tractors and implements. For instance, when a Ford plough at Akoekuta THU was used on other tractors,

it weakened the hydraulic. Also, the only ridger available on the unit is meant for David Brown tractor. At Eruwa THU, 6 M.F. ploughs had no discs, but they are not interchangeable with D.B. ploughs. David Brown spare parts are different from Ford parts, and Ford parts are different from Massey-Ferguson parts. This means that there is no substitutability in spare parts for repair work and also it means that there is need to stock too many spare parts.

There are three different types of suppliers. J. Allen supplies Ford tractors, Leventis supplies David Brown tractors and BEWAC supplies Massey-Ferguson tractors.

Agricultural Engineers

There is a shortage of Agricultural Engineers in the Ministry. Only six of the 16 THUs have resident Engineers. In all, there are eight Agricultural Engineers, Table 7.2.

Table 7.2 AVAILABLE AGRICULTURAL ENGINEERS
Western Nigeria, 1970

Location	Number of Agricultural Engineers
Ibadan	2
Oyo	1
Oshogbo	1
Ilesha	1
Akure	1
Ado-Ekiti	1
Abeokuta	1
Total	8

In addition to the problem of a shortage of Agricultural Engineers, those available are engaged with administrative duties with little time left for research on equipment adaptation and analysis of tractor performance.

Oshun Division Hire Units

There are two hire units in Oshun Division--one at Oshogbo and one at Ogbomosho. Oshogbo THU serves Oshun South, Central and North East, while Ogbomosho serves Oshun North West. The principal crops dealt with by Oshogbo THU are maize, cotton and kenaf. Kenaf was grown by two part-time women farmers in Oshun Central. Ogbomosho THU dealt with maize, cotton, tobacco, cassava and kenaf.

The field work output for Ogbomosho hire unit is shown in Table 7.3 This table shows the heavy concentration of work on Ogbomosho farm settlement. Over 80 percent of the total field output was achieved on farm settlement alone.

Most of the transporting work was done on the farm settlement. Ninety-nine percent of the total 950 hours of transporting were on the farm settlement. On Oshogbo THU, work done for farm settlements was smaller than work done for private farmers except in ploughing operation, Table 7.4. More work was done for private farmers than in Ogbomosho hire unit. There was a greater concentration of work in Oshun South followed by Oshun Central. Oshun North East was the smallest area of field work concentration.

The seasonal work pattern for Oshogbo THU is shown in Table 7.5. There are two peak seasons--March/May and July/September. The first peak is higher than the second peak. Tractor utilization is heavy during the

Table 7.3 FIELD WORK OUTPUT
Ogbomosho Tractor Hire Unit,
Western Nigeria, 1970

Operation	Total acres	Ogbomosho farm settlement	Iresadu farm settlement	Private farmers
		Percent of Total Acres		
Ploughing	2988.7	91.4	6.6	2.0
Harrowing	986.0	88.3	6.0	5.7
Ridging	653.3	86.2	5.2	8.6
Planting	673.0	100.0	--	--

Table 7.4 FIELD WORK OUTPUT
Oshogbo Tractor Hire Unit,
Western Nigeria, 1970

Owner of work	Type of Operation		
	Ploughing	Harrowing	Ridging
		Acres	
Research division	522.5	320.5	370.5
Farm settlements*	481.5	93.5	72.5
Private farmers (Oshun South)	190.7	100.4	82.4
Private farmers (Oshun Central)	88.6	80.0	75.5
Private farmers (Oshun North East)	37.2	22.0	33.0
Extension work station	20.0	20.0	20.0

*Includes Oshun, Ede and Illa farm settlements.

Table 7.5 SEASONAL TRACTOR UTILIZATION
Oshogbo Tractor Hire Unit,
Western Nigeria, 1970

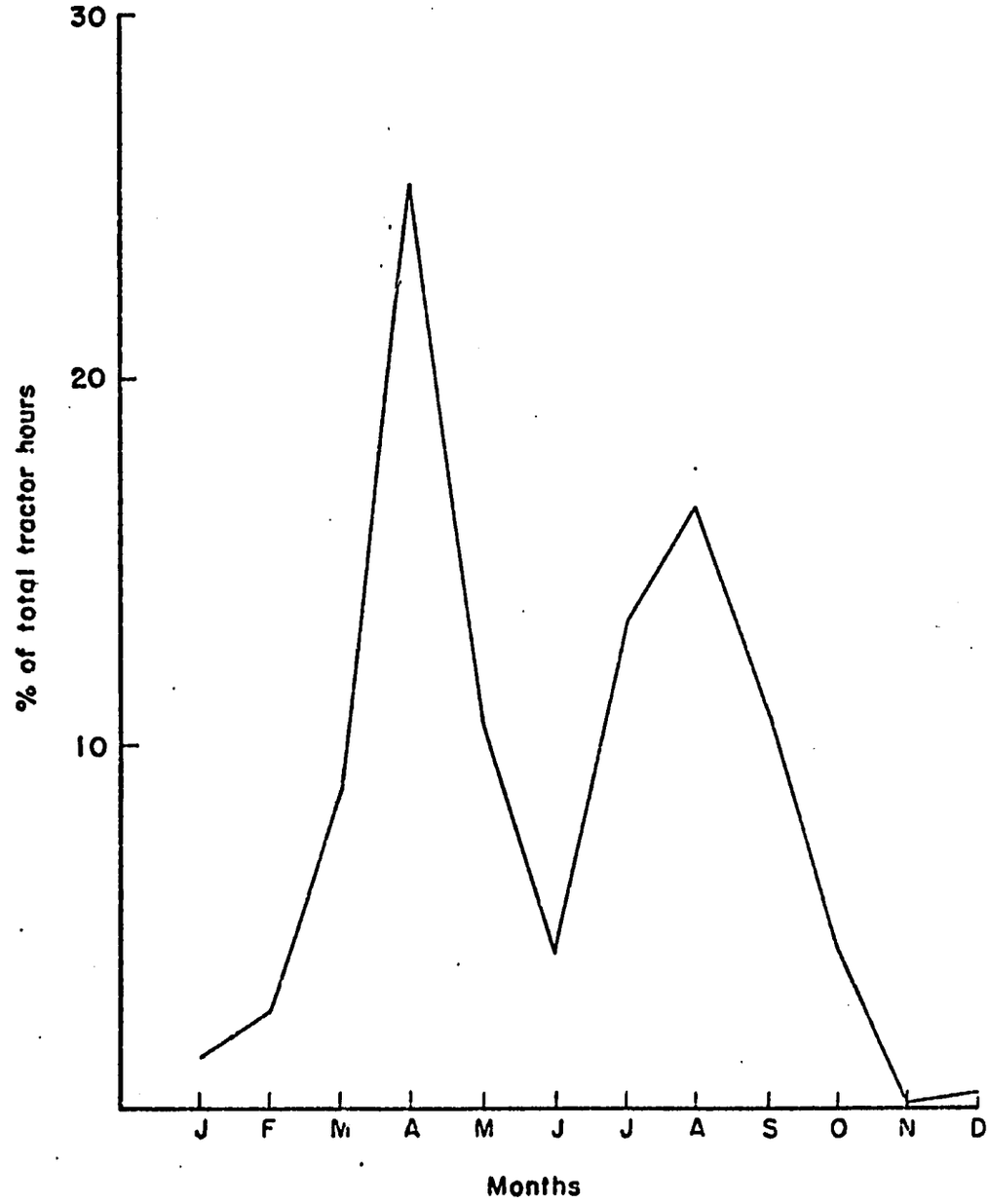
Months	Total hours	Type of Use	
		Transporting	Field work*
		Percent of Total Hours	
January	66.5	100.0	0
February	125	100.0	0
March	389.5	28.5	71.5
April	1180.2	29.1	70.9
May	485.0	45.6	54.4
June	220.8	78.8	21.2
July	640.5	50.9	49.1
August	751.6	50.0	50.0
September	516.9	34.2	65.8
October	207.6	71.7	28.3
November	13	100.0	0
December	14	100.0	0

*Ploughing, harrowing, ridging and planting.

early crop season and late crop season, Figure 7.1. The slack periods, October/February and June are used mostly for transporting

The total annual hours of tractor utilization were dominated by hours of field work. Hours of transporting were 45.4 percent of total hours against 54.5 percent for field work. Hours of transporting were low during the peak seasons and high during the slack periods. Distribution-free Speaman's rank correlation technique (32) was employed to examine the direction and degree of relationship between transporting and field work.

FIGURE 7.1 · SEASONAL USE OF TRACTORS, OSHOGBO THU



$$r_s = 1 - \frac{6\Sigma d_i^2}{n(n^2-1)}$$

where r_s = Speaman's rank correlation coefficient

d_i = differences between the ranks

Calculated $r_s = -0.9$. This indicates a high negative correlation between transporting and field work.

Output was 512.2 hours per tractor of Oshogbo THU. Table 7.6 shows the inability at Oshogbo hire unit to cope with the available volume of work.

Table 7.6 ACRES PLOUGHED IN RELATION TO ACRES PROPOSED
Oshogbo Hire Unit, Western Nigeria, 1970

Farmer	proposed	ploughed	Acres ploughed as percent of acres proposed
1	10	7.5	75
2	10	7.5	75
3	10	3	30
4	2	0	0
5	10	3	30
6	10	2.5	25

Potential output is therefore higher than realized output. This means that there were certain constraints on the THU which kept output low.

One reason for low output is the seasonal pattern of work requirements. Assuming 20 working days per month, Table 7.7 shows the structure of lost time.

Table 7.7 TIME LOST BY TRACTOR OPERATORS
Oshogbo Tractor Hire Unit, Western Nigeria, 1970

	Days Lost		Days Lost During Slack Period	
Tractor operator	Total	During slack period	Percent of total available*	Percent of total days lost
1	138	81	33.7	58.7
2	125	67	27.9	53.6
3	118	53	22.1	44.9
4	101	40	16.7	39.6

*Assumes 20 working days per month.

Days lost during the slack period averaged 25 percent of the total yearly working days while 49 percent of the total time lost occurred during the slack period. A large portion of time was lost because there was no work. But lack of work is inconsistent with ploughing less acres than farmers proposed. This indicates that during the normal work season, there were factors which held down the level of output. Table 7.8 gives an indication of these factors. This table shows that apart from seasonality of work, breakdowns and lack of fuel were important causes of low output.

Ondo Circle Tractor Hire Units

Ondo Circle consists of three Divisions--Ondo/Okitipupa Division, Ife/Ilesha Division and Akure Division--with headquarters at Akure. Ondo/Okitipupa is a sub-pool, directly run by the Akure pool. Ondo hire unit folded up at the end of the 1969/70 financial year

Table 7.8 CONSTRAINTS ON TRACTOR UTILIZATION
Oshogbo Tractor Hire Unit, Western Nigeria, 1970

Reason for idleness	Tractor Operators						
	I	II	III	IV	V	VI	VII
	Percent of Total Days Idle						
Breakdowns	1.4	1.7	15.3	17.2	20.0	0.0	0.0
No authorized job	87.7	77.6	82.2	76.3	30.8	97.8	94.6
No fuel	2.2	0.0	0.0	0.0	12.3	0.0	2.7
Other*	8.7	20.7	2.5	6.5	36.9	2.2	2.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Includes miscellaneous reasons such as:
(1) Public holiday
(2) Sickness
(3) Bad weather
(4) Tractor went for service
(5) Nobody to follow the operator to the farm
(6) On vacation

because of lack of mechanization activities. It is a predominantly cocoa growing area. The farm settlements in the Division, Ile-Oluji, Onisere and Okitipupa are also predominantly tree crop settlements.

In Ondo Circle, tractor output was generally low, ranging from 10.8 hours per tractor in Akure to 595.9 hours per tractor in Ondo/Okitipupa, Table 7.9. The highest output was achieved in Ondo sub-pool. The performance in Akure is too low. It indicates that this unit is simply a co-ordinating unit rather than being involved in any significant mechanization activities. In fact, the greater percent of the output achieved was from mowing activities, such as mowing high school and police compounds. The output of the unit would have been higher if,

Table 7.9 THE STRUCTURE OF OUTPUT
Ondo Circle Tractor Hire Units,
Western Nigeria, 1970

Tractor hire unit	Total hours	Hours of transporting (percent of total)	Hours per tractor
Ondo-Okitipupa	4169.1	92.9	595.5
Ilesha-Ife	1638.9	74.6	136.5
Akure	43.3	14.1	10.8
Circle Total	5851.3	87.3	

according to the Agricultural Engineer, the unit had more mowers. There was greater concentration of work load in Ondo sub-pool followed by Ilesha Tractor Hire Unit.

Transporting was the main activity of THUs in the Circle. Transporting constituted 93 percent and 75 percent of total output in Ondo/Okitipupa and Ife/Ilesha respectively. The amount of mechanization activities connected with growing of crops was almost nil. Transporting was 87 percent of total circle output.

The single most important constraint on output in Ondo sub-pool was the breakdown of tractors and implements. Other contributory factors however, included lack of supplies (fuel and engine oil) and lack of work, Table 7.10.

Ekiti Circle Tractor Hire Units

Ekiti Circle is made up of Ekiti, Akoko and Owo Divisions, with headquarters at Ado-Ekiti. There are two hire units--at Ado-Ekiti and Ikare. Ikare is a sub-pool to Ado-Ekiti pool. In the Circle, concentration of work was mostly in Ekiti and Akoko Divisions.

Table 7.10 CONSTRAINTS ON TRACTOR UTILIZATION
Ondo-Okitipupa, Western Nigeria, 1970

Reasons for idleness	Tractor Operators I	II	III	IV
	Percent of Total Days Idle			
Breakdowns	46.2	63.7	69.4	75.0
No authorized job	38.4	0	8.3	12.5
No engine oil	0	0	5.6	0
Other	15.4	36.3	16.7*	12.5

*Refused to work because, according to the operator, he had worked on Saturdays but had not been paid for it.

Transporting dominated the activities in the Circle. Transporting was 69.7 percent of the total output in the Circle. Output in Ekiti Division was 61.0 percent of total Circle output. At Ado-Ekiti THU, work concentration was on farm settlements, Table 7.11.

The work on farm settlements was over 70 percent of total THU output. Total output was also dominated by transporting in each Division. For all divisions, transporting was 75 percent of total output. Although more field work was done in Ekiti central than in other divisions, the tractors were used principally for transporting.

A low of 184.05 hours per tractor was achieved at Ado-Ekiti THU. The distribution of constraints on output among tractor operators is shown in Table 7.12. The most important factors are, as usual, equipment breakdowns, no work and lack of supplies. Note that the lack of fuel problem played a major role in Ado-Ekiti.

Table 7.11 THE STRUCTURE OF OUTPUT
Ado-Ekiti Tractor Hire Unit,
Western Nigeria, 1970

Division	Total hours	Hours of transporting (percent of total)
Farm settlements	2131.9	80.4
Ekiti Central	577.6	59.9
Other	235.3	61.0
Total	2944.8	

Table 7.12 CONSTRAINTS ON TRACTOR UTILIZATION
Ado-Ekiti Tractor Hire Unit,
Western Nigeria, 1970

Reasons for idleness	Tractor Operators			
	I	II	III	IV
	Percent of Total Days Idle			
Breakdowns	0	55.9	50.0	12.0
No authorized job	25.0	7.3	32.8	4.0
No fuel	7.5	11.8	13.8	36.0
Other*	67.5	25.0	3.4	48.0
Total	100.0	100.0	100.0	100.0

*Included public holiday, vacation, bad weather, tractor accident, exchange of tractor and sickness of operator.

Egba/Ijebu Circle Hire Units

Egba/Ijebu Circle consists of three divisions--Ijebu-Ode/Remo, Egbado and Egba. There are three hire units in the Circle--at Ikenne, Abeokuta and Ilaro. At Abeokuta unit, output was low and dominated by transporting, Table 7.13.

Table 7.13 THE STRUCTURE OF OUTPUT
Abeokuta Tractor Hire Unit,
Western Nigeria, 1970

Division	Total hours	Hours of transporting	Hours of field work
		Percent of Total Hours	
Extension (includes private farmers)	2043.7	65.3	34.7
Farm settlements	1523.8	63.0	37.0
Odeda Farm Institute	833.8	74.3	25.7

Work was concentrated on farm settlements and Extension Divisions. Transporting was 66.2 percent of total output in the Unit. Work on Odeda Farm Institute was low in respect of both field work and transporting. A low of 400.11 hours/tractor was achieved during the year.

At Ilaro hire unit, work was mostly concentrated on farm settlements. Work done for private farmers was the smallest, Table 7.14. Most of the private farmers in Egbado Division were group farmers. In addition to the problems of group farms,[1] there was only one tractor and one operator allocated to private farmers. At the time of the author's visit, the only available tractor operator was being withdrawn to the farm settlement.

Transporting was 61.7 percent of total output. The private farmers did the smallest amount of transporting. A low of 220.77 hours/tractor was achieved in the unit. Table 7.15 shows the constraints on output. Work output was low due to equipment breakdowns and seasonality

[1]These problems are discussed in Chapter IV.

Table 7.14 THE STRUCTURE OF OUTPUT
Ilaro Tractor Hire Unit,
Western Nigeria, 1970

Division	Total hours	Hours of transporting	Hours of field work
		Percent of Total Hours	
Farm settlements	1585.1	65.8	34.2
Extension	364.6	84.0	16.0
Private farmers	258.2	5.7	94.3

Table 7.15 CONSTRAINTS ON TRACTOR UTILIZATION
Ilaro Tractor Hire Unit, Western Nigeria, 1970

Reasons for idleness	Tractor Operators				
	I	II	III	IV	V
	Percent of Total Days Idle				
Breakdowns	61.1	47.8	74.5	26.6	22.2
No authorized job	0	0	6.4	59.2	66.7
No fuel	0	0	0	14.2	0
Other	38.9	52.2	19.1	0	11.1
Total	100.0	100.0	100.0	100.0	100.0

of work. There was also a moderate contribution from fuel supply problem.

In Ijebu-Ode Division, work was concentrated on farm settlements--Ago-Iwoye and Ibiade farm settlements. Transporting was also the principal activity of the engineering branch, Table 7.15. Transporting was 89 percent of total output in the Division. The Extension Division did more field work than the farm settlements. Hours per tractor was 838.40, the highest in the Circle.

Table 7.16 THE STRUCTURE OF OUTPUT
Ijebu-Ode Division,
Western Nigeria, 1970

Division	Total hours	Type of Tractor Use	
		Transporting	Field work
		Percent of Total Hours	
Farm settlements	1913.9	93.3	6.7
Extension	601.3	76.4	23.6
Total	2515.2		

In Remo Division, work was concentrated on the rubber plantation and the Dairy Herd Multiplication Centre (D.H.M.C.). Thirty-six and 32 percent of total output was achieved on the rubber plantation and the Dairy Herd Multiplication Centre respectively. The Government Crop Research Station was the third largest area of work concentration, Table 7.17.

Transporting was the main activity of the Tractor Hire Unit in the Division. Transporting was 70 percent of total output. The rubber plantation did more transporting than other areas in the Division. Tractors were used, principally, to transport rubber latex. The largest amount of field work was achieved on Government Research Stations.

The overall output was 528.31 hours per tractor, the second largest output in the Circle. Equipment breakdowns was the most important single constraint on output, Table 7.18.

Table 7.19 puts together the salient features of output for selected areas. The use of tractors for growing crops is heaviest in Oyo Divisions of the State, followed by Oshun Divisions. Away from

Table 7.17 THE STRUCTURE OF OUTPUT
Ikenne Tractor Hire Unit,
Western Nigeria, 1970

Division	Total hours	Type of Tractor Use	
		Transporting	Field work
		Percent of Total Hours	
Rubber plantation	1317.6	98.7	1.3
Dairy Herd Multiplication Centre	1166.2	91.2	8.8
Crop research	918.9	15.8	84.2
Farm settlements	203.9	25.3	74.7
Extension	91.6	19.6	80.4
Total	3698.2		

Table 7.18 CONSTRAINTS ON TRACTOR UTILIZATION
Ikenne Tractor Hire Unit, Western Nigeria, 1970

Reasons for idleness	Tractor Operators			
	I	II	III	IV
	Percent of Total Days Idle			
Breakdowns	39.3	80.8	39.5	100.0
No authorized job	24.5	5.1	21.0	0
No fuel	17.6	0	0	0
Other	18.6	14.1	39.5	0
Total	100.0	100.0	100.0	100.0

these areas, the use of tractors for transporting predominates. This work pattern is highly correlated with the vegetation pattern and types of crops grown in the State. The less forested, predominantly food crop growing areas show low transporting and high field work. The opposite holds in the more forested, predominantly tree crop areas.

Table 7.19 TYPE AND OUTPUT OF TRACTOR HIRE UNITS
Selected Units, Western Nigeria, 1970

Area and tractor hire unit	Total hours	Hours per tractor	Type of Tractor Use	
			Transporting	Field work
			Percent of Total Hours	
Oshogbo Hire Unit	4610.6	512.3	45.5	54.5
Abeokuta Hire Unit	4401.3	400.1	66.2	33.8
Ondo/Okitipupa	4169.1	595.6	92.9	7.1
Ikenne Hire Unit	3698.2	528.3	69.8	30.2
Ado-Ekiti Hire Unit	2944.8	184.1	74.8	25.2
Ijebu-Ode Division	2515.2	838.4	89.2	10.8
Ilaro Hire Unit	2189.9	220.7	61.7	38.3
Ilesha Hire Unit	1638.9	136.5	74.7	25.3
Akure Hire Unit	43.3	10.8	14.1	85.9[a]
Oyo Division Hire Units	N.A.	535.0[b]	25.3[b]	74.7

[a]Spent on mowing of compounds.

[b]Source: M. J. Purvis, "A Study of the Economics of Tractor Use in Oyo Divisions of the Western State." C.S.N.R.D., Sept. 17, 1968.

The pattern of work concentration within circle, division or hire unit depends on the availability of work on government farms and/or farm settlements. In general, work for private farms is virtually nil in all circles except Ibadan/Oyo Circle, Table 7.20.

Table 7.21 puts together the salient factors that held down tractor utilization. With the exception of Oshogbo hire unit, this table indicates that the largest proportion of idle time resulted from equipment breakdowns. This is followed by the seasonality of work.

Table 7.20 THE STRUCTURE OF OUTPUT WITHIN HIRE UNITS BY OWNER OF WORK
Selected Units, Western Nigeria, 1970

Tractor Hire Unit	Owner of Work						
	Farm Institute	Private farmers	Extension work station	Farm settlements	Research Division	Rubber plantation	Dairy Herd Multiplication Centre
	Percent of Total Output						
Oshogbo	0	26.9	2.3	24.7	46.1	0	0
Ado-Ekiti	0	n.a.	n.a.	72.4	n.a.	0	0
Ijebu-Ode	0	0	23.9	76.1	0	0	0
Ilaro	0	11.7	16.5	71.8	0	0	0
Ikenne	0	0	2.5	5.5	24.9	35.6	31.5
Abeokuta	18.9	n.a.	46.5*	34.6	0	0	0
Ogbomosho	0	5.4	0	94.6	0	0	0

*Includes private farmers.

Table 7.21 SUMMARY: CONSTRAINTS ON TRACTOR UTILIZATION
Selected Hire Units, Western Nigeria, 1970

Tractor hire unit	Reasons for Idleness			
	Break-down	No authorized job	fuel	No engine oil
	Percent of Total Days Operators were Idle			
Oshogbo	7.9	78.1	2.5	0
Ondo/Okitipupa	63.6	14.8	0	1.4
Ado-Ekiti	29.5	17.3	17.3	0
Ilero	46.4	26.5	2.8	0
Ikenne	64.9	12.7	4.4	0

The productivity of hire units, measured by annual hours per tractor, is generally on the low side. Some of the causes of low power utilization such as frequent equipment breakdowns which remained unrepaired for long times, and the lack of supplies (fuel and oil) constitute an integral part of factor-proportions problem and under-developed supporting facilities. It is, thus, important to examine this problem a little further.

The Factor-Proportions Problem

One of the most important factors of highly productive employment of farm equipment is their timely, high-quality maintenance and repair. An effective repair network is an indispensable condition for increasing the efficiency of the State's implement and tractor fleet and the economic effect of agricultural production.

In addition, in an organized system of machinery where one is kept constantly employed by another, a fixed relation is established

between their numbers, type and size. Very often, some tractors are not employed fully because of lack of implements. The question of the quantitative and qualitative correlation of different types and makes of farm machines is solved incorrectly. For instance, a Ford harrow can not be used by a David Brown tractor. So, the Ford harrow may be unused while the David Brown tractor is awaiting the repair of the appropriate harrow. These are the kinds of factors on which the economic effect produced by machines largely depends.

Theoretical Framework

Complementary inputs constitute a factor-proportions problem, which, if not solved, would continue to cause under-utilization of existing power. A factor-proportions problem arises when factor substitutability is not great to allow full employment of all the existing power. It arises out of the limited substitutability between tractor, tractor operators and implements. The lack of substitutability between these inputs is complete.

The geometry of the implications of the factor-proportions problem on tractor utilization is shown in Figure 7.2. On the horizontal axis is measured the complementary inputs--repair shops, tractor operators, mechanics, spare parts, tractor implements and fuel--and on the vertical axis is measured farm power. The substitutability between the two categories of factors is zero, as shown by the right-angled isoquants.

If OT_1 measures the power available and if the complementary inputs available is OA, T_1 T_2, amount of farm power will be unused.

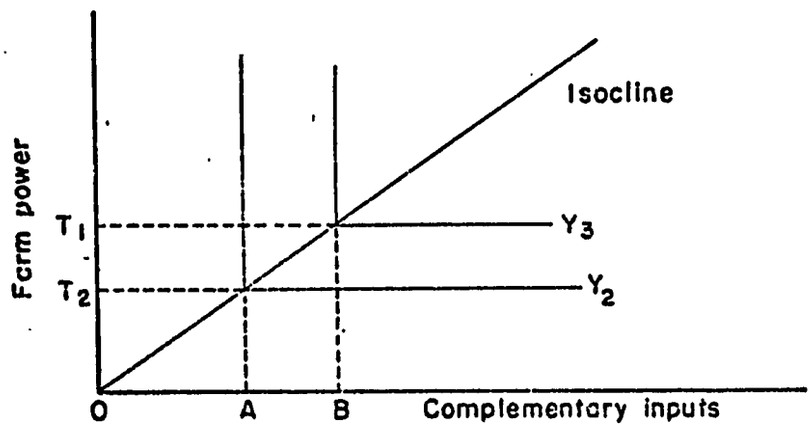
AB indicates the additional complementary inputs needed for existing power to be fully utilized and OB is the total complementary inputs needed. An additional AB amount of complementary inputs will enable T_1 T_2 additional power to be used and raise output from Y_2 to Y_3.

In the Western State, no attempt is being made to correlate the different types and makes of tractors and implements. The proliferation of tractors and implements is one cause of low output because of the limited substitutability among the available types and makes of farm equipment. The inadequacy of the complementary inputs has also been a persistent source of low output.

Implements

Implements are in short supply in the State. There are two main categories of implement problem:

FIGURE 7.2 THE DEPENDENCE OF TRACTOR USAGE ON COMPLEMENTARY INPUTS



(I) The very high rate of breakdown and untimely repairs.

(II) The proliferation of tractors and therefore of implements causing improper correlation between tractors and implements.

Ploughs and harrows have experienced the most frequent breakdowns. Discs get broken too quickly. To quote the February 1971 monthly report of the U.S.A.I.D. Agricultural Engineering Advisor:

> A special effort has been made throughout the month to encourage my Nigerian co-workers to make repairs, assemble and adjust for operation many of the ploughs, disc harrows, maize planters, and rice seed drills which are not at present serviceable because of missing or broken parts, improper assembly and/or improper adjustment. It is estimated that a minimum of twenty disc harrows inspected this month could be put in operation within a two-week period if the engineers, shop foreman and machinery technicians follow through on the recommendations we have made through the circle Agricultural Engineers. Since disc harrows are in short supply, the reconditioning of the above reference machinery could make a major impact on the equipment available for seed bed preparation this coming planting season.

Spare Parts

There is no other aspect of the whole set up which gives so much headache as spare parts. The broken-down equipment remained unrepaired for no other reason than lack of spare parts. If spare parts were available, overhauling would not take more than four days, decarbonizing four days, hydraulic reqpairs two days and implement repairs three hours.[2] But many tractors and implements keep a year or more in the workshop, waiting for parts to arrive. The following are some of the problems surrounding the supply of spare parts:

---

[2]These time requirements were given by the head mechanic, Fashola repair shop.

(I) Because there are many different makes and types of tractors, it is not possible to interchange parts in repairs and this also means many spare parts should be stocked.

(II) The catalogues for some tractors cannot be found and when a part is needed, it is very difficult to place an order for it.

(III) It is very difficult to get spare parts quickly because of long processing stages. For instance, if Ilesha needs a spare part, it cannot send requisition direct to Ibadan. The requisition has to go to Ibadan through the Akure Office. If not stamped and signed by the Akure Office, Ibadan will not accept it. If the spare part is available at the main store at Ibadan, the Akure Office will go and collect it and from the Akure Office, send it to Ilesha. If not in the store at Ibadan, Ibadan will send a requisition to the dealer concerned. All units send requisitions to Ibadan through the divisional or circle headquarters. Ado-Ekiti, for instance, gets its spare parts through the Akure Office. Waiting time for spare parts range from weeks to years.

(IV) If the part is not available at Ibadan main store, it may not ultimately be obtained because the dealer may refuse to accept the purchase order owing to outstanding debt. For instance, BEWAC, the supplier of M.F. tractors, had refused to accept a purchase order for this reason.

(V) Although repairmen have to wait long time for parts to arrive, when they finally arrive, the parts may be incomplete. To quote the Ibadan repair shop head mechanic, "if we place

an order for 20 parts, 18 may arrive and the remaining two will still delay the tractors."

(VI) There is also the problem of change and obsolescence, particularly with M.F. 35 tractors. There are no parts for them since they have been replaced by the M.F. 135.

The spare parts problem remains a highly frustrating experience to all those interviewed by the author. As the Mechanization Officer at Oshogbo succinctly put it, "an ordinary pin will stop work here."

Tractor Operators

The difficulties faced with tractor operators are:

(I) Shortage of operators.

(II) Poor working conditions.

(III) Inadequate training and experience in handling tractors.

(IV) Indiscipline and too sharp reactions to farmers.

Table 7.22 shows the available operators for selected units. This table underlines the accute shortage of tractor operators in the State. Of the seven operators available at Ado-Ekiti, three of them have been withdrawn and stationed permanently at the Livestock Investigation Centre. Farmers are hit most by this shortage because Government farms and agencies usually receive priority in service.

There is no overtime nor bonus system implemented for operators. There is no encouragement for them to spend extra time to complete the job not completed during the normal working hours and days. The circular on expectations of agricultural machinery output by the Principal Agricultural Engineer (P.A.E.). of May 11, 1971, noted that "if the bonus system is adopted, which has been doing wonders in the last

Table 7.22 AVAILABLE TRACTOR OPERATORS
Selected Hire Units, Western Nigeria, 1970

Tractor Hire Unit	Number of tractor operators	Number of available tractors
Ogbomosho	12	13
Ilesha	8	13
Eruwa	11	14
Ikenne	4	7
Abeokuta	3	11
Ilaro	5	10
Akure	1	4
Ondo Sub-pool	5	7
Ado-Ekiti	7	17
Oyo	6	6
Oshogbo	7	9

years,[3] the operators will put in their utmost and thus will get them to work on the statutory work-free days, i.e., Saturdays, Sundays and public holidays. This is what farmers will naturally do during the active season."

Fuel

Allocation for fuel and oil is made on the basis of acreage projections. Ten shillings per acre is allowed for fuel and oil. Fuel and oil are usually purchased on credit but the purchase might have started long before the budget speech; therefore, purchase can be more than allocations. The consequence has been increasing outstanding debt and refusal by oil companies to supply oil and fuel.

[3]It is not clear what wonders in the past year the P.A.E. referred to. What is certain is that overtime or a bonus system has at no time been paid to operators.

Secondly, there are no fuel supply depots on the hire units. In most cases, the unit obtains its fuel from Ibadan, which may be very far away from the unit. There is usually no container to stock large amounts of fuel. For intance, Ado-Ekiti Hire Unit had ten drums and all of them leak. The current practice is to ask the farmer to buy the fuel and then reduce his hire cost by the amount of fuel bought.

Repair Shops

There are four area repair shops in the State--at Fashola, Ibadan, Akure and Abeokuta. These repair shops receive broken-down tractors and implements from the surrounding hire units. The individual hire units are poorly equipped in tools and mechanics and are therefore, implicitly, not expected to do repair work, though, in theory, it is said that only major faults should go to the area workshop.

In all the hire units, only skeleton number of tractors mechanics are maintained in relation to the number of tractors available. Table 7.23 shows the distribution of tractor mechanics in the hire units. Ilaro Hire Unit had only one mechanic to 10 tractors while Eruwa Hire Unit had one to 14 tractors. Apart from shortage of mechanics, there are usually no welders, electricians and blacksmiths at the hire units. The second problem is lack of tools to do the repairs. All the hire units complained about lack of tools. Flat tires cannot even be repaired because there are usually no inflators nor compressors. At best, the problems can only be identified at the hire unit and then sent to the nearest area workshop for the necessary repairs.

Table 7.23 AVAILABLE TRACTOR MECHANICS
Selected Hire Units, Western Nigeria, 1970

Hire Unit	Number of mechanics	Number of tractors
Ilesha	3	13
Ogbomosho	2	13
Eruwa	1	14
Ikenne	1	7
Ilaro	1	10
Ado-Ekiti	3	17
Oyo	2	6
Oshogbo	1	9

There is no adequate training for the mechanics. The first set of mechanics were recruited from among the road-side auto-mechanics. The second set were trained at the Trade Centre, Oyo. There is dissatisfaction with the quality of training given at the Centre, even though the graduates are better than road-side mechanics. But very important is that not more than one out of every three mechanics went to the Trade Centre. There was a particular case at Oyo where the mechanics battled with a repair job for two weeks, a job that would normally not take more than one day--according to the Agricultural Engineer. There was no sufficient training and experience to handle the job and so the dealers have to be called, causing additional weeks of waiting before the dealer's engineer could come.

Ibadan Repair Shop

This repair shop serves Ibadan and Ibarapa Divisions. There were three mechanics, two of them had Trade Centre certificates, the third was an Artisan Grade Three.

According to the head mechanic, the most common faults brought to the repair shop were sucking in of air, hydraulic problem, clutch, steering trouble and incorrect alignment of front wheel. The problems faced at this repair shop, according to the head mechanic, were:

(I) Lack of standard tools.

(II) Inadequate staff. The three mechanics in the workshop were not enough to cope with the work.

(III) Spare parts were not available. The small staff available would still do a lot if only spare parts were available.

(IV) Untimely payment of salaries. The July 1971 salary was paid in August, for instance, and this was not an isolated case.

Abeokuta Repair Shop

This repair shop serves the whole of Egba-Ijebu Circle--Egba, Egbado, Remo, Ijebu-Ode. There were five mechanics at the workshop, two of them completed the training at Oyo Trade Centre and graduated as Artisan Grade II. The repair shop had one welder, one electrician and one vulcanizer. According to the head mechanic, the most frequent complaints usually received were overhauling, decarbonizing, hydraulic and broken wheel. On harrows, usual faults were braces, bearings and broken angle bars while the main complaint on ploughs was broken discs.

The problems faced at the workshops according to the head mechanic were:

(I) Not enough tools to work. The workshop is not well equipped.

(II) It is too difficult to get spare parts.

(III) The implements usually do not come with instruction books on how to use them.

Fashola Workshop

Fashola workshop serves the whole of Oyo and Oshun Divisions. Broken-down equipment goes to Fashola from Oshogbo, Ogbomosho, Oyo, Shaki and Iseyin Hire Units. Usual complaints received include hydraulic trouble, starting problem and oil leakage. The Ford tractor had just been introduced in the State. So, no mechanic can deal with the Ford hydraulic system failure, and so the dealers have to be called to do the repairs. Arrival rate of broken-down tractors is high in the workshop, particularly at the peak season. The head mechanic gave an estimate of 10 tractors per week on the average, during the peak season. Four broken-down tractors arrived before noon on the day of the author's visit, each with different complaint, and according to the head mechanic, "we will receive more before three o'clock."

The problems faced at the repair shop, according to the head mechanic were:

(I) Spare parts headache.

(II) Shortage of mechanics.

(III) Untimely payment of salary to daily paid mechanics.

The effectiveness of a machine depends on the availability of spare parts, technical servicing and repairing. An establishment of repair network is indispensable to increased utilization of available tractors. In addition, introduction of incentive in wage payment and remuneration of tractor operators is an important condition for enhancing the economic efficiency of tractors. The operators will be happy and adopt the right attitude towards work. Indeed, all the supporting facilities and complementary inputs, both physical and human, on which the effectiveness of farm mechanization depends, are still in very poor shape.

CHAPTER VIII

TIMELINESS OF OPERATIONS

In agriculture the quantity and quality of a product depends on the work being started and ended within a certain time limit. The completion of all jobs on time to a large extent decides the yield. In a hire service setup, timeliness of operations is one of the most important measures of how efficiently it is functioning. At Ado-Awaye, in Iseyin District, the author saw a farm on which a 31-acre late maize crop failed completely because it was planted late. According to the farmer the late planting was due to untimely availability of tractors to make the ridges.

The optimum planting periods for maize are shown in Table 8.1.

Table 8.1 OPTIMUM PLANTING PERIOD FOR MAIZE CROPS
Western Nigeria, 1970

Crop	Period	
	From	To
Early maize	Last two weeks of March	First two weeks of April
Late maize	Last two weeks of July	First two weeks of August

Source: Extension Division, M.A.N.R. . Oyo.

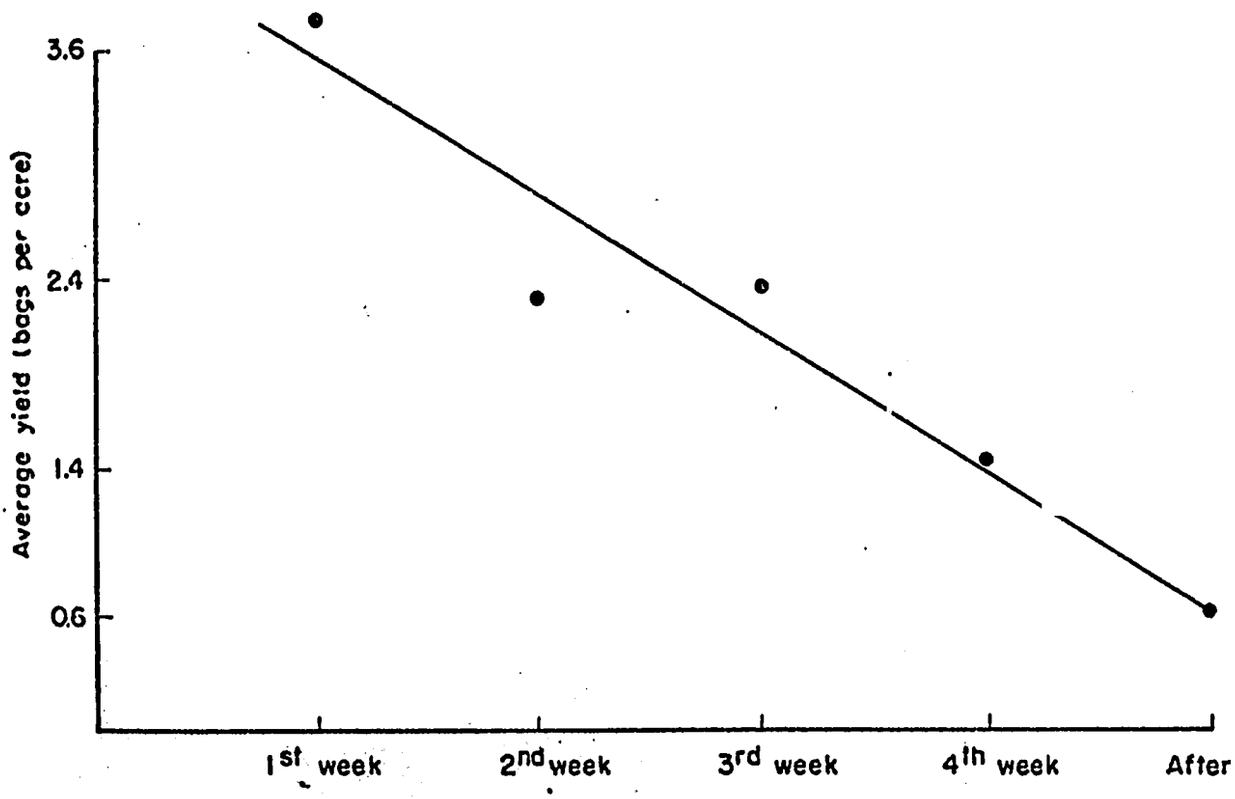
The designation of optimum planting period implies that departure from it has a cost in terms of yield lost. The yield-planting time relationship was analyzed using farm settlers who grew late maize. Farm settlers are used because they usually grow the same maize variety, follow reasonably uniform farm practices and maintenance and conduct their farm operations in the same environment. The uniformity in these other yield affecting factors facilitates the isolation of the impact of planting time on yield. The nature of the relationship is shown in Figure 8.1.

Planting in the first week of August gave the highest average yield. The average yield per acre is inversely proportional to planting after the first week of August, but the change in average yield does not show a consistent pattern. It averaged 0.8 of a bag or 179 lbs. of maize per acre, Table 8.2. At a price of 0.39 shillings/lb. for late maize, this loss amounts to 69.8 shillings per acre, due to planting after the first week of August.

Table 8.2 YIELD-PLANTING TIME RELATIONSHIP
21 Late Maize Growers, Western Nigeria, 1970

Planting time	Number	Average yield (bags/acre)	Change in Average yield
First week in August	7	3.75	-1.45
Second week in August	3	2.30	+0.03
Third week in August	4	2.33	-0.88
Fourth week in August	4	1.45	-0.82
After August	3	0.63	

FIGURE 8.1 YIELD- PLANTING TIME RELATIONSHIP



August 1970

Some indication of the loss due to late planting was also obtained by asking farmers to estimate what they would lose if they planted their maize late. The response is summarized in Table 8.3 The majority of the farmers estimated a loss of over 99 shillings per acre compared with an average of 70 shillings per acre obtained from reported yields and planting time. These figures clearly indicate that untimely planting could cost the farmer a lot of money.

Table 8.3 THE DISTRIBUTION OF FARMERS' ESTIMATED COST OF LATE PLANTING
Western Nigeria, 1970

Cost of late planting (shillings)	Farm Settlers		Individual Contractors	
	No. of farmers	% of farmers	No. of farmers	% of farmers
Less than 20	0	0	0	0
20-29	2	12.6	0	0
30-39	1	6.2	1	7.1
40-49	1	6.2	0	0
50-59	2	12.6	3	21.4
60-69	1	6.2	0	0
70-79	1	6.2	1	7.1
80-89	0	0	1	7.1
90-99	1	6.2	0	0
Above 99	7	43.8	8	57.2

In Table 8.4 the distribution of departure from the optimum planting time is shown.

Table 8.4 LATE PLANTING[a] OF MAIZE BY TYPE OF FARMER
Western Nigeria, 1970

Type of farmer	Type of Crop	
	Early Maize	Late maize
	Percent of Farmers	
Group farmers	18.7	61.1
Individual users	8.1	14.6
Farm settlers	42.5	40.4
Non-users	13.6	24.1

[a]Planting after the second week of April for early maize and planting after the second week of August for late maize.

For early maize, about 43 percent of farm settlers planted late while for late maize, more than half of the group farmers planted late. Between the crops, late maize was planted late among a larger percent of farmers than early maize. Twenty-three percent of tractor users planted early maize late while 39 percent of them planted late maize late. Among non-tractor users, the percentage was 14 and 24 respectively.

Among tractor users, planting time depends more on when tractor service is obtained. The timeliness of tractor service depends on:

(I) The number of available tractor operators.

(II) Availability of fuel.

(III) The number of active tractors and implements vis-a-vis the number of farmers who want service.

(IV) The time the stumped land is ready. There were a number of cases in which the tractor unit continued to wait for farmers to finish stumping.

(V) The length of advance notice for tractor service. If a farmer sends in his application two weeks before the day he wants the service, this could cause a delay.

Farmers were asked whether the tractor usually comes on time. The distribution of response is shown in Table 8.5.

Table 8.5 FARMERS THAT SAID TRACTOR USUALLY COMES LATE BY TYPE OF FARMER AND LOCATION
Western Nigeria, 1970

Type of farmer	Location		
	Oshun	Oyo North	Oyo South
	Percent of Farmers		
Farm settlers	90	0	30
Group farmers	75	88	66.6
Individual users	20	94.4	77.7

In Oyo Divisions, except for farm settlers, the majority of farmers said that the tractor usually comes late, but a greater percent of individual users answered in the affirmative. In Oshun Division, only 20 percent of individual users said tractor usually comes late. Most of the other type farmers said that the tractor usually comes late.

The waiting time before service, as reported by farmers, was examined by crop, type of farmer and location, Tables 8.6 and 8.7. For early maize, 25 percent of group farmers and 23 percent of farm settlers waited for over one month in Oshun Division.

Table 8.6 EARLY MAIZE GROWERS BY LENGTH OF WAITING TIME BEFORE SERVICE
Western Nigeria, 1970

Location and type of farmer	Waiting Time			
	Less than one month	One month	Two months	Above two months
	Percent of Farmers			
Oshun				
Farm settlers	6.6	70.1	23.3	0
Group farmers	50	25	25	0
Oyo North				
Group farmers	0	16.6	50.1	33.3
Individual users	7.1	50.1	28.5	14.3
Oyo South				
Farm settlers	22.2	44.4	22.2	11.2
Group farmers	0	50	50	0
Individual users	12.5	43.7	31.3	12.5

Half of the group farmers waited for over a month in Oyo South. In Oyo North, the percentage is 83. For the individual farmers, 44 percent waited for over a month in Oyo South. In Oyo North, the percentage is 43. A larger percentage of group farmers and farm settlers waited for over a month in Oyo and Oshun Divisions. In both divisions, the majority of farmers waited for at least one month. The same thing holds for late maize, Table 8.7.

Table 8.7 LATE MAIZE GROWERS BY LENGTH OF WAITING TIME BEFORE SERVICE
Western Nigeria, 1970

Location and type of farmer	Waiting Time		
	Less than one month	One month	Two months
	Percent of Farmers		
Oshun			
Farm settlers	25	50	25
Group farmers	25	37.5	37.5
Individual users	50	50	0
Oyo North			
Group farmers	0	100	0
Individual users	20	80	0
Oyo South			
Farm settlers	25	50	25
Group farmers	0	100	0
Individual users	0	77.8	22.2

The majority of farmers waited for at least one month in all the divisions. The percent of farmers that waited for over one month was smaller among late maize growers than early maize growers.

These figures suggest that (i) Farmers waited for long times, sometimes over two months, before they get service, (ii) Waiting is a more serious problem in Oyo Divisions than Oshun Division, and (iii) Waiting time during early crop season is longer than waiting time during late crop season.

Waiting Line Problem

The preceding analysis of farmers' responses shows that there are symptoms of a waiting line problem. Queuing theory is, therefore, employed to further examine the problem and gain insight into the performance of the tractor hiring system.

Queuing Theory

In any service system a line forms in front of the server if at a point in time the number of calling units in the system exceeds the number of available servers. Owing to the stochastic nature of arrivals there are times when the server will be idle and when a waiting line will develop. Queuing theory can provide information of interest to understand the performance of the system under these conditions.

A waiting line system has the following properties (Figure 8.2). (1) The pattern of arrival rates. (2) The pattern of service times. (3) The service discipline. (4) The queue classification.

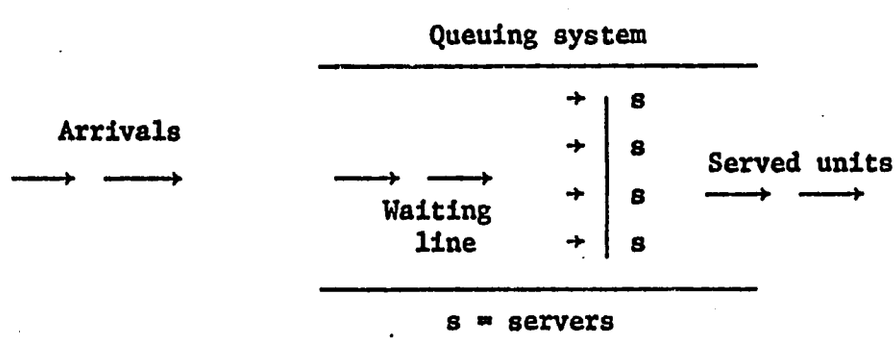


Figure 8.2 One line four-server queue process.

Poisson distribution is used to describe arrival pattern. It is a discrete distribution which counts values throughout the range of K. There is a finite number of calling units that can arrive in a point in time. The distribution is given by

$$f(k) = \frac{\lambda^k e^{-\lambda}}{k!} \qquad k = 0, 1, 2, \ldots \qquad \lambda > 0$$

λ = the expected value of the distribution and it is equal to its variance. At low level of λ, the distribution curve is a reverse of J type curve, but for $\lambda > 1$, they gradually approach a normal distribution as λ increases. In fact, at $\lambda > 10$, the normal distribution can be used to approximate the distribution of k.

The inter-arrival time is exponentially distributed. The service times are also exponentially distributed. The distribution of service times t when the mean service rate is u is given by $g(t) = Ue - ^{ut}$ for $U > 0$ and $t \geq 0$. With knowledge of U, the function can be plotted for the values of service times. It is a strictly decreasing function, with a declining probability of long service times.

A more general, more flexible service times distribution is the Erlang distribution. The distribution of service time t when the mean service rate is u is given by

$$g(t) = \frac{(UK)^k}{(K-1)!} t^{k-1} e^{-kut} \qquad \text{for } U > 0 \text{ and } t \geq 0$$

The distribution is indexed by u, t and k. K is the shape parameter. The exponential service time is a member of the family of Erlang distribution. When k=1, the distribution is the exponential type. The mean = 1/u and $\sigma^2 = \frac{1}{ku^2}$, so that when k=1, $\sigma^2 = 1/U^2$. This family of distribution provides flexibility because if the data do not fit the exponential service distribution, it may fit one member of the Erlang distribution, with an appropriate selection of K value.

There are two principal types of service discipline (I) First-come-first served. (II) Priority for service. Priority for service may or may not be pre-emptive. In the pre-emptive case, there is a random selection of the unit to be served by the server. Thus, for some calling units, those arriving after them could be selected. In the non-pre-emptive case, a fraction α, possesses priority over the other arrivals $(1 - \alpha)$ (33).

Possible classification of queues are numerous. Queues can be classified on the basis of (a) The form of the servicing system. (b) Finite or infinite source. (c) Priorities and customer preference. (d) Arrival-service combinations. The servicing system may take the form of one line-one server, one line multiple server, multiple line-multiple server and networks. In the multiple line-multiple server case, if there is no line switching, this will be an example of many cases of one line-one server. In network models, there is a network of service facilities, where calling units must receive service at some or all of these facilities. If there are multiple service facilities, $m = 1, 2, \ldots M$, when a calling unit is served at m, the calling unit goes (instantaneously) to k ($k = 1, 2, \ldots M$). "This is the basis for calling this system a 'network' of waiting lines" (34). Arrivals may be random or constant while service may also be constant or random. There are four possible combinations by letting the arrivals or service be either random or constant.

There are also converse waiting line problems. These require calculating the quantity of servers sufficient to meet specific objectives such as cost minimization, limiting values of average or maximum delay and queue length.

There are two main solution techniques to queuing problems. (1) Mathematical solution. (II) Simulation solution. For the mathematical (analytical) solution, there are standard formulas already developed which can be used if the data conform with the assumptions or do not grossly deviate from them. Choosing an appropriate solution method therefore begins with accumulation and analysis of data which adequately describe the system's properties. These are then tested for conformance with the standard assumptions. The Erlang distribution permits an analytical solution for some quantities of interest in cases of non-exponential distributions. In order to analyze most waiting line systems, the standard practice is to combine the two approaches. The first is to use simple models as rough approximations then, with these results for insight and guidance, a computer simulation model is developed that takes account of those facts that are important but hard to deal with by mathematical analysis.

The foregoing theory was applied to the problem of tractor hire service. The calling unit in the system is the farmer who sends his application for tractor service. The server is the equipment (the tractor and its implement), guided by a tractor operator. The service facility is the tractor hiring unit. While there may be no physical waiting line forming in front of the tractor hiring unit, conceptually, the farmers are scattered over the area awaiting the arrival of the tractor to perform the farm operations requested.

Jobs performed include ploughing, harrowing and ridging. These jobs are sequenced, with ploughing operation coming first, followed by harrowing and ridging for each farmer. The service system is one job

at a time. That is, all tractors in a unit are sent out to do ploughing operation. When ploughing operation is completed, harrowing operation is started and finally ridging operation. Each operation is a queuing problem.

Within each type of farmers, the service discipline is first-come-first served although there are some occasional departures. When a farmer is well intimate with the Mechanization Officer, he might use this influence to get an earlier service. Between types of farmers, service discipline is on priority basis. Group farmers, for instance, get priority in service over individual farmers. The dominant form of queuing system is the one line-multiple server case. Areas that had the one line-one server system include Oshun North East, Egbado, Ado-Awaye and Oshun farm settlement. In all these places, there was only one tractor available in 1970/71.

Specification of the Queuing Model

Queuing model considered here consists of multiple exponential channels with a poisson input, infinite population, constant service rate and arrival rate and strict queue discipline. Multiple exponential channels means that there are more than one server and service time is exponentially distributed. Poisson input means that the arrival pattern has a poisson distribution, while strict queue discipline implies first-come-first served. Given these specifications, mathematical solution of the problem is possible.

Let:

Pn = Probability that there are n units in the system.

L = Expected number of calling units in the system.

Lq = Expected number of calling units on the queue.

W = Expected waiting time in the system per calling unit (it includes service time).

Wq = Expected waiting time on the queue per calling unit (it excludes service time).

S = Number of servers in queuing system.

λ = Expected arrival rate of calling units.

U = Expected service rate per busy server.

$1/\lambda$ = Expected inter-arrival time.

$1/u$ = Expected service time

ρ = Is the traffic intensity or utilization factor for the service facility.

Un = Expected service rate for the overall queuing system.

These quantities provide information about the performance characteristics of the system which can be calculated by using the following formulas (35).

$$P_o = 1/\left[\sum_{n=o}^{s-1}\frac{\left(\frac{\lambda}{u}\right)^n}{n!} + \left(\frac{\left(\frac{\lambda}{u}\right)^s}{s!}\right)\left(\frac{1}{1-\frac{\lambda}{su}}\right)\right]$$

$$Lq = \frac{P_o\left(\frac{\lambda}{u}\right)^5 \rho}{s!\,(1-\rho)^2}$$

$$Wq = \frac{Lq}{\lambda}$$

$$W = Wq + \frac{1}{u}$$

$$L = Lq + \frac{\lambda}{u}$$

$$\rho = \lambda/su$$

If n = the number of units in the system, then

$$Un = \begin{cases} nu \text{ if } 0 \leq n \leq s \\ su \text{ if } n \geq s \end{cases}$$

For steady-state condition, the restriction $\rho < 1$ must be met. That is, $\frac{\lambda}{su} < 1$ or $\frac{\lambda}{u} < s$. If $\lambda \geq su$ so that the expected arrival rate exceeds the expected service rate, the queue explodes.

Empirical Results

This model was applied to Oshogbo tractor hiring unit, using 1970 data for ploughing operation. The yearly work pattern showed the typical two peak seasons--early and late crop seasons. Two time periods were considered: (I) The two seasons, March to August. (II) The early season, March to May. There were nine tractors on the unit and seven tractor operators. Since tractor breakdown was a frequent occurrence, and the seven operators available meant that only a maximum of seven tractors would be ready to go to work per day, a value of six active tractors, ready to go to work any time was used.

For each period, the average arrival rate and average service rate were calculated. Based on these estimates the assumptions of poisson input and exponential service times were tested by the chi-square test of goodness-of-fit. Table 8.8 shows the test for poisson arrival pattern for the period March to August 1970.

At the 5 percent level of significance, X^2 (1) = 3.84. The critical region is $X^2 \geq 3.84$. We cannot reject the hypothesis that the sample is from a poisson distribution.

Table 8.8 CALCULATED X^2 FOR THE OBSERVED DISTRIBUTION OF FARMER ARRIVALS IN COMPARISON TO THE POISSON DISTRIBUTION WITH A MEAN OF 0.30

Class	fo	Probability for exact number	fe	$\frac{(e - o)^2}{e}$
0	90	0.7408	89	.0112
1	24	0.2222	27	.2222
2	6	0.0333	4	1.0000
				$X^2 = 1.2334$

In a similar manner, service times were analyzed. It was checked against an exponential distribution. The calculated X^2 was large. This indicates that the data fit poorly to the negative exponential distribution. This is not unexpected because of the strictly decreasing assumption of the distribution.

The service time could be thought of as including (a) The breakdown time. (b) Actual time spent in servicing. (c) Traveling time. (d) The inspection time. An average distance of 20 miles is assumed and since tractors normally return to base, the round trip is 40 miles. A speed of 10 miles per hour is assumed. Adjusting the recorded actual time used to service farmer for traveling time, the data input consisted of:

$U = .065/\text{day}$

$\lambda = 0.30$

$\lambda/U = 4.615$

Assuming an exponential service time and a multiple server model, the calculated performance characteristics of the system are shown in Table 8.9.

As arrival rate approaches the servicing capacity, average time in system and on the queue increases.. For a six-tractor unit, a farmer spends an average of 20 days in the system of which five days were spent on the queue. A breakdown of one tractor causes the waiting line on the queue to increase more than five fold.

For the early season, March-May, continuing with preceding assumptions, the data input consisted of:

$U = .073$

$\lambda = 0.40$

$\lambda/U = 5.479$

The calculated performance characteristics are shown in Table 8.10.

At least six tractors are required if the queue is to have any bounds. With available six tractors to go per day, a farmer spent an average of 32 days in the system of which 19 days were spent on the queue. As more tractors are provided these averages fall, and the total time spent in the system is dominated more by the service time rather than the waiting time on the queue.

Apart from the waiting time, the other important aspect of queuing is the idle time of the servers due to the random nature of arrivals. For instance, if there are six active tractors, there is a probability of 0.2 percent that this will happen compared with 0.4 percent when eight active tractors are available. The probability that tractors are idle, waiting for arrivals, increases as the number of tractors increases. The calculated expected ideal time is shown in Table 8.11.

Table 8.9 CALCULATED PERFORMANCE CHARACTERISTICS
Oshogbo Hire Unit, Western Nigeria, March-August 1970

Number of tractors[a] (S)	ρ	Probability of tractors idle (Po)	Expected queue length (Lq)	Expected line length (L)	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)
5	.92	.003	9.2	13.8	30.8	46.2
6	.76	.008	1.4	6.0	4.7	20.1
7	.65	.009	0.4	5.0	1.4	16.8
8	.57	.0096	0.1	4.7	0.5	15.8

[a]For S from 0-4, the restriction $\lambda/SU < 1$ is not met.

Table 8.10 CALCULATED PERFORMANCE CHARACTERISTICS
Oshogbo Hire Unit, Western Nigeria, March-May 1970

Number of tractors[a] (S)	Traffic intensity (ρ)	Probability of tractors idle (Po)	Expected queue length (Lq)	Expected line length (L)	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)
6	0.91	0.0018	7.4	12.8	18.5	32.2
7	0.78	0.0033	1.5	7.1	3.9	17.6
8	0.68	0.0038	0.5	5.9	1.2	14.9

[a]From S from o-5, the restriction $\lambda/SU < 1$ is not met.

Table 8.11 EXPECTED FRACTION OF TIME TRACTORS WERE IDLE
Oshogbo Hire Unit, Western Nigeria, 1970

Number of tractors	Period	
	March to August	March to May
	Percent of Available Tractor Time	
8	43	32
7	35	22
6	24	9
5	8	--

The excess capacity of eight active tractors as compared with six active tractors is indicated by the increase in expected idle time. But, expected waiting time per farmer declines as more active tractors are available.

One Line-One Server Model

Assume that there is only one server with the service capacity of all the available servers. The data input would consist of:

$U = 0.438$

$\lambda = 0.40$

$\lambda/U = 0.91 = \rho$

The following table gives the probabilities for various number of units in the system.

N	Pn	Pr (N > n) = $\left(\frac{\lambda}{u}\right)^{n+1}$
0	0.09	0.91
1	0.08	0.82
2	0.07	0.75
3	0.06	0.68
4	0.06	0.62
5	0.05	0.56
6	0.05	0.51
7	0.04	0.47

A farmer has the probability of 0.09 of being immediately serviced, and a probability of 0.07 of being the second in line. When n = 0, the Pr (N > 0) indicates that the probability that the line size will be greater than zero is 0.91. For 75 percent of the time, more than two farmers are waiting for service.

The performance characteristics for this model are calculated for exponential and non-exponential service times. When non-exponential service time is assumed, the variance of service time is 1.398 times the exponential case. The data input consisted of:

$1/u = 2.28$

$\sigma^2 u = 9.19$

$\lambda = 0.40$

$\lambda/u = 0.91 = \rho$

The performance characteristics are shown in Table 8.12.

Table 8.12 PERFORMANCE CHARACTERISTICS BY TYPE OF SERVICE TIME DISTRIBUTION
Oshogbo Hire Unit, Western Nigeria, March-May 1970

	Type of Service Time Distribution		
	Exponential	Non-exponential	Percentage
Lq	9.6	12.7	32.7
L	10.5	13.6	29.9
Wq	24.0	31.9	32.8
W	26.3	34.2	30.0

All the expected values of the performance characteristics increased by an average of 31 percentage points over the exponential case. In the exponential case, a farmer spent an average of 26 days in the system of which 24 days were spent on the queue. In the non-exponential case, he spent 34 days in the system of which 32 days were spent on the queue. In agriculture where waiting time has a high priority, these conditions suggest a poor performance and/or underdesigned system.

Sensitivity Analysis

The preceding results were based on estimated values of λ and U as though they were "true" values. In practice these estimates are subject to sampling errors. It is thus pertinent to check the effects of incorrect specifications of λ and U on the performance characteristics. The most important item considered is the variation in traffic intensity as estimates of λ and U fluctuate. The results are presented in Table 8.13.

Table 8.13 EFFECT OF VARIATION OF ESTIMATES OF λ AND U ON PERFORMANCE CHARACTERISTICS
Oshogbo Hire Unit, Western Nigeria, 1970

		U = 0.5			U = 1			U = 2			U = 4		
Traffic Intensity (ρ)	Probability of server idle (1-ρ)	λ	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)	λ	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)	λ	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)	λ	Expected time in line per farmer (days) (Wq)	Expected time in system per farmer (days) (W)
.1	.9	0.05	0.22	2.22	0.1	0.11	1.11	0.2	0.06	0.56	0.4	0.03	0.28
.3	.7	0.15	0.86	2.85	0.3	0.43	1.43	0.6	0.21	0.71	1.2	0.11	0.36
.5	.5	0.25	2.00	4.00	0.5	1.00	2.00	1.0	0.50	1.00	2.0	0.25	0.50
.7	.3	0.35	4.67	6.67	0.7	2.33	3.33	1.4	1.17	1.67	2.8	0.58	0.83
.8	.2	0.40	8.00	10.00	0.8	4.00	5.00	1.6	2.00	2.50	3.2	1.00	1.25
.9	.1	0.45	18.00	20.00	0.9	9.00	10.00	1.8	4.50	5.00	3.6	2.25	2.50
.95	.05	0.475	38.00	40.00	0.95	19.00	20.00	1.9	9.50	10.00	3.8	4.75	5.00
.99	.01	0.495	198.00	200.00	0.99	99.00	100.00	1.98	49.50	50.00	3.96	24.75	25.00

λ = Arrival rate/day
U = Service rate/day
ρ = λ/U traffice intensity

As λ increases, ρ increases and waiting time in line increases. The waiting time in line decreases as U increases for given values of ρ. Suppose $\rho = 0.9$, then on average, the tractor is idle 0.1 day (or 48 minutes per day) during the peak season. If $U = 0.5$, then the average time a farmer spends in the system is 20 days, and 18 days of this is due to waiting in line. If ρ remains at 0.9 but both U and λ double, then the average time spent in the system and in waiting are cut by 50 percent.

The one line-one server model shows a 30 percent increase in expected waiting time per farmer over the multiple channel model, assuming exponential service time for the early season period. Expected waiting time declines as the number of active tractors[1] increases. Planting would, therefore, be expected to be nearer the optimum and average yield per acre would increase. But the number of active tractors and expected idle time are directly proportional. Therefore, increases in average yield due to better timely planting would be obtained at the expense of increasing tractor costs. The increase in average yield would have to be balanced against the increase in tractor costs. Apart from increased numbers of active tractors, alternative methods of scheduling the available tractors is another way by which service might be improved.

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[1]An active tractor is not only in working condition but all the supporting inputs such as fuel and operator are also assumed to be satisfied.

CHAPTER IX

THE PROBLEMS OF FARM MECHANIZATION IN WESTERN NIGERIA

There are a host of challenging problems facing the farm mechanization project in Western Nigeria. This chapter discusses some of the more important specific problems. The chapter is divided into three parts: (i) The basic problems faced in introducing tractors, (ii) Problems faced by farmers using the hire service, and (iii) The weak points in the scheme as now operated.

The Basic Problems of Introducing Tractor Use

The cost of stumping and clearing the land is high, particularly in the more forested areas of the State. The thick vegetation has been one of the most serious problems farmers have to face. It restricts the level of annual and year-to-year use per farmer and the spread of mechanization activities from the savanna areas of Oyo Divisions.

The majority of farmers are poor. The tractor hire charges are high for many farmers. Many are unable to pay the initial cash of one-third deposit required and, to reduce costs, many would prefer to plough alone. Added to these is the unwillingness and/or inability of farmers to pay the remaining two-thirds after sale of produce. Farmers are not economically viable enough to use tractors.

There is a shortage of complementary inputs such as tractor operators, mechanics, well-equipped repair shops, tractor implements

and fuel. The frequency of tractor and implement breakdowns is high and breakdowns may remain unrepaired for length of time ranging from weeks to years, owing to lack of spare parts. The supporting facilities are not yet well developed for a successful use of tractors.

The existing type of farming is a source of problem, particularly the practice of mixed cropping and the small, scattered nature of holdings. The Government is pushing group farming to encourage the larger size farms. But unfortunately, group farming has not lived to expectations due to petty quarrels and rapid disintegration. The nature of crops grown has virtually restricted mechanization activities to Oyo Divisions. In the more forested areas, tree crops are more important than mechanizable arable crops. In Shagamu, for instance, the growing of kolanuts is so extensive that there is no land available for arable crops.

Many farms are not accessible due to hills and/or streams. In many cases only small foot paths lead to the farms. This means that some farmers will have to relocate or forget about the use of tractors except the accessibility problem is solved in some way.

Work is highly seasonal. This causes reduced utilization as the tractor is only fully employed during the peak seasons.

Problems Faced by Farmers Using the Tractor Hire Service

Farmers were asked about the problems they experienced in using the hire service. Problems cited are shown in Table 9.1.

The three principal problems users experienced were the high cost of tractors, initial stumping of land and the untimeliness of

Table 9.1 PROBLEMS CITED BY TRACTOR USERS
Western Nigeria, 1970

Type of problem cited	Type of User		
	Settler users	Group users	Individual users
	Percent of Users		
High hire charges	16.3	10.0	10.0
Not enough tractors and/or tractor not on time	79.0	82.0	70.0
Stumping	--	8.0	10.0
Other	4.7	--	10.0

service. The majority of farmers cited the fact that the tractor was usually not on time. One source of this situation is that there are not enough tractors vis-a-vis the number of farmers. This problem existed even on farm settlements that have the hire units located on them. On Oshun farm settlement, there was only one tractor allocated to all settlers. On Ogbomosho farm settlement, tractors available were not enough to cope with the number of settlers. About 30 farmers might meet at the THU in a day, developing into serious argument on who would have the tractor. Quarrels with the mechanization officer occurred so frequently that some officers wished to have nothing more to do with mechanization. In some cases, it almost degenerated into use of bribes in order to have the service first.

Other problems cited include:

(I) Lack of fertilizer.

(II) Farmers were asked to buy fuel sometimes so that the work would be done on time.

(III) Lack of hired labor to weed.

Farmers were also asked on the frequency of their visits to THUs to ask that the tractor be sent.

The majority of farmers visited the depot three to five times before being serviced. About 29 percent of group farmers and 25 percent of individual contractors said they visited over eight times. As many visits as 20 was also reported. One only needs to relate this to the distance covered to realize the problem faced by the farmer. It has been pointed out that most of the village serviced were beyond the ten-mile radius rather than within it. A number of farmers said they stopped going from Okaka to Iseyin or from Ago-Are to Shaki to ask for the tractor when they ran out of transport money.

Table 9.2 DISTRIBUTION OF FARMERS BY NUMBER OF VISITS TO TRACTOR HIRE UNITS BEFORE SERVICE
Western Nigeria, 1970

Number of visits to hire units	Type of Tractor User	
	Group users	Individual users
	Percent	
Less than 3	14.3	9.8
3-5	35.7	45.1
6-8	21.4	19.6
Above 8	28.6	25.5

Another problem recently created was the requirement that each application form should bear a photograph of the applicant. This requirement had been introduced in Oyo North and it arose from the difficulties faced by the Government to recover tractor costs. Identification

became a problem and so photorgraphs were required, but this represents an added cost for the potential user.

The Weaknesses of the Tractor Hire Scheme

There is an imbalance in the distribution of equipment and tractor operators in the State. For instance, Oyo Divisions are short of tractors but tractors are surplus in Ondo/Ife/Ilesha Circle. While Ado-Ekiti and Egbado, for instance, are short of operators, Ilesha has an excess. The shortage of tractors in Oyo Divisions was reflected in the failure to cope with farmers' demands. The Agricultural Superintendent at Iseyin, for instance, was asked to cease accepting applications in March 1970 "in view of the congestion on hand." In addition, some hire units are too far from the farmers they service, and since the tractors usually return to base daily, the distance covered and travel time can be tremendous. For instance, tractor went from Ado-Ekiti Unit to Iddo, 22 miles, to plough four acres and to Ijero, 26 miles, to plough three acres. For such long distances, the tractor could be stationed there until the job is completed, but usually there is no transport to carry along all the implements and fuel that would be needed.

The tractor operators are not disciplined. They are late to get to the farm for work. They are neither friendly nor sympathetic enough with the farmers. If a farmer complained about a poor job, the operator would be annoyed and leave the farm. The payment of wages to operators and mechanics is usually late causing low enthusiasm for work. There is also no incentive plan (overtime pay or bonus) approved for the operators.

There are a number of other problems associated with the extension arm of the project. These include (i) The extension man may not visit the farm for inspection and write his report in his office saying that the farm is in a mechanizable condition. When the inspector from the engineering division gets there, he finds a different situation. (ii) The extension division may not give enough advance notice of work to the engineering branch, (iii) Irregularities in the submission of advance program of work to the engineering division. Such estimates, when made, may be grossly over-estimated. For instance, in Ado-Ekiti, it was estimated that there would be 91 acres to be ploughed for March 1970 whereas actual acres ploughed were four and a half. (iv) It is also felt that the extension division is not giving enough publicity to the scheme. Lack of adequate co-ordination and co-operation between the two divisions has hampered the running of the hire scheme.

The fact that the scheme is operated by the Government is a source of problem. Since it is a Government job, nobody feels seriously worried or hurt by the outcome of the scheme. Farmers also feel that since it is a Government project, it is unfair to charge them anything. To this type of attitude is added the usual Government red tape. The hiring set up is thoroughly inefficient. Service is notoriously untimely with the result that many farmers have been frustrated. It is clear that the Government is not the appropriate institution to manage the tractor hiring business. The private units have shown greater efficiency and farmers have enjoyed their services much better than the Government hiring units. A project operated by the Government will, in all probability, fail unless it is run on strictly business lines and independent of Government functionnaries.

Farmers face the problem of market limitation. There is no market for high-yielding, new varieties of maize. The market limitation is aggravated by crude storage methods. Insect damage of maize is the rule rather than the exception. Farm mechanization policy is not accompanied with an appropriate policy in the area of marketing.

Manpower problems, both in quantity and quality abound. The Ministry is short of agricultural engineers. The quality of training of mechanics and operators is questionable. Supervision of work is not thorough because of shortage of the supervisory staff. The area under each supervisor is too large, particularly in Oyo Divisions, to do a thorough job.

There is no established machinery to ensure that farmers pay their balance of tractor hire costs. The practice of refusing service to farmers who have failed to pay was not vigorously pursued to prevent reduction in the number of users.

All the mechanization activities are confined to seed bed preparation. To this extent, mechanization is partial. That is, the tractor is used to supplement, and not to replace, the hoe and cutlass. It can be argued that because of the high cost of tractor operation, tasks to be mechanized should be selective. On the other hand, partial mechanization creates two other problems: weeding and harvesting.

Both problems can place serious limitations on expansion of acreage. Since no mechanical help is available after land preparation operations, the farmer faces the serious problem of keeping weeds down. At Mokwa (8) (Nigeria) and Nachingnea (36), this problem was faced. The expansion of cultivable acres will be restricted unless attention is given to the provision of simple hand tools for weeding. The

severity of the harvesting problem depends on the amount of labor required and the possibility of spreading out harvest period without undue loss. Timely harvesting is as important as timely planting. At the symposium on mechanical cultivation in Uganda in 1960 the observation was made that ". . . the overall availability of labour at harvest places a limit on the expansion of cultivation at the moment." Inadequate labor supplies to ensure timely harvesting together with inability to keep weeds down (due to lack of laborers or money to hire them) may totally nullify the benefits derived from mechanical land preparation.

Farmers were asked why they did not grow more acres than they did. The response is set out in Table 9.3.

Table 9.3 RESTRICTIONS ON FARM SIZE BY TYPE OF FARMER
Western Nigeria, 1970

Type of restrictions	Type of Farmer		
	Farm settlers	Group farmers[a]	Individual users
	Percent of Farmers		
Unable to maintain a larger size[b]	71.9	57.5	74.4
Inadequacies in the tractor hire service[c]	17.5	24.3	17.0
Stumping	0	18.2	4.3
Land shortage[d]	10.6	0	4.3

[a]In case of group farmers, acreage cultivated may be restricted by: (1) very small size of group, (2) the fact that members have individual farmers, separate from the group farm.

[b]Maintenance operations include weeding, thinning and harvesting. Laborers are either not available or the farmer has not the money to employ them.

[c]These inadequacies include untimeliness in service and/or non-availability of service.

[d]This is particularly important on Oshun farm settlement where the available stumped land is too small.

There are two salient points to be deduced from this table. The first is that for a large number of farmers, the maximum size of operation is about reached until solutions are found to the post-planting problems of weeding and harvesting. A farmer in Oyo South, for instance, wanted to plant 25 acres of maize but when he thought of the maintenance problems, he grew only five acres. Secondly, there are still a number of farmers who want to grow bigger, who could have cultivated more acres, but failed to do so owing to problems associated with the tractor hire service. The author saw acres of land in Ado-Awaye, Iseyin District, already stumped but no tractor was available to plough. Some were ploughed but not harrowed and returned to bush. Similar conditions were seen in Ago-Are/Offiki area. In Oyo North, rice farmers were to grow a total of 1,000 acres in 1971, only 400 acres were mechanized for them. In Ado-Awaye, over 200 acres of late maize were planned, but only one tractor was available and that one broke down. In 1970, tractor problems caused similar acreage restrictions for rice farmers in Oyo North. According to the circle annual report, ". . . Out of the 680 acres requested by (rice) farmers to be cultivated, only 310 acres or about 46 percent were cultivated whereas the one-third tractor deposit required was paid for 680 acres." (26) This shows that for some farmers, acres cultivated were limited by problems associated with tractor services rather than by unwillingness on the part of the farmers.

CHAPTER X

SUMMARY AND RECOMMENDATIONS

The subject of farm mechanization in developing countries is a controversial area. It is controversial because of doubts about its rationale in the setting of developing countries into which it is imported. Because of high cost of tractor operation and the "cheap" labor, the establishment of farm mechanization projects is insensitive to an otherwise highly price sensitive principle of substitution. What is more, the consideration of alternatives has been neglected. In particular, the usual sequence of change from manual to animal to mechanical power has been broken by jumping from manual to mechanical power. The result is that while aspiring to modernize agriculture, there is an implicit belief that only the modern sophisticated mechanized production techniques of the western countries can do it.

Farm mechanization in developing tropical countries finds itself in a different setting and set up. It is a foreign and specialized production method, imported into different economic, social and institutional arrangement. All these factors underline the doubts, in the minds of many economists both from developed and developing countries and indeed in the minds of governments that set up the projects, concerning how the new mechanized production techniques will fare.

The above considerations prompted the research on which this study was based. It does not tackle an otherwise basic problem of implicit acceptance that the use of sophisticated western production technique is the only way to modernize peasant agriculture. Rather it takes this production technique as given and proceeds to clear the doubts concerning how it might perform in developing countries, using the case of Western Nigeria.

Farm mechanization was introduced in Western Nigeria as a tractor hiring service. Although there are a few private hiring services, the Ministry of Agriculture is the principal agency that operates tractor hiring service for farmers. According to the Ministry, the project was started to introduce the benefits of farm mechanization to the farmers and thereby create the demand for tractor use after which the project will be turned over to private investors. In the process, it is hoped, food production will be increased, farmers will be able to increase their size of farms and the drudgery and backache that accompany the use of traditional methods of the hoe and cutlass will be reduced.

As of 1971, there were 16 government tractor hire stations in the State from which farmers obtain tractor services by sending applications to the Engineering branch through the Extension Service Division of the Ministry. The hire service prepares seed bed for farmers which consists of ploughing, harrowing, and ridging/planting. All mechanization activities end there. In studying this type of farm mechanization project in the setting of predominantly poor, illiterate peasant farming families guided by a civil service type project administration and operation, the author examined (1) The users and structure

of tractor hiring service. (2) The peasant farmer economic base and ability to use hire service to any significant profit vis-a-vis non-users. (3) The utilization of available tractors and problems that tend to hamper productivity. (4) The performance of the system in meeting the requirements of farmers on time. (5) The magnitude of tractor hire cost in the cost structure of the peasant farmers. (6) The impact of tractor use on labor requirements, farm size and farm practices.

Primary data were collected by personal interview method in the summer of 1971. Three undergraduates of the University of Ife assisted the author in the survey. Data collected included information on the farming operations of farmers who used the hire service, data on the tractor utilization and operational problems plus information on delays in servicing farmers. Four types of farmers--farm settlers, group farmers, individual users and non-users were interviewed. In all, a sample of 193 farmers and nine private tractor owners were interviewed. Fifteen of the 16 tractor hire stations were visited. Farmers were interviewed concerning crops for which they used tractor service only. Such crops included maize, cotton, tobacco and rice.

Analysis of farming operations of users was done for maize crops alone--both the early and late maize crops. Size of operation, cash receipts and cost structure were analyzed by type of farmer and location. Analysis of variance technique was used to examine whether net return per acre significantly depends on type of crop, type of farmer, location, the number of operations mechanically performed and use vis-a-vis non-use of tractor.

The tractor users have a number of alternative operational procedures open to them. Before the ploughing stage, there is the option to clear the grass or not to clear the grass. The difficult problem of decision making is faced by the farmer after ploughing his field. He has to decide what other operations he can do mechanically before the planting stage. Some farmers skip harrowing, some trade harrowing for fertilizing, and some double plough instead of harrowing. Budgeting technique was used to examine the relative profitability of these alternative procedures. The equally basic questions of whether a farmer should add the tractor hiring to his farm practice and the size-cost relationship were also analyzed using the budgeting technique.

The question of whether the use of tractor services has been growing and if so at what rate was analyzed only at the aggregate level. Five operations--ploughing, harrowing, ridging, planting and transporting were analyzed for three circles--Ibadan, Abeokuta and Akure for the period 1965/66-1969/70. Both linear and exponential trends were fitted using the ordinary least squares estimator.

The usage of tractors constitutes an important segment of the study. Utilization of tractors was analyzed by circle, regional work concentration per circle, seasonal work patterns and the ratio of hours of transporting to hours of field work by circle and region within circle. The factors which tend to hold down the level of tractor utilization were also examined.

In farming, time has a high marginal utility as farm operations have to be performed to meet rigid time deadlines. How timely the hire units serviced their customers to enable them to plant their crops on

time therefore represents an important yardstick of the performance of the whole hiring setup. The analysis of farmers' responses indicate that there are symptoms of waiting lines. The system was therefore studied using Queuing Theory.

The modern tractor method of crop production is a labor saving technology. The impact of the tractor on labor was examined. The use of tractor increases labor inputs at the stumping stage while it reduces labor inputs after the stumping stage. Thus, it is the net effect of tractor use on labor inputs that was estimated on the basis of an assumed eight-hour working day.

Findings

Both private farmers and government farms use the tractor hire services. In Oyo and Oshun Divisions, the private farmers are the more important customers; but away from Oyo and Oshun Divisions, the opposite is true. Maize is the most important crop for which tractor hire service is extensively used. Ninety-two percent of farm settlers, 52 percent of group farmers and 75 percent of individual users interviewed grew maize.

Private farmers using the hire service consist of individual farmers, group farms, farm settlers, absentee farmers, retired civil servants and high school principals and proprietors. The use of hire service does not seem to be significantly dependent on age and level of formal education. Seventy percent of the individual users had no formal education. There were many old people (above 40 years) as well as many young people (20-30 years) among users. Income level is an important source of difference in respect of size and number of operations mechanized. Many of the users are poor, with a high propensity for

irregular use both in terms of year-to-year use and number of operations mechanized. The absentee farmers, retired civil servants and high school principals have higher incomes, mechanize larger acres for all operations and are consistent in use from year to year.

Among private farmers, the modal size of farm is three acres, indicating that farm size is still generally on the low size. But the use of tractors has been increasing the size of operation. The tractor users were found to have a greater tendency to grow more acres than non-users. For early maize, 13 percent of individual tractor users as against 1.6 percent of non-tractor users grew more than ten acres. For late crop the percentages are 8 and 1.9 respectively.

For both early and late maize crops, costs of tractor hire constitute the largest percentage of total expenses per acre for tractor users. It averaged 45.8 percent for individual users, 46.5 percent for farm settlers and 56.5 percent for group farmers. For non-tractor users, labor takes the largest slice of total expenses per acre.

For both early and late maize crops, the non-users got a higher mean net return per acre than users. Among early maize growers, non-users earned a mean net return of 91 shillings per acre as against a mean net return of 58 shillings per acre for users. Among late maize growers, non-users earned a mean net return of 76 shillings per acre as against a mean net return of 34 shillings per acre for users. For both early and late maize crops, gross receipts per farmer was lowest among non-users. This factor might explain why farmers want to use the service. Alternatively, it is possible to argue that many farmers still use the service because it is profitable but that the damage to

crops caused by the drought of 1970 (Chapter III) beclouds this picture. The fact that mean net return per acre or per farmer was higher among non-users than users reflected the higher cash expenses of users and therefore a greater adverse effect of the drought on the users than non-users. The data do not lead one to reject the null hypothesis of equal mean net return per acre between users and non-users. There is no significant difference in net return per acre between users and non-users of hire service in maize production. Tractor users do not show significant superior operating results over non-tractor users. The lack of statistically significant difference in mean net return per acre or per farmer between users and non-users should not be taken as conclusive because the drought problem beclouded farm operating results in 1970.

Budgeted results show that tractor hire use is a very expensive addition to the package of farm practices. Cost of stumping is 59 percent of added costs. The added costs are very high relative to costs eliminated when mechine hire is added to farm practices. With stumping cost at zero level, yield would have to increase by at least 10 percent or tractor costs reduced by at least 24 percent for the change in net income per acre to be positive.

The tractor hire service is an effective vehicle for promoting the use of improved agricultural technology and increasing the level of commercialization of inputs. The growing of improved seed varieties and the use of fertilizers were higher while the practice of mixed cropping was lower among the tractor users than non-users. Farmers

have realized the benefits from the new package of modern farming practices--use of tractor, fertilizer application, growing of improved, high-yielding varieties and sole cropping. But they have been unable to absorb these practices to a significant degree because of lack of operating capital, lack of storage facilities and market limitations. In fact, low product prices, lack of market for the high-yielding, new maize varieties, lack of storage facilities and lack of supply of and/or inability to buy fertilizer had almost completedly wiped out the financial gains farmers could obtain from mechanization.

It was found that it is profitable for farmers to skip the harrowing operation. But the less profitable it becomes the higher is product price and/or yield. Harrowing operation could also be traded for fertilizing with profit. This operational procedure was found to be more profitable the lower is fertilizer prices and/or the higher is maize response to fertilizer applications. For both crops, mean net return per acre was highest for carrying a complete operation--plough,

harrow and ridge/plant. In respect of late maize, net return per acre does not significantly depend on the number of operations mechanically performed among individual users. But in case of early maize, it is the opposite among settler users.

The use of tractor caused a net decrease in labor requirements for seed bed preparation. There is at least a saving of 4.77 man-days per acre. For eight-hour working day, the time released to the farmer is at least 2.2 shillings per hour. The general tendency is for the released labor to move into non-agricultural occupations, of which the most important is small trading business.

The labor/tractor price ratio does not show a consistent pattern among all places and types of operation. The hypothesis that labor is cheap relative to tractor needs to be examined by location and type of operation. At the current Government tractor charges, it is cheaper to do ridging and fertilizing with tractors than with labor. But labor is cheaper for planting operations. The labor/tractor cost ratio averaged 1.4 for ridging operation and 3.7 for fertilizing operation in Oyo Divisions. For planting operation, the ratio average 0.55 in Oyo Divisions and 0.78 in Oshun Divisions.

Outside of Oyo and Oshun Divisions of the State, available mechanization activity is almost nil. Engineering work is small owing to the nature of crops grown and the thick vegetation. Therefore, tractors in these areas are used predominantly for transporting. The ratio of hours of transporting to hours of field work is highest in these areas and lowest in Oyo and Oshun Divisions.

Work load is highly seasonal. There are two main peak seasons--early and late seasons. The early season is from March-May

while the late season is from July to August. Tractors are fully engaged for not more than six months in the year. The slack period, September/October-February are devoted to transporting and clearing of tractor station surroundings.

Productivity, measured in hours per tractor is low, ranging from 10.84 in Akure to 838.4 in Ijebu-Ode Division. The causes of low productivity include: lack of work, seasonality of work, high frequency of tractor and implement breakdowns which remained unrepaired for length of time ranging from weeks to years. The reason is due to spare parts problem. Inadequate supply of supporting inputs--spare parts, mechanics, repair shops, tractor operators and fuel--also hold down the level of productivity. No enthusiasm for work was found among tractor operators and mechanics. Everywhere the author was presented with long lists of complaints about conditions of work and irregularities in wage payment.

Service was found to be highly untimely. This was the most frustrating experience of farmers. Some dropped out of the list of users because of long delays, subsequent late planting and failure of crops. With six tractors available per day, it was found that a farmer would spend an average of 32 days in the system of which 19 days were spent on the queue. In Oyo Divisions, the congestion problem is so serious that the Agricultural Engineer ordered that new applications should not be accepted, particularly in the early peak season of March-May. Congestion builds up because all the farmers want to do the same operation at the same time and the available tractors and implements are not enough. A large percentage of those available were rendered inactive because of breakdown. As far as Oyo and Oshun Divisions are

concerned, it is certain that Government tractor stations alone can not cope with the available volume of work.

Conclusions

Certain tests can be used to judge the economics of mechanization of peasant farms. These tests include (i) mechanization will be questionable if it does not permit expansion of the tillage area and induce changes in farm practices (ii) to be worthwhile, the use of tractors has to result in much earlier average date of sowing (iii) it should afford the farmers higher returns in the form of cash than the native method of cultivation. The current mechanization scheme has been more successful in the first test. Overall success and performance have been below expectations. To a large extent this is due to the fact that machine technology had been introduced into an environment where the basic supporting facilities for its successful operation are not yet well developed.

Recommendations

In Western Nigeria, the use of tractors has entered the agricultural scene in a significant way, through the tractor hiring service. Farmers have been exposed to the benefits and comforts of tractor use. There are still many of them, particularly in Oyo and Oshun Divisions, that are likely to use the service. Therefore, anything done to improve this service to farmers will contribute, in no small measure, to the pace of agricultural modernization in the State. Based on this study, the following suggestions are put forward to illustrate the areas where changes can be carried out to improve the scheme and give better service to farmers.

The primary recommendation is to divide the mechanization project into two and put each part under a different operator. The first section will consist of all Government and Government-related farms, the second section will consist of all private farms. The mechanization of Government farms will continue to be managed and operated by the Government, but the Government will relinquish the operation of mechanization activities connected with private farms. Instead, a body that will run the hire system on a strictly commercial line should take over. The Government can hand this phase of the project to one of two alternative bodies: (a) Sponsored individuals along the lines similar to the system of the Nigerian Tobacco Company, (b) A corporate firm. One of the tractor distributing firms may be a good candidate in this regard.

Apart from the primary recommendation, there are others which deal with specific aspects of the mechanization project. It is recommended that the Western State Ministry of Agriculture:

1. Implement a policy of guaranteed product price. Only the high-yielding maize variety will be covered. The Government will specify the prices at which it will purchase the improved type maize and farmers will only sell to the Government if a higher price cannot be obtained in the open market. The policy should be designed to provide guaranteed markets for this type of maize and thus encourage farmers to grow them. In servicing farmers, priority might be given to farmers who want to grow the improved varieties so that there will exist a built-in mechanism to collect tractor costs.

2. Establish a code of conduct and an incentive plan for tractor operators. A bonus system is recommended, payable only if a target is exceeded per month. This will promote greater work enthusiasm and serve as a tractor operator allocation device.
3. Increase the number of trained operators and mechanics. Better training in tractor handling could reduce the rate of equipment breakdowns.
4. Provide the required tools on each hire unit that will enable the mechanics to do minor repairs. Only major breakdowns ought to go to the area workshop. In addition, provide each hire unit with a fuel depot or large number of containers (drums) to be able to stock large quantities of fuel on the hire station.
5. Carry mechanization a step further. Weeding is the real problem between planting and harvesting. Farmers could be given loans to purchase the small inter-row cultivators. This will reduce one of the most critical problems that currently plague the farm mechanization project.
6. Assess the mechanization status, its performance and effectiveness, on a periodic basis.
7. Attack the stumping problem by either (a) mechanize the operation but find ways to reduce the loss of top soil (b) subsidize farmers on the cost of stumping.
8. Decentralize the tractor hire stations, particularly in respect of hire units that cover long distances. Tractors would be stationed in the field during the working season and transportation provided to carry the fuel and implements that would be

required. Only major repairs should necessitate the return of the tractor to the station before job completion. This system will cut down the traveling time, allowing tractors to be within reach of the farmer thus reducing his trouble of having to visit a distant hire station several times, and allow distant farmers to be serviced with minimum cost.

9. Deplore equipment from the surplus, low work load areas, to the areas of heavy work and inadequate equipment such as Oyo Divisions. The work load and equipment statistics in Akure Circle shows that some of the equipment can be transferred to Oyo Divisions.

Areas for Further Research

In the course of this study the following problem areas were identified as worthy of further research:

1. The selection of appropriate size tractors. Such selection should take account of the performance of the various types of tractors under the Western Nigerian conditions, the nature and volume of work to be done and availability of spare parts and repair shops.
2. Agronomic studies to throw light on the impact on yield of the following procedures:
   (a) Omitting vis-a-vis not omitting harrowing operation.
   (b) Planting vis-a-vis not planting on the flat.
   (c) Cutlassing tall grasses vis-a-vis not cutlassing tall grasses before ploughing operation. What effect it has on quality of ploughing could also be ascertained.

(d) Late planting of crop.

3. A study of the economics of full mechanization. A question to answer is: will the cost of mechanizing weeding and harvesting be too much relative to any net increase in production it might bring about or as compared with the cost or value set on the hand labor that would otherwise accomplish the tasks?

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APPENDICES

APPENDIX A

APPENDIX A

THE GOVERNMENT TRACTOR HIRE CHARGES

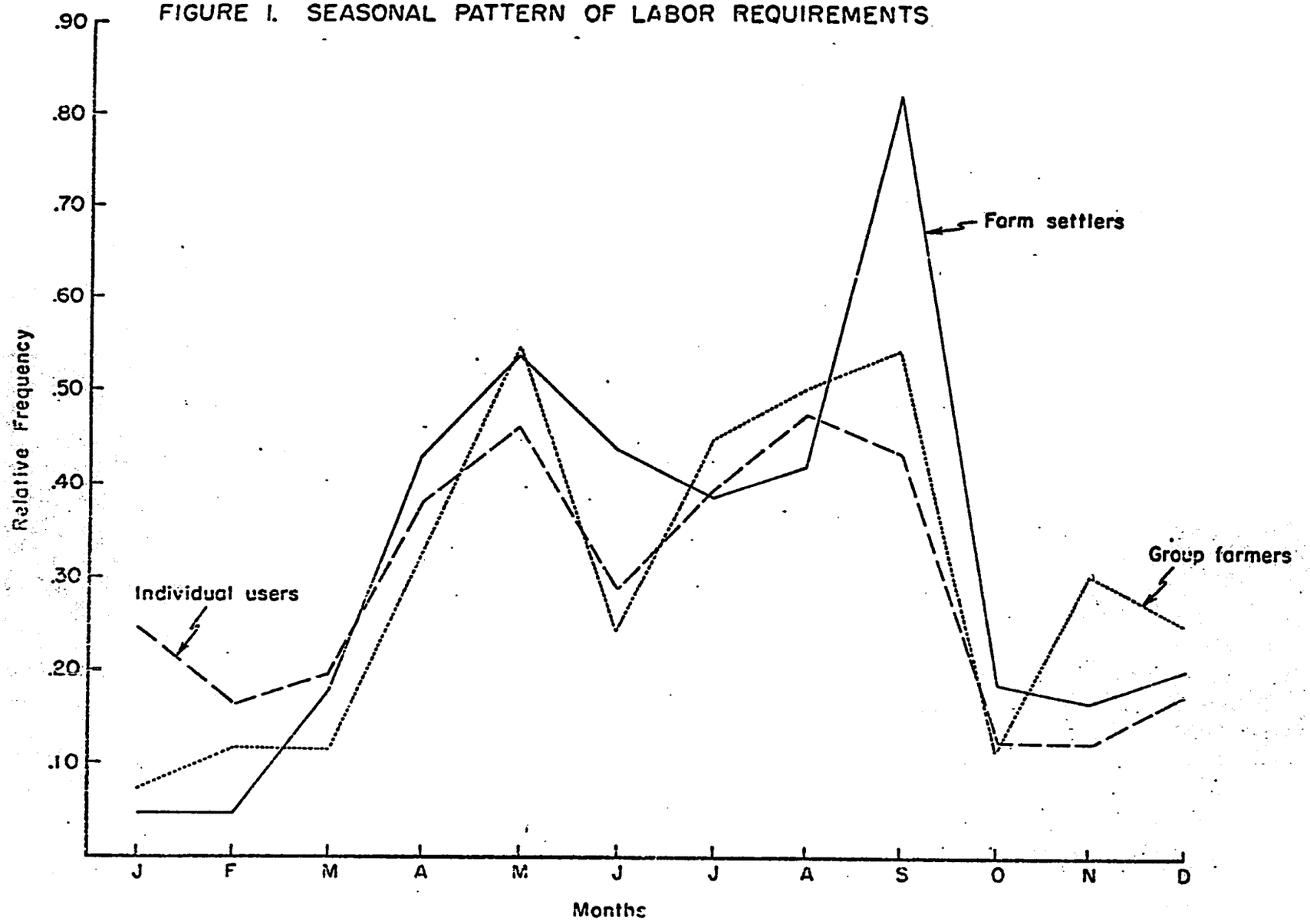
The Ministry claims that farmers are charged full operating expenses, and that there is a subsidy of about 30 percent which consist of supervisory staff and cost of moving the tractors from farm to farm.[1] For ploughing and ridging, government rate is 65 shillings per acre irrespective of crop grown. Rev. Macbee, a private tractor hirer, charges tobacco farmers 75 shillings per acre and 60 shillings for food crop farmers. Average price charged per acre for these two operations comes to 67.5 shillings per acre. For the same two operations, Chief Olaniyan, another private tractor hirer, charges 82.5 shillings per acre. Government rate is thus smaller than rates charged by these private hirers. Of course, if food crop farmers alone are considered, the rate charged by Rev. Macbee is smaller than that of the government. There is some reason to suspect that the government is not charging farmers the full operating expenses, that the government is subsidizing the rates farmers pay per acre.

Labor Bottlenecks

Labor requirements are highly seasonal in nature. The months of May and September are the peaks of seasonal labor requirements (Figure 1). The demand for labor starts to rise from about March to

[1]Activities and programs of the M.A.N.R., Western State of Nigeria, March, 1971.

FIGURE I. SEASONAL PATTERN OF LABOR REQUIREMENTS



April for ridging and planting of early crop. The peak May demand is for weeding of early crop. The rise in demand from July to August is for preparation for late crop. The September peak is for weeding of late crop. The moderate increase in October to December is for harvesting.

Although the peak periods of heavy labor requirements are May and August/September, labor bottlenecks set in from March. The slack period is generally from November to February. Farmers are heavily burdened with farm work from March to September with a low in June.

There is a shortage of farm labor in all areas for all type farmers between May to August. In Oyo South shortage is in May/June while in Oyo North and Oshun it is in July/August.

It is difficult to get hired help because of the following:

(I) The unwillingness of people to be or be called a laborer. People prefer to be owners. Farmers interviewed were very annoyed when asked if willing to work for others for pay at their spare time. They regarded such a step as a retrogression. The question was dropped when it was realized that farmers hated it.

(II) The heavy dependence on the use of immigrant people as laborers. This point ties with the above point. There is no farmer in the same locality who will work for others for pay. They all depend on farmers from other parts of the country. These immigrant laborers are

mostly from the Kwara State. Therefore, there is no hired help before they arrive and when they go back. It is common for these immigrant farmers to arrive late since they have their own farms and only work for others to supplement their income.

(III) The demand for hired labor far exceeds the supply. Most farmers want farm help for similar operations at similar periods, particularly for ridging and weeding for both early and late crops. Since they all depend on immigrant laborers, farmers have to que up for services. Some farmers adopt the practice of yearly employment of hired labor to get over this problem. The limitations of this practice are (a) shortage of cash to pay (b) the non-availability of people ready to be engaged as permanent laborers.

(IV) Lack of money to employ laborers. Usually, hired labor is paid after the work is finished and are ready to return. But many farmers had faced serious troubles with the laborers when unable to pay on time. Therefore, many farmers hesitate to employ laborers if not completely sure of ability to pay.

The lack of money problem is further reinforced by the fact that laborers want to be paid government rates, sometimes. For instance, at Ogbomosho farm settlement, laborers asked for 6.25 shillings per day, which is government rate instead of 4.16 shillings per day which settlers usually pay. The

settlers figure that it will not pay them to employ laborers at the government rate.

(V) The type of crop grown may also constitute a source of problem. For instance, laborers do not want to weed rice farms because it is difficult and rice irritates during the operation. All rice group farmers in Ekiti Division mentioned the difficulty of getting hired help because of this factor.

(VI) Price relatives. Since the immigrant laborers' principal aim is to get additional money to supplement his income, he is ready to do that work that gives higher pay. Farmers face the competition of other jobs which offer higher pay. For instance, in Oyan, Oshun Division, laborers tend to go to other jobs which pay five shillings per day instead of going to the farm where farmers are only able to pay 3.5 shillings per day. This type of competition was also mentioned at Eruwa as being responsible for the difficulty of getting hired help.

(VII) There is also competition from cocoa growing areas. The immigrant farmers move to the cocoa growing areas for employment in weeding around July/August thus depleting the hired help available to the food growing areas. All these factors, added to the increasing absence of help from children (as a result of free primary education) and wives, make the farm labor situation one of the most critical problems currently faced by the farmer.

Farm mechanization of seed bed preparation has, to some extent, helped to reduce the peak labor demand of March/April. But because mechanization has been used to supplement rather than replace the hoe and cutlass, that is, mechanization is partial, it has helped to create the peak labor demands for May (for weeding) and August/September (for weeding and harvesting). This is due to the fact that mechanization of the tasks associated with crop planting has a tendency of increasing the acreage cultivated.

Table A-1 TRACTOR HIRE CHARGES BY TYPE OF SERVICE
Western Nigeria, 1970

Service	Charge in shillings/acre
Ploughing	45.0
Harrowing	17.5
Ridging	20.0
Planting without fertilizer	20.0
Planting with fertilizer	22.0
Transporting	15/hour

Source: M.A.N.R. Engineering Branch, Ibadan.

Table A-2 TRACTOR HIRE CHARGES BY REVEREND MACBEE
Igbo-ora, Western Nigeria, 1970

Type of farmer	Tractor Operation	
	Ploughing	Ridging
	Shillings per Acre	
Tobacco growers	45	30
Maize growers	40	20

Table A-3 THE LEVELS OF SUBSIDIES FOR FERTILIZERS
Western Nigeria, 1970

Type of fertilizer	Regular price in shillings per cwt	Subsidized price in shillings per cwt	Percent subsidy
15-15-15	45.0	23.0	48.9
25-10-10	41.5	20.8	49.9
Sulphate	31.4	15.7	50.0

Table A-4 PRICES OF FERTILIZER SUPPLIED BY
NIGERIAN TOBACCO COMPANY
Western Nigeria, 1970

Fertilizer type	Price in shillings per 66 pound bag
D	28.08
K	28.08
P	35.66/ 100 lbs.

Source: NTC Office, Iseyin.

Table A-5 THE LEVELS OF SUBSIDIES FOR SEEDS AND CHEMICALS
Western Nigeria, 1970

Crop type	Subsidized price pence/lb.	Unsubsidized price pence/lb.	Percent subsidy
Maize	3	n.a.	n.a.
Rice (OS6)	6*	n.a.	≥ 50
Cotton seed	1	n.a.	n.a.
Kenaf	42	60	30
Vetox 85 (for cotton farmers)	93	144	36

*The price was 3/lb. till 1970. From 1971, it was increased to 6/lb.

Table A-6 LABOR-TRACTOR COST RATIO BY TYPE OF OPERATION AND LOCATION
Western Nigeria, 1970

Oyo Divisions			Oshun Division
Planting	Ridging	Fertilizing	Planting
0.4	2.1	1.8	1.8
1.5	2.0	8.3	1.8
0.5	1.0	3.3	1.7
1.7	1.2	3.3	0.12
2.8	1.1	3.3	0.12
0.5	0.9	0.8	0.35
0.5	1.3	2.2	0.12
0.3	1.5	5.0	0.2
0.4	1.5	4.5	
0.2	1.8	4.3	
0.5	1.2		
0.7			
0.2			
0.4			
1.0			
0.4			
0.3			
0.6			
0.12			
0.12			
0.12			
0.2			
0.2			

Table A-7 LABOR/TRACTOR COST RATIO IN PERFORMING THE RIDGING OPERATION
Western Nigeria, 1970

Oshun Divisions		Oyo Divisions		Oyo Divisions	
Shilling /acre	Labor/ tractor	Shillings /acre	Labor/ tractor	Shillings /acre	Labor/ tractor
40.0	2.00	83.3	4.10	9.10	0.40
30.0	1.50	4.5	2.20	23.75	1.18
40.0	2.00	4.5	2.20	17.50	0.80
25.0	1.20	4.5	2.20	14.20	0.70
20.0	1.00	1.5	0.75	17.50	0.80
35.0	1.75	1.6	0.80	16.60	0.83
20.0	1.00	1.4	0 70	16.60	0.83
15.0	0.75	46.6	2.30	16.60	0.83
22.0	1.10	60.0	3.00	4.50	2.25
15.0	0.75	83.3	4.10	8.80	0.40
35.0	1.75	7.5	3.75	10.00	0.50
60.0	3.00	7.5	3.75	15.00	0.75
60.0	3.00	7.0	3.50	11.60	0.58
60.0	3.00	7.0	3.50	30.00	1.50
50.0	2.50	4.5	2.25	40.00	2.00
40.0	2.00	8.0	4.00	40.00	2.00
50.6	2.53	4.5	2.25	34.50	1.72
70.0	3.50	4.0	2.00	35.00	1.75
72.6	3.60	2.0	1.00		
41.6	2.08	6.6	0.30		
37.5	1.08	2.0	1.00		
38.8	1.40	27.7	1.38		
50.0	2.50	30.0	1.50		

Table A-8 HIRED LABOR DAILY WAGES BY LOCATION AND TYPE OF JOB
Western Nigeria, 1970

Type of job	Location					
	Oyo North	Ekiti	Eruwa	Odo-ogun	Ilobu	Ilesha
	Shillings					
Maize						
Fertilizing	--	--	--	3-4	5	--
Thinning	--	--	--	3	--	--
Planting	3.5	--	10	--	--	--
Weeding	5.5-6	--	--	--	--	--
Harvesting	--	--	5	--	3.5	--
Tobacco						
Fertilizing	--	--	7	--	--	--
Planting	--	--	5	--	--	--
Harvesting	--	--	4.5-5	--	--	--
Rice						
Bird scaring	--	7	--	--	--	--
Stumping	--	--	--	--	--	12

Table A-9 MAIZE YIELDS[a] BY LOCATION
Western Nigeria, 1968/69-1970/71

Region	Period 1968/69	1969/70	1970/71	Standard yield
	Lbs. per Acre			
Owo E.W.S.[b]	781.25 (500)	—	—	—
Ikare E.W.S.	798	—	—	—
Ado-Ekiti E.W.S.	1300	—	—	—
Ife E.W.S.	354 (371)	—	—	—
Ikole E.W.S.	1708 (431)	—	—	—
Odeda Farm Institute	—	1231.7 (1136)	1867.6 (514)	1200-3000 (650-1000)

Source: Circle Annual Reports. M.A.N.R., 1968/69-1970/71. Ibadan.

[a]Figures in brackets are for late maize.

[b]E.W.S. = Extension work station.

Table A-10 MAIZE YIELDS[a]
Western Nigeria, 1970

Type of farmer	Early Maize Mean	Early Maize Median	Late Maize Mean	Late Maize Median
	Bags[b] per Acre			
Farm settlers	4.7	4.8	2.2	1.3
Non-tractor users	2.47	2	1.62	1.16
Group farmers	2.47	1.75	1.77	1.33
Individual contractors	3.44	3	2.48	2.13

[a]These figures are not adjusted for domestic consumption, seed allowance and poultry feed (in case of farm settlers). An adjustment for these factors will contribute an increase to the figures.

[b]10 bags = 1 ton or 1 bag = 2 cwt.

Table A-11 MAIZE YIELDS[a]
Western Nigeria, 1970

Tractor Users		Non-users	
Early maize[b]	Late maize[c]	Early maize	Late maize
Bags per Acre			
8.4	5.5	6.0	4.9
6.5	4.0	5.0	3.3
5.5	3.3	3.3	2.0
5.0	2.5	2.6	1.7
4.0	2.3	2.0	1.4
3.1	1.8	1.7	1.2
2.5	1.3	1.5	1.0
2.0	1.0	1.3	0.9
1.6	0.8	1.0	0.8
1.0	0.5	0.9	0.5

[a]The figure at the top of each column is the median of the highest ten percent of the growers in yield/acre. For example, 8.4 is the median of the ten percent of the growers of early maize with the highest yield.

[b]Variance = 5.98.

[c]Variance = 3.12.

Table A-12 ACRES OF MAIZE GROWN
Western Nigeria, 1970

Type of farmer	Early Maize				Late Maize			
	Mean	Median	Mode	Variance	Mean	Median	Mode	Varianc
Group farmers	7.06	4	4	35.6	6.4	5	3.5	15
Farm settlers	9.7	8	5	44	5.6	3	2	26.9
Individual users	6.5	4	2	61	4.9	3.5	2	44.6
Non-users	4	3	3	7	4.1	3	2	7.6

Table A-13 ACRES OF MAIZE GROWN*
Western Nigeria, 1970

Early Maize			Late Maize		
Farm settlers	Individual users	Non-users	Farm settlers	Individual users	Non-users
22.0	30.0	9.5	21.0	15	10.0
17.8	15.0	8.0	10.5	10	8.0
15.0	7.0	6.0	10.0	5	5.0
12.8	6.0	4.8	8.5	5	4.0
8.5	6.0	3.0	6.0	4	4.0
8.0	4.5	3.0	5.0	4	3.0
7.0	4.0	2.5	4.5	3	2.5
6.0	3.0	2.0	3.0	2	2.0
5.0	3.0	2.0	2.3	2	2.0
5.0	2.0	1.0	2.0	2	1.0

*The figure at the top of each column is the median of the highest ten percent of acres grown. The other figures in the column are the medians for the next best ten percent, etc.

Table A-14 MAN EQUIVALENT BY TYPE OF FARMER
Western Nigeria, 1970

Type of farmer	Average	Range
Farm settlers	1.6	2.8
Individual users	2.2	6.8
Non-users	2.1	3.3

Table A-15 LABOR FORCE BY TYPE OF FARMER[a]
Western Nigeria, 1970

Type of farmer	Type of Labor		
	Unpaid family	Hired	Other*
		Months	
Individual users	8.5	6.8	1.9
Settler users	2.9	4.6	1.8
Non-users	8.8	4.6	1.2

[a]For youths under 15, one month is taken as two-thirds adult month.
*Includes relatives, communal labor, friends and apprentices.

Table A-16 LABOR INPUTS
Western Nigeria, 1970

Tractor users*	Non-tractor users
Man Equivalent[a]	
4.4	4.6
2.7	3.0
2.2	2.6
1.8	2.2
1.7	2.0
1.5	1.8
1.3	1.6
1.1	1.3
1.0	1.2
0.9	1.1

*Excludes group farmers

[a]The figure at the top of each column is the median of the highest ten percent. The next figure is the median of the next ten percent, etc.

Table A-17 CAPITAL EQUIPMENT[a] BY TYPE OF FARMER
Western Nigeria, 1970

Capital equipment in shillings	Type of Farmer		
	Individual users	Farm settlers	Non-users
		Percent	
Less than 50	7.9	32.7	8.8
50-100	43.1	44.2	40.4
101-150	21.6	21.2	22.8
151-200	7.9	1.9	8.8
201-250	1.9	0	10.5
251-300	3.9	0	3.5
Above 300	13.7	0	5.2
Total	100.0	100.0	100.0

[a]Capital formation by self and communal labor is common. Many farm buildings (huts) and baskets were made by the operator himself or by communal help (owe). These are not included.

Table A-18 THE STRUCTURE OF FARM EQUIPMENT BY TYPE OF FARMER
Western Nigeria, 1970

Type of equipment	Type of Farmers		
	Individual users	Farm settlers	Non-users
	Percent of Total Equipment		
Hoe	21.9	30.3	31.0
Cutlass	20.7	29.4	27.6
Bags and baskets	39.6	39.2	27.0
Farm buildings[a]	8.3	0	14.4
Axe and digger[b]	8.2	0	0
Other*	1.3	1.1	0
Total	100.0	100.0	100.0

*Includes sickle, hand sprayer and mortar for maize shelling.

[a]Excludes dwelling house.

[b]Used for stumping.

APPENDIX B

Table B-1 TRACTOR MECHANICS
Ibadan Hire Unit, Western Nigeria, 1970

Mechanic	Daily pay in shillings	Year employed	Grade
1	13.66	1965	Art III
2	14.08*	1969	Art II
3	15.00*	1967	Art III

*Have passed the intermediate City and Guild Exmination.

Table B-2 DAILY WAGES, TRACTOR OPERATORS AND MECHANICS
Ado-Ekiti Hire Unit, Western Nigeria, 1970

	Tractor operator	Tractor mechanics
	Shillings per Day	
1	--	15.66
2	15.66 (15.83)	--
3	15.00 (15.83)	--
4	15.00	--
5	12.00	--
6	--	12.5
7	--	19.83

Figures in parentheses are the Friday rate.

Table B-3 WAGES OF TRACTOR OPERATORS AND MECHANICS
Abeokuta Circle, Western Nigeria, 1970

Tractor Operators			Tractor Mechanics		
Location	Daily pay in shillings	Grade	Location	Daily pay in shillings	Grade
Otta	17.16	Art III	Ikenne	19.83	Art II
Otta	15.00	Art III	Ilaro	15.66	Art III
Abeokuta	12.00	Art III	Abeokuta	19.83	Art II
Abeokuta	17.16	Art II	Abeokuta	12.91	Art III
Ijebu	17.16	Art II	Abeokuta	18.91	Art II
Ijebu	17.16	Art II	Abeokuta	17.33	Art II
Ijebu	12.50	Art III	Abeokuta	15.25	Art III
Ikenne	12.50	Art III			
Ikenne	12.50	Art III			
Ikenne	10.58	Special labor Grade I			
Ikenne	12.50	Art III			
Ilaro	17.16	Art II			
Ilaro	16.41	Art II			
Ilaro	16.41	Art II			
Ilaro	12.91	Art III			
Ilaro	14.16	Art III			

Table B-4 WAGES OF TRACTOR OPERATORS AND MECHANICS
Akure Circle, Western Nigeria, 1970

Tractor Operators			Tractor Mechanics		
Location	Daily pay in shillings	Grade	Location	Daily pay in shillings	Grade
Akure	18.91	Art II	Akure	P.E.*	Art I
Onisere	17.16	Art II	Akure	17.16	Art II
Ile-Oluji	18.00	Art II			
Ile-Oluji	12.50	Art III			
Okitipupa	12.91	Art III			
Okitipupa	12.50	Art III			

*Permanent Establishment. He is the head mechanic at the Akure workshop.

Table B-5 WAGES OF TRACTOR OPERATORS AND MECHANICS
Ilesha H're Unit, Western Nigeria, 1970

Tractor Operators		Tractor Mechanics	
Daily pay in shillings	Grade	Daily pay in shillings	Grade
18.00	Art II	19.66 (19.83)	Art II
17.16	Art II	15.66 (15.83)	Art III
16.41	Art II	10.58 (10.66)	Special labor Grade I
15.00	Art III		

Figures in parentheses are the rates paid on Fridays.

Table B-6 WAGES OF TRACTOR OPERATORS AND MECHANICS
Oshogbo Hire Unit,* Western Nigeria, 1970

Tractor Operators		Tractor Mechanics	
Daily pay in shillings	Grade	Daily pay in shillings	Grade
13.66	Art II	13.66	n.a.
10.00	Art III		
7.83	Special labor Grade I		

*The chargeman who supervises the tractor operators is on £364 p.a. while the mechaniczation officer is on £476 p.a.

Table B-7 MECHANICAL CULTIVATIONS BY CIRCLE
Western Nigeria, 1965/66-1969/70

	Ibadan Circle				Akure Circle				Abeokute Circle			
Year	Acres ploughed	Acres harrowed	Acres ridged	Acres planted	Acres ploughed	Acres harrowed	Acres ridged	Acres planted	Acres ploughed	Acres harrowed	Acres ridged	Acres planted
1965/66	3,084	5,599	1,451	2,084	925	90	200	20	431	341	145	—
1966/67	9,649	8,524	2,188	2,511	1,000	120	225	25	500	421	246	—
1967/68	11,029	7,413	2,326	2,922	1,221	175	300	41	635	640	305	—
1968/69	71,906	8,260	2,911	3,337	11,321	200	325	51	850	800	375	—
1969/70	12,268	8,383	3,033	5,222	1,428	210	338	71	894	815	401	—

Table B-8 HOURS OF TRANSPORTING BY CIRCLE
Western Nigeria, 1965/66-1970/71

Year	Ibadan Circle	Ondo Circle	Akeokuta Circle
1965/66	3,984	912	2,225
1966/67	3,349	10,512	3,725
1967/68	7,284	11,505	4,000
1968/69	7,781	12,001	4,252
1969/70	8,112	12,707	4,452
1970/71	--	11,248	9,102

Table B-9 THE PROFITABILITY OF GOVERNMENT TRACTOR HIRING OPERATION
Western Nigeria

Operation	Acres per hours[a]	Tractor costs in shillings per hour[a]	Charges in shillings per hour[d]			Potential Returns in shillings per hours			Actual[e] returns in shillings/hr.
			1968 Rates	1970 Rates	Percent change	1968 Rates[a]	1970 Rates[b]	change	1970 Rates
Ploughing	0.59	29.56	22.12	26.55	20.02	-7.44	-3.01	-59.54	-16.28
Harrowing	1.16	29.56	20.30	20.30	0	-9.26	-9.26	0	-19.41
Ridging	1.02	29.56	20.40	20.40	0	-9.16	-9.16	0	-19.36
Planting	1.54	29.56	26.94[c]	32.33	20.01	-2.62	2.77	205.72	-13.39

[a] Purvis: Economics of tractor use in Western Nigeria, September, 1968.

[b] Assumes same tractor costs per hour.

[c] Average of charges for planting with and without fertilizer.

[d] Calculated from the rates of work.

[e] Assumes 50 percent of hire charges are actually recovered by the government.

APPENDIX C

Table C-1 RATES OF WORK
Selected Hire Units, Western Nigeria, 1970

Task	Type of Hire Unit			
	Oyo[a]		Ado-Ekiti	Oshogbo
	Acres per Hour			
Ploughing	0.6	0.7	0.7	0.7
Harrowing	1.2	1.6	1.3	1.4
Ridging	1.0	1.5	0.9	1.3
Planting	1.5	n.a.	1.1	1.5

[a]Figures in the first column are from: M. J. Purvis, A Study of the Economics of Tractor Use in Oyo Divisions of Western Nigeria, C.S.N.R.D.-17, 1968.

Table C-2 TRACTORS AND IMPLEMENTS
Selected Hire Units, Western Nigeria, 1970

Hire unit	Tractors		Ridgers		Ploughs		Harrows		Planters	
	Available	Active	Available	Active	Available	Active	Available	Active	Available	Active
					Numbers					
Oshogbo	9	8	1	0	13	10	6	4	2	1
Ilora	7	4	n.a.	n.a.	5	4	2	n.a.	n.a.	n.a.
Ogbomosho	13	8	3	1	11	5	3	2	5	1
Akure	4	4	0	0	6	6	1	1	1	1
Eruwa	14	9	3	2	13	10	5	4	3	2
Ondo/Okitipupa	7	n.a.	0	0	2	n.a.	2	n.a.	3	n.a.
Ife-Ilesha	13	12	5	3	17	12	12	5	5	2
Ado-Ekiti	17	16	5	5	21	16	6	4	3	3
Abeokuta	11	n.a.	1	n.a.	10	n.a.	1	n.a.	2	n.a.
Ilaro	10	n.a.	0	0	3	n.a.	1	n.a.	2	n.a.
Ikenne	8	5	0	0	8	7	6	4	2	n.a.
Ijebu-ode	3	n.a.	2	n.a.	2	n.a.	4	n.a.	0	0

Table C-3 TRACTOR AND IMPLEMENT BREAKDOWNS
Ogbomosho Tractor Hire Unit, Western Nigeria, 1970

Tractors	Number	Since When	Nature of Fault
M.F. 165	1	n.a.	Bolt of steering broke
	1	3 weeks	Fuel pump is bad
Ford 4000	1	20 days	Leaking water*
David Brown	1	3 months	Engine knocked*
Implements	1	6 weeks	Complete breakdown
Plows	6	n.a.	No discs
Harrow	1	2 months	n.a.
Planter	2	n.a.	n.a.
	2	12 months	n.a.

*Dealer is needed to deal with the problem.

Table C-4 TRACTOR AND IMPLEMENT BREAKDOWNS
Oshogbo Tractor Hire Unit, Western Nigeria, 1970

	Number	Since When	Nature of Fault
Tractors			
Ford 3000	1	4 months	n.a.
Implements			
Plows	3	n.a.	n.a.
Harrows	2	12 months	n.a.
Planter	1	12 months	n.a.
Cultivator	1	36 months	n.a.
Trailers	2	36 months	No tires

Table C-5 AN INVENTORY OF BROKEN DOWN TRACTORS AND IMPLEMENTS
Ilesha Tractor Hire Unit, Western Nigeria, 1970

	Number	Since When	Nature of Fault
Tractors			
D.B. 990	1	6 months	n.a.
Implements			
Plough	5	n.a.	No dics and furrow wheel
Harrows	7	n.a.	n.a.
Ridgers	2	2 years	n.a.
Planters	1	2 years	n.a.
	1	2 years	n.a.
	1	5 months	n.a.
Trailers	4	n.a.	No tires, no tubes

Table C-6 BROKEN-DOWN EQUIPMENT
Ikenne Tractor Hire Unit, Western Nigeria, 1970

	Number	Since When	Nature of Fault
Tractor			
D.B. 990	2	6 months	n.a.
	1	2 years	Hydraulic trouble
Implements			
Plough	1	18 months	Disc trouble
Harrow	1	2 years	n.a.
	1	1 year	n.a.
Trailers	2	n.a.	No tires

Table C-7 BROKEN-DOWN EQUIPMENT
Eruwa Hire Unit, Western Nigeria, 1970

	Number	Since When	Nature of Fault
Tractors			
D.B. 990	2	18 months	Stearing problem
	1	3 months	Hydraulic
M.F. 165	1	12 months	n.a.
135	1	1 month	No tires
Implements			
Ploughs	3	n.a.	No discs
Harrow	1	4 months	n.a.
Planters	1	n.a	n.a.
Ridgers	1	n.a.	n.a.
Trailers	4	n.a.	No tires

Table C-8 AN INVENTORY OF BROKEN-DOWN EQUIPMENT
Akure Workshop, Western Nigeria, 1970

Equipment Type	Number	Since When	Nature of Fault
Tractors			
D.B. 990	1	4 months	Overhauling
	1	2 years	Overhauling (its parts already being used to fix others)
	2	3 years	Their parts are being used to fix others when no more hope of their ever being repaired.
Implements			
M.F. 135	1	1 month	Fuel filter element
35	1	5 years	Fuel injection pump only the dealer can repair such fault

Table C-9 BROKEN-DOWN TRACTORS
Ibadan Workshop, Western Nigeria, 1970

Tractors	Number	Since When	Nature of Fault
D.B. 880	1	4 months	n.a.
	1	2 years	Engine knocked
	1	4 months	Engine knocked
D.B. 990	1	2 years	Overhauling and hydraulic problem
M.F. 165	1	n.a.	Injection pump
	1	2 months	n.a.
M.F. 135	1	2 years	Transmission and hydraulic problem
	1	2 years	Injection pump
	1	9 months	Engine knocked
	1	2 months	Starter and injectors
	1	1 month	Needs starter
	1	1 year	Hydraulic trouble
M.F. 35	1	1 year	Engine knocked
Ford 4000	1	1 year	Clutch trouble

C-10 BROKEN-DOWN EQUIPMENT
Abeokuta Workshop, Western Nigeria, 1970

Equipment Type	Number	Since When	Nature of Fault
Tractors			
D.B. 990	1	2 years	n.a.
	1	2 years	Engine knocked
D.B. 880	1	6 months	Condemned since new tractors arrived
	1	1 year	Broken crankshaft
	1	2 years	Overhauling
Trailers	7	n.a.	Need wood and body rebuilding
Implements*			
D.B. plough	1	1 years	Broken pin
	1	2 years	No furrow wheel
	1	2 years	n.a.
Ford harrow	1	3 months	Broken weldings
Ford plough	1	3 months	Broken discs
Ridger	1	6 years	n.a.

*A number of other implements such as fertilizer spinner (2), spinner cultivator (1), mower (1), were not repaired, condemned, because new implements arrived.

Table C-11 BROKEN-DOWN TRACTORS
Fashola Repair Shop, Western Nigeria, 1970

Tractors	Number	Since When
M.F.	2	Over 1 year
John Deere	1	Over 1 year
D.B.	1	Over 6 months
M.F.	1	8 months
M.F.	1	1 1/2 months
M.F.	1	1 year
M.F.	1	1 month (broken steering housing)

Table C-12 INVENTORY OF EQUIPMENT OWNED
Six Private Tractor Owners, Western Nigeria, 1970

Tractor owner	Type of Equipment				
	Tractors	Ploughs	Ridgers	Harrow	Trailer
	Numbers				
Rev. Macbee (Igbo-Ora)	2	2	2	1	1
Chief Olaniyan (Eruwa)	3	4	2	0	1
Latunde Laosun (Ibadan)	1	1	0	1	0
Chief Akinrinade (Oyo)	1	1	1	1	1
Omolanwa Group (Ilora farm settlement)	1	1	1	1	1
Upper Ogun Group (Ilora farm settlement)	3	2	1	1	2

Conversion Factors

Conversion factors are developed to be able to express any work done in acres of complete operation. Money allocations to the Circles can then be made on the bases of the acres of complete operation obtained and specified rates per acre of complete operation for labor, materials and depreciation.

The output in terms of full complement of operations and money allocations are directly proportional to the conversion factors and allocation rates of the various operations. A basic question is what the conversion factors and allocation rates should be. The figures used in Western Nigeria are shown in Tables C-13 and C-14.

At 0.396 conversion factor for transporting, a Unit is allocated 7.9 shillings per hour for labor. Akure Unit does almost nothing but transporting. At a conversion factor of 0.396, it was found that there was not enough money to meet the costs. The conversion factor was thus reduced to 0.24. At this rate, a Unit is allocated 4.8 shillings per hour for labor. The Ministry pays wages that averaged about 15 shillings per eight-hour working day to mechanics and operators. An allocation of 4.8 shillings per hour of transporting suggests that either the conversion factor or the labor allocation rate is on the high side.

Initial money allocations are made on the basis of output projections submitted to the Principal Agricultural Engineer from each of the divisional headquarters. The Principal Agricultural Engineer can influence the amount allocated through the conversion and scaling

factors applied to the estimates submitted. The value of the conversion factor depends on the overall available money to be spent and the desired mix of the various operations to be performed.

Table C-13 CONVERSION FACTORS OF INDIVIDUAL OPERATIONS TO EQUIVALENT FULL COMPLEMENT OF OPERATIONS
Western Nigeria, 1970

Operation	Unit	Equivalent complete operation in acres
Transporting	1 hour	0.396
Ploughing	1 acre	0.625
Harrowing	1 acre	0.156
Ridging	1 acre	0.208
Planting	1 acre	0.156
Mowing	1 acre	0.25

Table C-14 MONEY ALLOCATION RATES FOR WHEELED TRACTORS
Western Nigeria, 1970

Item	Allocation in shillings per acre of complete operation
Wages	20
Fuel	10
Spare parts	17
Miscellaneous workshop supplies	4
Depreciation	20