# THE ECONOMIC IMPLICATIONS OF THE INTRODUCTION OF IMPROVED METHODS FOR MAIZE: A STUDY IN THE MAMPONG DISTRICT.

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CHAPTER I

# INTRODUCTION

## Objective of Study

The study was motivated by the Ghana Government's proposal for an integrated crop improvement project for maize. The project seeks to promote the use of 'improved methods' of cultivating maize in selected centres of maize production in the country with the aim of increasing annual maize production by approximately 50,000 long tons over the next five years. It is hoped that the target would be achieved primarily through increasing yields on at least 100,000 acres of the approximately 537,000 acres annually devoted to maize during the major farming season. The project will embrace an integrated programme of research, field trials, extension, distribution of yield-increasing package of inputs, credit and improvement of storage techniques and marketing facilities to serve approximately 30,000 small holders in five of the nine regions of the country.

'Improved methods' are technically advanced methods recommended by the Ministry of Agriculture and the Crops Research Institute of the Council for Scientific and Industrial Research. These include the use of new improved seeds and fertilizer, early planting, row planting, close spacing and early weeding.

The objectives of the study fall under two main headings, namely:

(1) To evaluate improved methods of maize cultivation in relation to the traditional system;

(2) To assess the economic implications of the use of improved methods for the farmer.

Procedure:

The objectives of the study will be accomplished through a careful study of the traditional and improved methods of cultivating maize in the area of study. This will involve identifying different enterprises, involving maize, undertaken with both methods. Other tasks will be the collection of comprehensive data on production costs and returns of each of the enterprises. Information on the labour requirements for the different enterprises will also be sought.

Having collected the information outlined above, the next task will be to assess the relative profitability of the different enterprises. In the first place, assumptions on family and hired labour availability, capital situation and their constraints will be made. The farm management tool of linear programming, which can consider the resource avaibility and the constraints simultaneously, will then be employed (Chapter IV). The results of the linear programming will

indicate the combination of the enterprises which will yield the maximum returns. Since each enterprise and the method of cultivation of the enterprise will be clearly defined, the results of the linear programming will also indicate the most profitable method of cultivation. The economic implication of the use of the improved methods, for the farmers considered in the plan, can be deduced from the production methods of the enterprises that become part of the maximization plan.

Maize in Ghana:

Maize is the country's most important staple cereal in terms of quantity consumed and as a source of calcries as evidenced in Table I.

Maize plays an important role in the diet of many Ghanaians, particularly in the southern parts of the country or the coastal plain as referred to in Table I. The consumption of maize takes many forms. Green maize is boiled or roasted on the cobs; the mature grain is ground to make porridge or various kinds of doughy cakes of which kenkey is the most popular.

Maize is the most common grain fed to poultry in Ghana and the largest component in poultry ration. The poultry industry expanded greatly in the 1960's and this expansion increased the demand for maize.

Table I

ESTIMATES OF 12 MONTHS' FOOD CONSUMPTION IN GHANA: 1960

| Item | Coastal Plain Eastern | Coastal Plain Western | Southern Forest | Ashanti Survey Area | Kumasi Municipality | Northern Savannah | Total |
|---|---|---|---|---|---|---|---|
| | (1) Quantity: '000 Tons | | | | | | |
| Maize | 100.0 | 38.5 | 30.9 | 12.7 | 5.7 | 36.5 | 224.3 |
| Rice | 11.8 | 9.6 | 3.0 | 1.7 | 2.4 | 7.5 | 36.0 |
| Guinea Corn | - | - | - | - | - | 61.0 | 61.0 |
| Millet | - | - | - | - | - | 76.0 | 76.0 |
| Other Cereals | 16.8 | 5.3 | 4.9 | 3.0 | 1.3 | - | 31.3 |
| | (2) Food Value: '000 in Calcries | | | | | | |
| Maize | 171.8 | 62.7 | 63.4 | 23.9 | 11.3 | 131.7 | 469.1 |
| Rice | 42.8 | 31.5 | 9.2 | 4.9 | 7.2 | 27.4 | 123.0 |
| Guinea Corn | - | - | - | - | - | 212.7 | 212.7 |
| Millet | - | - | - | - | - | 256.3 | 256.3 |
| Other Cereals | 44.5 | 13.9 | 14.1 | 8.5 | 3.6 | - | 84.6 |

SOURCE: Central Bureau of Statistics, Field Survey Work in the Ghana Statistics Office, January 1961, pp.85 - 86.

Most of the imported maize, which is yellow, is used by the poultry industry rather than in human consumption. An increase in the domestic maize production could play an important role in the development of the poultry industry in Ghana. This conclusion is supported by studies on poultry which single out the cost of feed as one of the major factors limiting the expansion of the industry (Gyasi, 1971).

Maize also provides excellent forage and/or concentrate for all classes of livestock in the country.

The production of maize has been taking place over the last few years against the background of rising prices, primarily as a result of the failure of domestic production to keep pace with the growth in demand. The price of maize has been increasing throughout the last decade as shown in Table 2, which relates the supplies of maize over the last decade to the wholesale price index for maize in Accra. Although prices of maize reached very high levels in 1965/66 and in 1968/69 and are still much higher as compared to 1958/59 - 1962/63 prices, maize is not relatively more expensive in relation to other starchy foods except for rice. This is illustrated by Figure 1.

In current times high priority has been placed on the agricultural sector, efforts to increase grain production, particularly maize and rice, are emphasized in hopes of reversing the imbalance between domestic supply and demand for these commodities. Given the importance

Table 2

SUPPLIES AND PRICES OF MAIZE
1959/60 -- 1969/70

| July-June | Production[a,b] '000 Long Tons | Imports '000 Long Tons[c] | Production and Imports '000 Long Tons | Accra Wholesale Price[d] Index (Maize) 220 lbs 1953/54-1957/58 = 100 |
|---|---|---|---|---|
| 1959/60 | 175.2 | 0.3 | 175.5 | 82 |
| 1960/61 | 230.2 | 1.0 | 231.0 | 112 |
| 1961/62 | 222.4 | 0.7 | 223.1 | 125 |
| 1962/63 | 242.0 | 0.3 | 242.3 | 126 |
| 1963/64 | 180.0 | 1.9 | 181.9 | 162 |
| 1964/65 | 170.0 | 2.5 | 172.5 | 193 |
| 1965/66 | 206.0 | 1.2 | 207.2 | 260 |
| 1966/67 | 396.0 | 11.2 | 407.0 | 143 |
| 1967/68 | 337.5 | 3.4 | 340.9 | 156 |
| 1968/69 | 296.3 | 0.8 | 297.1 | 275 |
| 1969/70 | 299.2 | 1.2 | 300.4 | 244 |

SOURCE: (a) Ministry of Agriculture, unpublished records, 1963/64 - 1969/70.

(b) Economic Research Services, USDA, Africa Indices of Agricultural Production. December 1966, p.27 (production data from 1959/60 - 1962/63).

(c) Central Bureau of Statistics, External Trade Statistics, Monthly.

(d) Rourke, B.E. (1970), Wholesale Prices of Starchy Foods in Major Urban Centres, Department of Agricultural Economics, Faculty of Agriculture, Legon, Mimeo.

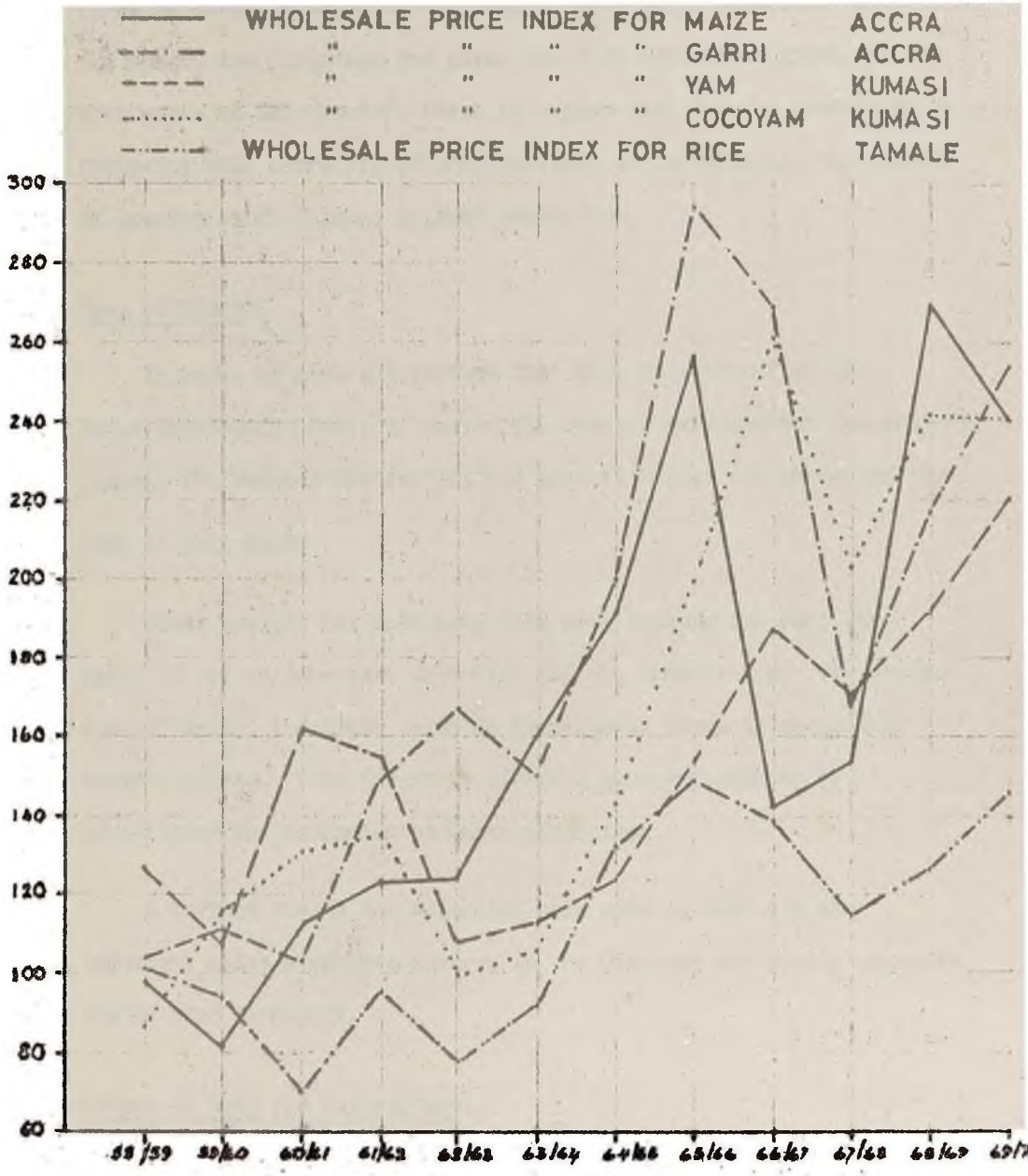


FIG.1 Price Trends in Maize and other Selected Starchy Foodstuffs From 1958-1970 (1953/54 - 1957/58 =100)

of maize in the economy of the country as a major food item both for humans and livestock and given the fact that maize grows well in many parts of the country, there is a good case for the government in proposing this commodity of concentration in pursuing its objectives of greater self-reliance in food production.

Area of Study:

In order to gain information that will be relevant to the Maize Development Project, one of the centres selected for the project, namely, the Mampong District of the Ashanti Region was chosen as the area of this study.

Other reasons for selecting this area include the fact that maize is not an important food item for the inhabitants. The production of maize, therefore, even on traditional farms is noticeably commercialized. This situation offers a good opportunity to investigate the economics of maize production.

A further reason for selecting this area is that all the important maize producing centres in the district are easily accessible by road transport.

Source of Data and Methodology:

A total of 62 individual farmers comprising 25 farmers using improved methods and 37 farmers using traditional methods were inter-

viewed. Only 25 farmers using improved methods could be traced with the help of the Extension Officers and the Local people. Farmers using traditional methods were interviewed as they were encountered in the process of tracing farmers using improved methods. At the end of the study they turned out to be 37. All farmers were personally interviewed by the writer during August to September of 1971 and December to January of 1972 with a pre-tested questionnaire.

The author was accompanied by an Extension Officer, who was familiar with the farmers, during the interview. The duty of the Extension Officer was to introduce the author to the farmers and thereby removing any suspicion on the part of the farmers.

In smaller villages it was possible to conduct a group interview. In such cases the sub-chief or the 'Odikro' was the spokesman of the group, although all the other farmers had to agree with what he said.

Some possible sources of bias of the method employed in collecting information from farmers as outlined above are varied. Both categories of farmers, i.e., farmers using traditional and improved methods of cultivation, were not randomly selected. Since farmers using improved methods were more difficult to come by there was the need to look for them. This was precisely what the author did. As the time available for the project was limited, the author took advantage to interview any

farmer using traditional method of cultivation who was encountered in the exercise of tracing farmers using improved methods. The method adopted was convenient, though there was no randomness in the selection of respondents.

A further source of bias was the possibility of embellishing the reports, on the part of the respondent, especially those using improved methods. It was obvious to the author that these were too eager to please the Extension Officer and the author, therefore the likelihood of embellishing reports. No formal records were kept by all the farmers interviewed and they recalled everything from memory. The chances were that they may recall wrong details due to lapse of time. Further source of bias could be deliberate telling of lies by some respondents.

CHAPTER II

## TRADITIONAL METHODS FOR CULTIVATING MAIZE IN THE MAMPONG DISTRICT

### Husbandry and Management Practices

Maize cultivation under traditional methods is in most cases undertaken in mixture with other crops such as yam, cassava and groundnuts. However, it is common to come across large acres of pure stand maize farms.

In each of the villages visited a system of bush fallowing is practiced and chemical fertilizers are not used. After cropping a particular piece of land for 2 to 5 years there is a serious decline in fertility and crop yields fall. The plot is then allowed to revert to bush for a variable period, ranging from 2 to 6 years, depending on the availability of land in the area to recuperate its fertility. In some cases cropping is done till the appearance of peculiar weeds called 'eserebegoro' and 'nkyenkyema' before the plot is abandoned.

Maize is grown twice a year. A major crop and a minor crop is obtained in correspondence with the intensity of the rainy seasons. The major season begins with the major rains in March through April and lasts until July and August when harvesting is completed. The minor

season starts with the minor rains in September through October. Harvesting is done between December and January.

Maize has been cultivated in this area over the years by traditional methods characterized by the dependence on almost entirely on human power, the use of simple tools and small holdings. The main implements of cultivation are the cutlass, hoe and the axe. The area farmed is limited to the amount which can be cultivated by the farm family with some hired labour using these simple tools. Sizes of maize holdings of 37 traditional farmers interviewed ranged from less than 3 acres to 10 acres.

Table 3

DISTRIBUTION OF FARM SIZES OF TRADITIONAL FARMERS

| Size of Farm | Number of Farmers |
|---|---|
| Less than 3 acres | 11 |
| 3 - 4 acres | 16 |
| 5 - 8 acres | 7 |
| 9 - 10 acres | 3 |

Preparation of the land for the major season crop starts between January and February. This consists of clearing of bushes and felling of trees. The cut leaves and trees are left to dry and after 2 or 3 weeks fire is set in to get rid of them. Burning is followed by stumping. The land is then left to cool off before sowing starts.

Some farmers sow dry in anticipation of the rains in March, however, the onset of the rains is generally a signal to the farmers to start sowing. Seeds for sowing are selected from the previous season's harvest. In some cases germination test is performed when selecting the seeds. By this test, some seeds are deposited in a bowl of water and the viable ones would settle at the bottom of the bowl. Seeds varying from 2 to 8 may be dibbled into each hole. Planting is at random and spacing variable with distances ranging from 4 feet by 4 feet to 4 feet by 5 feet. The local maize variety is used.

Post planting operation consists of weeding and harvesting. The number of times a farm is weeded is a function of the state of the initial land cleared. If a farm is made out of a forest there might be only one weeding or none at all, otherwise farmers weed their farms 2 or 3 times before harvesting is done. Weeding is done with cutlass and since the maize plants do not allow enough room for the swinging of the cutlass, weeding in all cases is not thoroughly done. Thinning may be done during the first weeding.

Harvesting of the major crop starts from July and may extend to early August and it is done by hand. The mature maize are left standing longer in the field to dry properly before harvesting takes place. Where the harvest is large tractors are hired to cart the crop home, otherwise the crop is carried on the head.

At the discretion of the farmer the maize may be store or threshed and sold immediately after harvest. The use of insecticides is non-existent. Maize attract low prices immediately after harvest and the usefulness of storing the maize lies in getting a higher price for it. Maize is stored either in the husks or with the husks removed. The latter is the more popular practice and according to the farmers has three advantages. The intake of the barns are maximized and it offers an opportunity to separate the weeviled from the unweeviled maize to prevent further infestation during the period of storage. A further advantage is that the weevilled maize so removed could be consumed or threshed and sold immediately. In either case there is a clear economic gain. If maize is stored in the husk this gain would not be realized. Apart from the fact that initial weeviled maize would introduce the weevils to the unweeviled maize, the initial weeviled would have deteriorated so much during the storage period that they would be lost into powder during threshing.

Most purchasing of the maize is done in the homes of the farmers by traders who bring their bags along. A bag of maize bought in the farmer's home does not refer to the conventional 220 lbs bag of shelled dried maize, but a 'bush weight' of about 260 lbs shelled dried maize or more. Some farmers convey their maize to the marketing centres of Ejura, Mampong and Sekodumasi to sell.

Farmers using traditional methods finance their operations in three main ways: from their own resources; loans from traders and loans from money lenders.

Table 4

MAIN METHODS OF
FINANCING FARM OPERATIONS

| Source | No. of Farmers | % of Total Farmers |
|---|---|---|
| Traders | 26 | 70 |
| Money Lenders | 7 | 19 |
| Own Resources | 4 | 11 |

The most popular source of financing operations of traditional maize farmers as indicated by Table 4 is loans from traders. 70% of farmers employing traditional methods of cultivating maize interviewed depended on traders for financing their farming operations. Though there are no interests attached to such loans, the farmer who contracts a loan from a trader is obliged to sell to the latter at least maize to the value of the loan contracted. In theory the farmer has the right to determine when to sell his produce, however, to retain the goodwill of the trader so as to be assured of future loans, this right has been passed over to the trader. The trader in his attempt both to be sure of getting a refund of the loans and to maximize profits comes soon after harvest to make his purchases. This is the time of plenty and therefore prices tend to be low.

Loans from money lenders attract interest. Though farmers would not tell how large the interest is, they indicated that it was inimical and they took it because there was no other alternative. It seemed that farmers who take loans from money lenders have ceased to enjoy the confidence of the traders and they have therefore been refused loans by them. This conclusion seems tenable because these farmers have at one time or other taken loans from traders and they do not have any tangible reasons to offer for not taking loans from traders at the present time.

Financing operations from one's own resources makes him free from all other obligations but only 11% of the farmers interviewed could afford this.

Why Farmers Grow Maize:

Maize is not an important staple crop for the inhabitants of the survey area, therefore, the subsistence element is not important in maize farming. The major reason given by farmers for growing maize is to sell for cash. Table 5 summarizes the reasons given by farmers for growing maize.

Table 5

REASONS GIVEN BY FARMERS FOR GROWING MAIZE

| Reason | No. of Farmers | % of Total Farmers |
|---|---|---|
| For cash or the market | 31 | 84 |
| Suitable land | 17 | 46 |
| For consumption | 15 | 41 |
| It is the traditional crop | 15 | 41 |

Growing maize for cash is the reason given by 84% of the farmers interviewed. The cash realized from the sale of maize is used to hire labourers to prepare new lands for farming and to weed the existing farms. Some of the cash is used to purchase the needs of the farmers that could not be produced on the farm.

Other reasons given for growing maize are that the land is suitable for its cultivation; maize is grown for home consumption and a further reason is that maize cultivation is an ancestrial heritage. Out of the 15 farmers who grew maize for consumption, only six were natives of the area, the remaining nine were Northerners. This supports an earlier assertion that maize is not an important food item for the natives of the survey area.

Problem of Traditional Maize Farmers:

All farmers interviewed reported that lack of funds was their biggest problem. Shortcomings of farmers such as late planting and late weeding, which detract from potential yields, were blamed on the unavailability of cash to hire labour at the right time. Loans or advances from traders are often late in coming. In their determination to surmount this problem, there has been formed pockets of Producers' Co-operatives with the main objective of securing loans from the Agricultural Development Bank (ADB). No information could be obtained from the ADB relating to loans obtainable from the Bank in the district,

however, it was reported by some farmers that their Co-operatives have succeeded in obtaining loans from the ADB. Many Co-operatives are yet to be considered for loans. Some Co-operatives which have at one time received loans from the ADB have been refused loans in recent times because they have defaulted payment of loans already received. It seems that the success of any programme involving traditional maize farmers would depend very much on the extent to which it includes a provision for solving this problem of limited finance.

Another problem is that of shortage of farm labourers. Since the enactment of the Aliens Compliance Order, 1970, labourers have been in short supply and as a consequence considered by the farmers as expensive to hire. Daily rated workers in the Mampong district who accepted 55 pesewas before 1970 now demand 75 pesewas, and the cost of farm contracts have almost doubled. The situation has rather aggravated the problem of limited finance.

A further problem encountered by farmers is the destruction of seeds by pests, especially when sowing is done dry or late. To check this, farmers at times build fences around their farms and leave space in the fences where traps are set. This method of checking the destruction of seeds by pests is tedious and would not be feasible where holdings are large.

Additional problem pointed out by the farmers is the low prices offered for their maize. Maize has constantly been sold below the current guaranteed minimum price of ¢6.00 per 220 lbs bag of shelled, dried maize. Apart from the fact that price paid to the farmer is low, he is also required to sell his bag of maize at a 'bush weight' which is over and above the conventional weight.

Yet another problem is that of securing tractors to cart the produce home, in cases of large harvests. A farmer's inability to get a tractor at the right time may result in his maize going bad on the farm. Tractors in the survey area are few and are unable to match the great demand made on them. All other farm produce in the area when they are large depend on tractors for transportation.

Maize Farmers' Attitude to Improved Methods:

The aims of the proposed maize project is to promote the use of yield increasing package of inputs among maize farmers using traditional methods of cultivation. The inputs include improved seeds, chemical fertilizers and insecticides. In order to obtain the maximum results from the use of these inputs some set of agronomic practices are advised. It is recommended that maize is grown in pure stand. Other recommendations include early planting, close spacing, row planting and early weeding.

Farmers interviewed are aware of the availability of improved seed. They do not use the new seed because they do not seem to have any problem of yield. Another reason for not using the improved seed is that the farmers can always get free seeds from the previous year's harvest. These reasons make the farmer reluctant to buy the improved seeds. Notwithstanding this unwillingness to buy the improved seed, there exists some degree of willingness on the part of the farmer to give the improved seed a trial provided they are given free to them.

Farmers are familiar with fertilizers and insecticides. It was even discovered that five of the farmers had used fertilizer on their tomato farms and had been impressed by the results. In general farmers seemed to be aware of the potential increase in yield associated with the use of fertilizer. They do not apply fertilizer because they seem to be satisfied with their present yield **or** they do not have funds to purchase the fertilizer. The same reasons hold for not using insecticides.

Farmers are agreed with recommendations such as early planting and early weeding and maintain that they are the best practices if one could afford them. Their failure to plant early or weed early has been blamed on lack of funds or shortage of farm labourers. With regard to other recommendations such as growing maize in pure stand, close spacing and row planting, traditional farmers cannot easily appreciate their usefulness. They have confidence in their present agronomic practices

which cannot be easily shaken. Generally, farmers do not believe that the adoption of recommended practices would bring them more income.

Most farmers have obtained information about improved seed and fertilizer from fellow farmers. It was obvious from the survey that all the 37 traditional farmers do not have close association with the extension personnel. At least the 25 farmers who have adopted improved practices were either friends of the Extension Officers or know of their existence. This lack of close association on the part of the 37 farmers limits their ability to appreciate the potential gains associated with the use of the recommended practices.

Summary:

Producing maize by the traditional method is by far the widest spread method in the area of the study. In general both the major and minor seasons maize are grown though it is obvious that farmers devote more attention to the major season crop.

The holdings of farmers using the traditional methods of cultivation are relatively small and range from less than 3 acres to about 10 acres. The holdings of 73% of the farmers interviewed and categorized as using traditional method of cultivation have farm sizes ranging from less than 3 acres to 4 acres.

There is a clear-cut programme of activities. The major season starts in February when the land is cleared and prepared for cropping. The main implements are the axe, hoe and cutlass. Planting begins in March with the rains till April. No fertilizers are used. This is followed by one or more weeding before harvesting is done in July and probably early part of August. Storage of maize over long periods to obtain higher prices is not a common place among this group of farmers.

There are 3 main sources of finance for this category of farmers. The most important source is the contracting of loans from traders. This arrangement is a sort of a 'future's market' arrangement, where farmers pledge their expected crop to the loan contracted. The remaining sources of finance are loans from money lenders and from the farmers' own savings.

The most important reason given by farmers for growing maize is the promise of a readily financial reward. Other reasons for growing maize include the suitability of the land for the crop and for the fact that it is a traditional crop. Maize is also grown for home consumption.

The inadequacy of funds to meet farm expenses seem to be the most important problem of this group of farmers. Other problems mentioned were shortage of farm labourers, destruction of seeds by pests, low prices paid for maize and inadequacy of tractors for carting farm produce.

The farmers are familiar with some of the recommended practices but lack of funds and lack of conviction that these practices would bring greater financial rewards are some of the reasons militating against the adoption of the recommended practices.

# CHAPTER III

## IMPROVED METHODS OF CULTIVATING MAIZE

### The Recommended Farm Practices

The traditional type of agriculture characterized by low yielding seeds, intercropping, shifting cultivation and cutlasses is more prevalent in the study area. The sharp rise in the prices of maize in this country (see Figure 1) underscores the inability of the present system of cultivating maize to produce enough quantities to match the growth in the demand for this commodity. As a result of this imbalance, the Ministry of Agriculture with the aid of the information provided by the Crops Research Institute and the Extension Services Unit of the Crops Production Division from its 'Ghana 20' programme, designed to promote the use of fertilizer, had developed a set of recommended practices for maize with the aim of acquainting farmers with their application. It is believed that this programme would help to correct the present imbalance between the supply and demand of maize.

The recommended farm practices are the following:

Recommended Variety: Composite - II developed by the Crops Research Institute and Diacol 153.

## Cultural Practices

Methods of Cultivation: Land should be cleared of bush and burned by traditional method. Burning should, however, be avoided if possible and the organic matter incorporated with the soil by hoe cultivation.

Planting Method: Intercropping is not recommended. On hilly areas farmers are advised to plant on the contours. Row planting is recommended and the row should be 2 feet to 3 feet apart and seeds planted at 2 feet interval at 3 seeds per hole to be thinned to 2 when plants are 18 inches high. Alternatively, sow on 3-foot ridges at one foot apart at 2 seeds per hole. Thin to one when plants are 18 inches high.

Weeding: Weeds must be controlled so that potential yield is not reduced. It is recommended that the farm is weeded 2 weeks after planting with hoe followed by cutlass weeding when the plants are 6 weeks old.

Planting Time: In the major season planting should be done with the early March rains and never later than April. Minor season planting should be done between September and early October.

Fertilizer Requirements: An application of 2 hundred weight of 20-20-0 at planting and a side dressing of Sulphate of Ammonia

when plants reach 18 inches is recommended. Application is by hand placement or broadcast and hoed in where feasible.

Storage: It is recommended that shelled grains are dried to 12% moisture content and stored in bags lined with 100 gauge polythene and treated with ethylenodibromide (EDIB). Alternatively, the envelope method of fumigation, which does not involve shelling of the maize, could be used. This alternative recommendation involves the use of plastic sheets, edib and selvin.

Yield: It is believed that the adoption of the entire set of recommendation would result in a yield of 1980 - 3080 lbs dry shelled grains or between 9 and 14 bags of 220 lbs of shelled dried maize per acre.

The Use of the Recommended Farm Practices:

It is not easy to come across a farmer who has adopted the entire set of the recommended practices. What is common is an amalgam of some of the recommended practices and the traditional practices. Out of the 25 farmers interviewed and classified as using improved methods of cultivating maize only 6 of the farmers have adopted the entire set of the recommended practices. The farming operations of 2 of these six farmers are partially mechanized, with preparation of the land, planting and fertilization done with machines. These same farmers use mechanical

shellers in shelling their maize. The remaining 4 farmers use human power for all the farming operations. All the 25 farmers grow maize in pure stand.

Table 6

THE USE OF THE RECOMMENDED PRACTICES

| Type of Recommendation | No. of Farmers |
|---|---|
| Improved Seed | 25 |
| Early planting/weeding | 25 |
| Fertilizer | 23 |
| Sulphate of Ammonia | 6 |
| Seed Rate | 25 |
| Hoe Weeding | 6 |
| Improved Storage | 6 |

Land preparation is generally by traditional method as already described, however 9 farmers use the services of tractors in preparing the land. Fertilizer may be springled on the prepared land, to be washed in by the rains, before planting or it may be applied after planting. Where planting is mechanized fertilization is done simultaneously with planting.

As indicated in Table 6, all the 25 farmers use improved seeds and all but 2 apply fertilizer. Planting is done with the early March rains, but where mechanical planters are used planting is done just

before the rains. Planting is in rows and the planting distances and seeding rate conform to the recommended practices when mechanical planters are used. Planting in rows without mechanical planters is accomplished by laying ropes along pegs fixed in the ground. The seeds are then planted 2 to 3 seeds per hope along the line formed by the ropes, keeping to the recommended spacing. The remaining farmers plant at random and the spacing is variable, however, they keep to the recommended seeding rate.

Weeding is generally done twice before harvesting the crop. The first weeding which takes place between 2 to 3 weeks after planting is done with hoes by the 6 farmers who have adopted the entire set of recommended practices. Thinning to the recommended plant population and the application of Sulphate of Ammonia is accomplished at this time. The 2 farmers among this group of farmers who have partially mechanized their operations do not do a second weeding. The second weeding is done with cutlasses. The remaining farmers weed with cutlasses. Thinning may be done when the plants are found to be too close together.

Harvesting is done by hand, after the ripe maize have been left to dry in the field. Harvesting begins in July through September. The harvested maize is carted home by tractors at an average charge of ¢4.00 per trip. This charge could either be increased or decreased depending

on the distance to be covered by the tractor. Each trip made by a tractor contain maize enough to fill about 10 bags when shelled.

All the 24 farmers store all or part of their maize in anticipation for higher prices. Maize is stored either in barns or in rooms. The length of time maize may be stored is a function of how early the market price of maize rises to the level of the 'waiting price' of the individual farmer storing. The waiting price was generally reported to be between ¢8.00 and ¢12.00 per 220 lbs bag of shelled dried maize. The financial position of the farmer is also a crucial factor in determining the length of the storage period. There is the tendency for farmers in need of cash to sell their maize rather than leave them in storage even if prices are below their expectations. The range of storage period reported by the farmers in the study area was between 3 and 6 months. Out of the 25 farmers categorized as using improved methods of cultivating maize, 16 treated their stored maize with insecticides against weevils and other harmful insects. This number include 6 farmers who use a recommended storage practice, namely the envelope method of fumigation. By this method, the unhusked maize are heaped on a plastic sheet and edib is springled on them. The plastic sheet is then folded over the maize with the edges rolled twice over. The rolled edge of the sheet is held down with stones and other heavy objects and left in this position for at least 2 days before the maize are finally removed

and put into barns or rooms sprayed with Selvin. The remaining 10 farmers springle D.D.T. powder on their stored maize. Storage losses were reported negligible among the farmers who use insecticides, however, it was estimated that about one out of every 5 bags of maize put into storage is lost to insects and rodents among the farmers who do not treat their maize with insecticides before storing.

With the exception of the 2 farmers who use mechanical shellers, shelling is by traditional methods. The shelled maize is then put into bags and conveyed to one of the marketing centres of Ejura, Mampong and Sekodumasi during a market day to be sold. The average charge of transporting a bag of maize is 20 pesewas.

Farm sizes of this group of farmers range from 5 acres to over 30 acres. The distribution of the acreages farmed by the 25 farmers interviewed is the subject of Table 7.

Table 7

DISTRIBUTION OF FARM SIZES
OF FARMERS USING IMPROVED FARM PRACTICES

| Acreage | No. of Farmers |
|---|---|
| 5 - 9 | 4 |
| 10 - 15 | 9 |
| 16 - 30 | 7 |
| Over 30 | 5 |

The main source of finance for this group of farmers is loans from the ADB. As many as 21 of these farmers obtain loans from the ADB. All these farmers but 4 claimed that they are able to supplement loans obtained from the Bank with cash from their own resources. The remaining 4 farmers who do not take loans from the ADB contract loans with traders in much the same way as the farmers using traditional methods.

Background of Farmers Using Improved Methods:

It was discovered by the author that this group of farmers have very close association with the Extension Officers and this association might have made it easier for them to be influenced to adopt the improved practices. The evidence for this conclusion is that, as many as 17 of the 25 farmers making up this group were friends of the Extension Officers and have in fact obtained information about improved practices from the Extension Officers. The remaining obtained the information from fellow farmers.

Among this group of farmers were 8 individual farmers who have had some formal education. These include 3 of the farmers who have adopted the entire set of the recommended practices.

Another interesting observation is that this group contain some local notable farmers who have attained some degree of successes in farming. For their remarkable performances in farming, 3 farmers among

this group had been presented with prizes during past Agricultural Shows.

Problems of Farmers Using Improved Methods:

A summary of the problems reported by farmers is found in Table 8. All the farmers who obtained loans from the ADB are of the opinion that the loan arrangement is deficient. In the first place the magnitude of the loan is said to be small, even if it is meant as a supplement to the farmer's own resources. Farmers are granted loans of ¢15.00 per acre of maize farm cultivated.

Table 8

PROBLEMS OF FARMERS USING IMPROVED METHODS

| Problem | No. of Farmers | % of Farmers |
|---|---|---|
| Deficient ADB Credit Arrangement | 21 | 84 |
| High Cost of Labour | 20 | 80 |
| Availability of Tractors at the Right Time | 19 | 76 |
| Inadequate Storage Space | 12 | 48 |
| Poor Storage Ability of the Improved Seed | 9 | 36 |
| Lack of Planters | 5 | 20 |

The timing of the loan, in view of the farmers, is disappointing. In extreme instances, farmers get the loans during the harvesting time. This practice is at variance with the correct implementation of the ADB credit programme. Under this programme loans are expected to be disbursed in three instalments to coincide with major farming operations such as planting, weeding and harvesting. The result of this departure from the laid down principle is that loans granted to farmers are in some cases used for personal commitments other than farming. In the view of the farmers, the poor timing of the loan does not encourage storage beyond the beginning of a new season, because farmers are compelled to sell their maize in order to obtain cash to pay for the cost of clearing the farm and to replay the ADB loan contracted for the previous season.

The high cost of labour is another source of discontent among some farmers. This is a direct consequence of the Aliens Compliance Order, 1970, which has resulted in an obvious decreases in the supply of available farm labourers. This decrease in supply has therefore, increased the market value of the existing farm labourers.

It was observed during the survey that the demand for the services of tractors was over and above the available tractor services. The services of tractors are demanded for the preparation of land for crops including maize and tobacco. This apart, tractors are demanded

for the carting of farm produce. The complaint of farmers was that they do not get tractors to hire at the right time. They further argued that it is necessary that the operations demanding the use of tractors are performed at the right time or production would be adversely affected.

Low prices attracted by maize immediately after harvest has made storage of maize a common place. Inadequate storage space was the complaint of some farmers. The result of this is that they are compelled to sell the produce they would have wished to store and thus detracting from their potential profits.

As stated above, 9 out of the 25 farmers do not treat their stored maize with insecticides. These were the same farmers who complained about the poor storage ability of the improved seeds, particularly Discoal 153, relative to the local variety. Since the farmers who treated their maize had nothing against the storage ability of the improved seeds it would seem that the solution to this problem is to treat maize with insecticide before storing.

An additional problem reported by 5 farmers is the lack of mechanical planters. They would have wished to plant maize in rows but for this problem. According to these farmers the number of farm labourers needed to effect row planting is difficult to obtain because

during the planting period the demand for farm labourers is so great that one cannot have a monopoly over the number needed to effect such an operation.

Summary:

The Extension Officers of the Ministry of Agriculture are the main source of extending the recommended practices to the farmers in the study area, in the absence of any organized demonstration like the Focus and Concentrates or Ghana '20' Programmes. Not less than 68% of the farmers who have adopted some or all of the recommended practices admitted having close association with the Extension Officers.

It is not easy to come across a farmer who has adopted the entire set of recommended practices. What is common is that farmers have adopted different degrees of the improved practices. The improved inputs most popular with the farmers are the improved seed and chemical fertilizer.

The holdings of this category of farmers is relatively larger than those using the traditional methods of cultivation. The farm sizes range from 5 acres to 30 acres, with 64% of the farmers interviewed holdings ranging between 10 acres and 30 acres.

The main source of finance for this group of farmers is loans from the ADB. Some of the farmers, however, contract loans from traders in much the same way as their counterparts using traditional methods of cultivation.

Problems reported by this group of farmers include deficient ADB credit arrangement, the unavailability of tractors at the right time, high cost of labour and inadequate storage space.

# CHAPTER IV

## OPTIMUM COMBINATION OF CROPS FOR MAIZE FARMERS: AN APPLICATION FOR LINEAR PROGRAMMING

The objective of this Chapter is to apply linear programming to determine the optimum cropping plan for maize farmers in the study area. The objective is accomplished within the restrictions of given methods of production. In general two techniques are considered, the traditional method and the recommended method. The planning period is one year and both the major and minor season crops are considered.

The analysis is based on data collected during August to September of 1971, and December to January of 1972. During this period, data on labour inputs for the different farming operations, the extent of the acreages farmed and the yields were collected. Price data were collected from farmers, traders and the local markets. The detailed input-output data required for the analysis pose substantial data problems but they are essential to any analysis of the farm production situation. The results of this analysis rely on the assumptions made and it is essential that any evaluation of the results starts with an examination of the technical assumption that contributed to them.

Logic and Technique of Linear Programming:

A linear programming problem generally has 3 quantitative components: an objective which can be quantified as in cedis of profit or costs; the alternative ways or processes of achieving this objective; and the restrictions which limit the amount of alternatives that can be used in attaining the objective. The tool is, therefore, relevant to any farm problem which has these three components.

The basic assumption of the linear programming technique is that production coefficients are constant or that the production function is linear. Constant rather than diminishing marginal products are employed. The term 'linear' refers to constant resources requirements per acre or constant yields for each additional acre, manday or cedi of resources used for different crops. Linear programming assumes that if an acre of maize yields 4 bags with 36 mandays and ¢22 capital expense, 8 bags will be forthcoming from 2 acres, 72 mandays and ¢44; 40 bags will be forthcoming from 10 acres, 360 mandays and ¢220. The same assumptions are used for the other crops grown with maize.

In the process of linear programming it is necessary to set a 'tableau' which allows 'automatic' solution for the crops that should be produced and the amount of resources to be used for each. In order

Several activities may be carried on simultaneously, hence the optimum use of resources can include a combination of enterprises. The quantity of the resources used is the sum of the quantities necessary for the different activities and the output is the production of the activities.

An algebraic presentation of the technique of linear programming may be outlined as follows:

The objective is to find the values of $X_1, X_2, \ldots, X_n$ which make

$$Z = \sum_{j=1}^{N} C_j X_j \qquad (1)$$

a maximum and which also satisfy the planning constraints

$$\sum_{j=1}^{N} a_{ij} X_j \leq B_i (i = 1, 2, \ldots, m) \text{ and } X_j \geq 0 \qquad (2)$$

where

$X$ = Total gross margins of the enterprises.

$C_j$ = Gross margin per unit of the jth activity.

$X_j$ = The level at which the jth activity is to be carried.

$a_{ij}$ = Per unit requirement of the jth activity for the ith resource.

$B_i$ = Level of the ith resource, there are m of such resources.

The constraints take the form of linear inequalities, which simply means that the total requirements for any resources must be equal or less than the total amount of that resource available. The inequality can be converted to equality by the addition of slack activities which allow for unused resource.

$$\sum_{j=1}^{N} a_{ij} X_j + P_{n+1} = B_i$$

where $P_{n+1}$ is the activity which allows non-use of part of all of the ith resource.

Quantities of Resources:

Capital:

One purpose of this study is to find the optimum cropping pattern for farmers who have different amounts of capital available to them, given the technique of production. Because of the farmers reluctance in revealing the amount of capital they control, four capital situations purporting to reflect the resource positions of various farmers were used and these are capital for annual production expenses on crops limited to ¢200, ¢300, ¢500 and ¢1,000.

Land:

Land is considered a homogenous resource, thus assuming away differences in fertility and locality. Farmers in the area of study

do not encounter any serious problems in acquiring land for farming. Land is, therefore, limited only by the extent the farmer's managerial ability could allow him to control effectively. Two land situations, namely, 10 acres, and 25 acres, assume to be these levels were included in the plan.

Labour:

Labour is made up of two types, family and hired labour. Hired labour is either on daily or contract basis. Labour is measured in mandays. Each day a man goes to the farm is reckoned as one manday, however, female labour is arbitrary reckoned as half a manday for the main reason that women leave the farms earlier to cook for the household.

In calculating the available hired labour by months it was assumed that the farm operator has available to him during the slack farming months a maximum of eight farm labourers and a maximum of six farm labourers during the busy farming months. The slack months are June and August because relative to the other months, far less farm work is done during these months. In June, practically, no work is done on the farms, June labour is, therefore, assumed not to be a constraint. The rest of the months are considered busy ones. Non-farming days which include Sundays, taboo days and festive days are

subtracted from the available mandays to arrive at the actual number of mandays that are available for use on the farms.

Table 9 shows the method of computing the available mandays in the month.

Family labour is assumed to consist of a farm operator, his two adult sons and two wives. The total supply of family labour for a given month is the number of mandays available from the operator's time, plus those of his two sons and wives. From this quantity is subtracted the amount of labour used on livestock and other activities such as palm wine tapping, charcoal burning and hunting. Non-farming days such as taboo days and Sundays are also subtracted to arrive at the available family labour.

These further assumptions are also made. During the busy farming months, half of the operator's time available in any month is spent on managing the farm, while a quarter of the opertor's time is spent for the same operation during the slack farming months. Half of the total family labour available for each particular month is assumed to be spent on activities other than farming during the slack farming months and a quarter during the busy farming months.

The calculation of the available family labour by months was done in the manner shown in Table 10.

Table 9

METHOD OF COMPUTING HIRED LABOUR AVAILABLE BY MONTHS

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of days in Month: | 31 | 28 | 31 | 31 | 31 | 30 | 31 | 30 | 30 | 31 | 30 | 31 |
| Less Sundays: | 5 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 4 |
| Less Taboo Days; Bad Weather & Festives: | 5 | 5 | 8 | 9 | 10 | 8 | 5 | 5 | 8 | 8 | 5 | 5 |
| No. of Hired Labourers Available to Farm Operator: | 6 | 6 | 6 | 6 | 6 | 8 | 6 | 8 | 6 | 6 | 6 | 6 |
| Available Hire Labour (Mandays): | 126 | 114 | 114 | 108 | 96 | 114 | 132 | 160 | 108 | 108 | 126 | 132 |
| Code: | X10 | X11 | X12 | X13 | X14 | - | X15 | X16 | X17 | X18 | X19 | X20 |

Table 10

METHOD OF COMPUTING FAMILY LABOUR
AVAILABLE BY MONTHS FOR USE ON THE FARM AND THEIR CODES

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Days in Month | 31 | 28 | 31 | 31 | 31 | 30 | 31 | 30 | 30 | 31 | 30 | 31 |
| Less Taboo and and Sundays | 9 | 8 | 8 | 8 | 9 | 8 | 8 | 9 | 8 | 9 | 8 | 8 |
| Available Working Days: | 22 | 20 | 23 | 23 | 22 | 22 | 23 | 21 | 22 | 22 | 22 | 23 |
| Total Available Family Labour for Month (Mandays): | 88 | 80 | 92 | 92 | 88 | 88 | 92 | 84 | 88 | 88 | 88 | 92 |
| Operator's Time Spent on Management: | 11 | 10 | 11 | 11 | 11 | 5 | 11 | 5 | 11 | 11 | 11 | 11 |
| Less Time Spent On Other Activities: | 19 | 18 | 20 | 20 | 19 | 41 | 20 | 40 | 19 | 19 | 19 | 20 |
| Available Family Labour Per Month (Mandays): | 58 | 52 | 61 | 61 | 48 | 42 | 61 | 39 | 58 | 58 | 58 | 61 |
| Code: | X21 | X22 | X23 | X24 | X25 | - | X26 | X27 | X28 | X29 | X30 | X31 |

Per Acre Resource
Requirements of the Crop Enterprises:

The linear programming requires estimates of input-output coefficients of each resource used in the activity being considered for the production plan. The input-output coefficient may be defined as the quantity of resource required to produce a unit of specified activity. The coefficients are required for each activity for the three resources -- capital expenses, land and labour.

In establishing these coefficients it is necessary to establish labour and capital requirements per acre. Table 11 shows per acre labour requirements for the different crop enterprises considered in the plan.

The crop enterprises consider in the plan, their codes and statuses are outlined in Table 12.

Below are the calculations made to arrive at the per acre capital expenses on the crop activities considered in the plan and their gross margins. In estimating the per acre capital expenses on the crop activities the following assumptions are made. Family labour is arbitrarily valued at 50p because it was found to be less efficient relative to the hired labour, Land clearing is assumed to be a common cost for all the activities and will, therefore, not affect the choice of activities. As a result this cost is assumed away.

PER ACRE LABOUR REQUIREMENTS FOR DIFFERENT CROP ENTERPRISES

| ENTERPRISE / MONTH | MAIZE/MAIZE TRADITIONAL | | MAIZE/GROUNDNUTS TRADITIONAL | | MAIZE/YAM TRADITIONAL | | MAIZE/CASSAVA TRADITIONAL | | MAIZE/MAIZE WITH FERTILIZER IMPROVED | | MAIZE/MAIZE PARTIAL MECHANIZATION IMPROVED | | MAIZE/MAIZE ALL RECOMMENDED PRACTICES — IMPROVED | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Activity | Mandays | Activity | Mandays | Activity | Mandays | Activity | Mandays | Activity | Mandays | Activity | Mandays | Activity | Mandays |
| JANUARY | Dehusking & Shelling | 4 | Shelling of Groundnuts | 4 | | | Harvesting of Cassava | 8 | Harvesting<br>Dehusking | 2<br>5 | Harvesting | 2 | Harvesting<br>Dehusking & Shelling | 4<br>8 |
| FEBRUARY | Land Clearing<br>Land Preparation | 6<br>4 | Land Clearing<br>Land Preparation | 6<br>4 | Land Clearing<br>Land Preparation<br>Mounding | 6<br>4<br>10 | Land Clearing<br>Land Preparation | 6<br>4 | Land Clearing<br>Land Preparation | 6<br>4 | Land Clearing | 6 | Land Clearing<br>Land Preparation | 6<br>4 |
| MARCH | Planting | 2 | Planting of Maize | 2 | Planting of Maize and Yam<br>Staking and Twining of Yam | 5<br>10 | Planting of Maize &<br>Cassava | 2<br>2 | Planting<br>Fertilization | 2<br>2 | | | Planting<br>Fertilization | 5<br>2 |
| APRIL | Weeding | 5 | Weeding | 5 | Weeding | 6 | Weeding | 6 | Weeding | 5 | Hoe Weeding<br>Application of Ammonia | 6<br>2 | Hoe Weeding<br>Application of Ammonia | 6<br>2 |
| MAY | Weeding | 5 | Weeding | 5 | Weeding | 6 | Weeding | 6 | Weeding | 5 | | | | |
| JULY | Harvesting<br>Shelling | 1<br>8 | Harvesting of Maize<br>Transportation | 1<br>8 | Harvesting of Maize<br>Transportation | 1<br>6 | Harvesting of Maize<br>Transportation | 1<br>6 | Harvesting | 2 | Harvesting | 5 | Harvesting | 5 |
| AUGUST | Dehusking and Shelling | 5 | Dehusking<br>Shelling | 1<br>4 | Dehusking and Shelling | 5 | Dehusking and Shelling | 5 | | | | | | |
| SEPTEMBER | Land Preparation<br>Planting | 4<br>2 | Land Preparation<br>Mounding | 4<br>5 | Harvesting of Yam | 4 | Weeding | 5 | Land Preparation<br>Planting and Fertilization | 4<br>4 | | | Land Preparation<br>Planting and Fertilization | 4<br>7 |
| OCTOBER | | | Planting of Groundnuts | 2 | Harvesting of Yam | 2 | | | Dehusking and Shelling | 8 | Application of Ammonia | 2 | Application of Ammonia | 2 |
| NOVEMBER | Weeding | 5 | | | | | | | Weeding | 5 | Hoe Weeding | 6 | Hoe Weeding<br>Dehusking and Shelling | 6<br>12 |
| DECEMBER | Harvesting<br>Transportation | 1<br>6 | Harvesting of Groundnuts<br>Transportation | 3<br>4 | | | | | | | | | | |

Table 12

CROP ENTERPRISES, THEIR CODES, LABOUR SITUATIONS AND STATUSES

| Code | Activity or Enterprise | Labour Situation | Status |
|---|---|---|---|
| X1 | Maize/Maize | Family (F) | Traditional |
| X2 | Maize/Cassava | Family/Hired (FH) | Traditional |
| X3 | Maize/Yam | Family/Hired (FH) | Traditional |
| X4 | Maize/Groundnuts | Family/Hired (FH) | Traditional |
| X5 | Maize/Maize (Fertilizer and Improved Seed | Hired (H) | Improved |
| X6 | Maize/Maize (Recommended Practice & Partial Mechanization) | Hired (H) | Improved |
| X7 | Maize/Groundnuts (Recommended Practice for Maize) | Hired (H) | Improved |
| X8 | Maize (Major Season) (Recommended Practice) | Hired (H) | Improved |
| X9 | Maize/Maize (Recommended Practice, No Mechanization) | Hired (H) | Improved |

X1 Maize/ Maize (F)

| | | N¢ |
|---|---|---|
| Gross Output: | | |
| 7 bags of maize @ ¢6.50 per bag | | 45.50 |
| Variable Cost: | | |
| Planting: 4 mandays @ 50p per manday | 2.00 | |
| Weeding: (3 times) 15 mandays @ 50p per manday | 7.50 | |
| Harvesting: 2 mandays @ 50p per manday | 1.00 | |
| Transportation: 14 mandays @ 50p per manday | 7.00 | |
| Dehusking: 2 mandays @ 50p per manday | 1.00 | |
| Shelling: 7 mandays @ 50p per manday | 3.00 | |
| Total Variable Cost | | 22.00 |
| Gross Margin | | 23.50 |

X2 Maize/Cassava (F/H)

| | | |
|---|---|---|
| Gross Output | | |
| 3 bags of Maize @ ¢6.50 per bag | 19.50 | |
| Cassava | 100.50 | |
| Total Gross Output | | 119.50 |

Variable Cost

| | | | |
|---|---|---|---|
| Planting: | Cassava, 2 mandays (F) @ 50p/manday | 1.00 | |
| | Maize, 2 mandays (F) @ 50p/manday | 1.00 | |
| Weeding: | (Contract) thrice @ ¢4.00/weeding | 12.00 | |
| Harvesting: | Maize, 1 manday (F) @ 50p/manday | 0.50 | |
| | Cassava, 8 mandays (F) @ 50p/manday | 4.00 | |
| Transportation: | Maize, 6 mandays (F) @ 50p/manday | 3.00 | |
| | Cassava (tractor) | 6.00 | |
| Dehusking: | 1 manday (F) @ 50p/manday | 0.50 | |
| Shelling: | 3 bags @ 40p per bag | 1.20 | |
| | Total Variable Cost | | 29.20 |
| | Gross Margin | | 90.30 |

X3 Maize/Yam (H)

Gross Output

| | | |
|---|---|---|
| 3 bags of maize @ ¢6.50 per bag | 19.50 | |
| 500 average sized-tubers of yam @ ¢25.00 per 100 tubers | 125.00 | |
| Total Gross Output | | 144.50 |

| | | |
|---|---|---|
| Variable Cost | | |
| Mounding: 10 mandays (Contract) | 10.00 | |
| Planting (Yam): 3 mandays (F) @ 50p/manday | 1.50 | |
| (Maize): 2 mandays (F) @ 50p/manday | 1.00 | |
| Staking and Twinning: 10 mandays (Contract) | 10.00 | |
| Weeding: (Contract) twice @ ¢4.00/weeding | 8.00 | |
| Harvesting: Maize, 1 manday (F) @ 50p/manday | 0.50 | |
| Yam, 4 mandays @ 50p/manday | 2.00 | |
| Transportation: Yam (tractor) | 7.00 | |
| Maize, 6 mandays (F) @ 50p/manday | 3.00 | |
| Dehusking: 1 manday (F) @ 50p/manday | 0.50 | |
| Shelling: 3 bags @ 40p/bag | 1.20 | |
| Total Variable Cost | | 44.70 |
| Gross Margin | | 99.80 |

X4 Maize/Groundnuts (F/H)

| | | |
|---|---|---|
| Gross Output | | |
| 4 bags of Maize @ ¢6.50 per bag | 26.00 | |
| 2 bags of shelled groundnuts @ ¢19.00/bag | 36.40 | |
| Total Gross Output | | 62.40 |

Variable Cost

| | | |
|---|---|---|
| Mounding: | (Contract) for groundnuts | 5.00 |
| Planting: | (Maize) 2 mandays (F) @ 50p/manday | 1.00 |
| | (Groundnuts) 4 mandays (F) @ 50p/manday | 1.00 |
| Weeding: | Twice on Contract @ ¢4.00/weeding | 8.00 |
| Harvesting: | (Maize) 1 manday (F) @ 50p/manday | 0.50 |
| | (Groundnuts) 3 mandays (F) @ 50p/manday | 1.50 |
| Transportation: | (Maize) 7 mandays (F) @ 50p/manday | 4.00 |
| | manday (Groundnuts) 4 mandays (F) @ 50p/manday | 2.00 |
| Shelling: | (Maize) 4 bags @ 40p per bag | 1.60 |
| | (Groundnuts) 4 mandays (F) @ 50p/manday | 2.00 |
| | Total Variable Cost | 28.10 |
| | Gross Margin | 34.30 |

X5 Maize/Maize: Fertilizer and Improved Seed (H)

Gross Output

| | |
|---|---|
| 10 bags of maize @ ¢10.00 per bag | 100.00 |

Variable Cost

| | | |
|---|---|---|
| Fertilizer: 3 bags @ ¢2.80/bag | 8.40 | |
| Seed: 30 lbs @ 5p per lb | 1.50 | |
| Planting & Fertilization: | 6.00 | |
| Weeding: (Contract) 3 times @ ¢4.00 | 12.00 | |
| Harvesting: 4 mandays (F) @ 75p/manday | 3.00 | |
| Cost of Insecticides: | 2.00 | |
| Dehusking: 3 mandays @ 50p/manday | 1.50 | |
| Shelling: 10 bags @ 40p/bag | 4.00 | |
| Transportation: From farm (tractor) | 8.00 | |
| To Market @ 20p/bag | 1.20 | |
| (Interest on ADB loan (2 seasons) | 2.70 | |
| Total Variable Cost | | 50.30 |
| Gross Margin | | 49.70 |

X6 Maize/Maize: Recommended Practice & Partial Mechanization (H)

Gross Output

| | |
|---|---|
| 17 bags of maize @ ¢10.00/bag | 170.00 |

Variable Cost

| | |
|---|---|
| Ploughing and Harrowing (tractor) twice | 18.00 |
| Seed: 30 lbs @ 5p per lb | 1.50 |
| 4 bags of Fertilizer & 2 bags of Ammonia | 15.20 |

| | | |
|---|---|---|
| Planting and Fertilization (planter) | 12.00 | |
| Weeding: Twice (Hoe) 12 mandays @ 85p/manday | 10.20 | |
| Application of Ammonia: 4 mandays @ 75p/manday | 3.00 | |
| Harvesting: 9 mandays @ 75p/manday | 6.75 | |
| Transportation: From Farm | 8.00 | |
| Storage: Envelope Fumigation @ 55p/bag | 9.35 | |
| Dehusking and Shelling (sheller) @ 60p/bag | 10.20 | |
| Transport to market @ 20p/bag | 3.40 | |
| Interest on ADB loan | 2.70 | |
| Total Variable Cost | | 100.30 |
| Gross Margin | | 69.70 |

X7 Maize/Groundnuts: Recommended Practice (H)

Gross Output

| | | |
|---|---|---|
| 10 bags of maize @ ¢10.00 per bag | 100.00 | |
| 2½ bags of shelled Groundnuts @ ¢18.20/bag | 45.50 | |
| Total Gross Output | | 145.50 |

Variable Cost

| | |
|---|---|
| Cost of 2 bags of fertilizer & 1 bag Ammonia | 7.60 |
| Seed (Maize): 15 lbs @ 5p/lb | 0.75 |
| Planting & Fertilization: 7 mandays @ 75p/ Manday | 5.25 |

| | | |
|---|---|---|
| Application of Ammonia: 2 mandays (H) @ 75p/manday | 1.50 | |
| Weeding (Maize): Hoe weeding, 6 mandays @ 85p/manday | 5.10 | |
| Cutlass weeding (contract) | 4.00 | |
| Harvesting (Maize): 4 mandays @ 75p/manday | 3.00 | |
| Transportation (Maize:) From farm (tractor) | 4.00 | |
| Storage (Maize): Envelope fumigation @ 55p/bag | 5.50 | |
| Dehusking (Maize): 2 mandays @ 50p/manday | 1.00 | |
| Shelling (Maize): 10 bags @ 30p/bag | 3.00 | |
| Transportation to Market: (Maize) @ 20p/bag | 2.00 | |
| Interest on ADB Loan | 1.35 | |
| Mounding (Groundnuts) Contract | 5.00 | |
| Planting (Groundnuts), 2 mandays @ 75p/manday | 1.50 | |
| Weeding: Contract | 4.00 | |
| Harvesting (Groundnuts): 3 mandays @ 75p/manday | 2.25 | |
| Transportation: From farm (Groundnuts), 5 mandays @ 50p/manday | 2.50 | |
| Shelling (Groundnuts): 3 mandays @ 50p/manday | 1.50 | |
| Transportation (Groundnuts): To market @ 20p/bag | 0.50 | |
| Total Variable Cost | | 63.30 |
| Gross Margin | | 83.40 |

X8 Maize/(Major Season): Recommended Practice

Gross Output

| | | |
|---|---|---|
| 10 bags of maice @ ¢10.00/bag | | 100.00 |

Variable Cost

| | | |
|---|---|---|
| Cost of 2 bags of fertilizer and 1 bag of Ammonia | 7.60 | |
| Seed: 15 lbs @ 5p/bag | 0.75 | |
| Planting & Fertilization: 7 mandays @ 75p/manday | 5.25 | |
| Weeding: Twice (1) Hoe weeding, 6 mandays @ 85p/manday | 5.10 | |
| (2) Cutlass weeding (Contract) | 4.00 | |
| Application of Ammonia: 2 mandays @ 75p/manday | 1.50 | |
| Harvesting: 4 mandayds @ 75p/manday | 3.00 | |
| Transportation: From farm | 4.00 | |
| Storage: Envelope fumigation @ 55p/bag | 5.50 | |
| Dehusking: 2 mandays @ 50p/manday | 1.00 | |
| Shelling: 10 bags @ 40p/bag | 4.00 | |
| Transportation: To the market @ 20p/bag | 2.00 | |
| Interest on ADB Loan | 1.35 | |
| Total Variable Cost | | 45.05 |
| Gross Margin | | 54.95 |

X9 Maize/Maize: Recommended Practice, No Mechanization

Gross Output

| | | |
|---|---|---|
| 17 bags @ ¢10.00/bag | | 170.00 |

Variable Cost

| | | |
|---|---|---|
| Cost of 4 bags of fertilizer | 11.20 | |
| Cost of 2 bags of Ammonia | 4.00 | |
| Seed: 15 lbs of seed @ 5p/lb | 1.00 | |
| Planting & Fertilization: 14 mandays @ 75p/manday | 10.50 | |
| Weeding: (Twice) Hoe weeding: 12 mandays @ 85p/manday | 10.20 | |
| Cutlass weeding: Contract | 4.00 | |
| Application of Ammonia: 4 mandays @ 75p/manday | 3.00 | |
| Harvesting: 9 mandays @ 75p/manday | 6.75 | |
| Transportation: From farm | 8.00 | |
| Storage: Envelope fumigation @ 55p/bag | 9.35 | |
| Dehusking: 4 mandays @ 50p/manday | 2.00 | |
| Shelling: 17 bags @ ¢0.40/bag | 6.80 | |
| Transportation: To market @ 20p/bag | 3.40 | |
| Interest on ADB Loan | 2.70 | |
| Total Variable Cost | | 83.40 |
| Gross Margin | | 86.60 |

Table 13 summarizes the gross output, variable costs and gross margins of the different enterprises considered in the plan.

Table 13

GROSS OUTPUT, VARIABLE COSTS AND GROSS MARGINS OF THE VARIOUS ENTERPRISES

| Code | Enterprise | Gross Output ¢ | Variable Cost ¢ | Gross Margin ¢ |
|---|---|---|---|---|
| X1 | M/M (F) | 45.50 | 22.00 | 23.50 |
| X2 | M/C (FH) | 119.50 | 29.20 | 90.30 |
| X3 | M/Y (FH) | 114.50 | 44.70 | 99.80 |
| X4 | M/G (FH) | 62.40 | 28.10 | 34.30 |
| X5 | M/M (H) (Fertilizer & Improved Seed) | 100.00 | 50.30 | 49.70 |
| X6 | M/M (H) (Recommended Practice & Partial Mechanization) | 170.00 | 100.30 | 69.70 |
| X7 | M/G (H) (Recommended Practice) | 145.50 | 63.30 | 83.40 |
| X8 | M(Major Season) (H) (Recommended Practice) | 100.00 | 45.05 | 54.95 |
| X9 | M/M (H) (Recommended Practice, No Mechanization) | 170.00 | 83.40 | 86.60 |

Given the activities, their gross margins and resource resctrictions, the simplex system of linear programming was used to find the optimal combination of activities to maximize the total gross margins. Activities X1 to X9 are the same activities in Table 12 and activities X10 to X31 are the same activities in Tables 9 and 10. Activities X32 to X33 represent the constraints on land and capital respectively.

The simplex tableau for solving the linear programming is shown in Table 14. In Table 14, the top row specified C lists the prices which may be obtained for each unit of activity included in the production plan. The price of disposal is by assumption zero. The B column specified the level of intensity of the disposal activities or the activity in that row.

The Z row specifies cost in an opportunity sense. The values in this row indicate the amount of revenue which will have to be sacrificed from the present programme to permit the inclusion of 1 unit of the jth activity in the programme. In Table 14, the Z row values are all zeros which means that addition of 1 unit of each activity involves no loss of revenue due to the giving up of some other crop activity.

The Z-C row indicates the addition to total revenue resulting from the production of 1 additional unit of a given activity. This is expressed in a negative quantity.

Table 14

THE SIMPLEX TABLEAU FOR
SOLVING THE LINEAR PROGRAMMING

| C | → | | 23.50 | 90.30 | 99.80 | 34.30 | 44.70 | 69.70 | 83.40 | 54.95 | 86.60 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 |
| X10 | 126 | > | 0 | 0 | 0 | 0 | 7 | 4 | 4 | 0 | 12 |
| X11 | 114 | > | 0 | 10 | 20 | 10 | 10 | 6 | 10 | 10 | 10 |
| X12 | 114 | > | 0 | 0 | 10 | 0 | 4 | 8 | 7 | 7 | 7 |
| X13 | 108 | > | 0 | 6 | 6 | 5 | 5 | 0 | 8 | 8 | 8 |
| X14 | 96 | > | 0 | 6 | 6 | 5 | 5 | 0 | 5 | 5 | 5 |
| X15 | 132 | > | 0 | 0 | 0 | 0 | 2 | 5 | 5 | 5 | 5 |
| X16 | 160 | > | 0 | 4 | 3 | 4 | 0 | 0 | 0 | 0 | 0 |
| X17 | 108 | > | 0 | 5 | 0 | 0 | 8 | 0 | 9 | 0 | 11 |
| X18 | 108 | > | 0 | 0 | 0 | 5 | 8 | 8 | 2 | 12 | 8 |
| X19 | 126 | > | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 12 |
| X20 | 132 | > | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 |
| X21 | 58 | > | 4 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| X22 | 52 | > | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X23 | 61 | > | 2 | 4 | 5 | 2 | 0 | 0 | 0 | 0 | 0 |
| X24 | 61 | > | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X25 | 58 | > | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X26 | 61 | > | 9 | 9 | 6 | 9 | 0 | 0 | 0 | 0 | 0 |
| X27 | 39 | > | 5 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| X28 | 58 | > | 6 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 |
| X29 | 58 | > | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| X30 | 58 | > | 5 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| X31 | 61 | > | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 |
| X32 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| X33 | | | 22.00 | 29.20 | 44.70 | 28.10 | 50.30 | 100.30 | 63.30 | 45.05 | 83.40 |
| | Z | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Z-C | | -23.50 | -90.30 | -99.80 | -34.30 | -49.70 | -69.70 | -83.40 | -54.95 | -86.60 |

The optimum plan is reached when it is no longer possible to add to total revenue by substituting one crop activity for another. That is until no negative quantities remain in the Z-C row. The activity brought into the plan is the one with the most negative Z-C value. Thus in the simplex tableau X3 is the first activity to enter the plan. Successive iterations in this computational table are progressive steps towards the optimal plan.

Since the matrix in the simplex tableau was too large to permit calculation by hand, it was solved using a computer. An optimum or profit maximizing programme was determined for the different level of land and capital included in the plan.

Presentation of the
Results of the Linear Programming:

As stated above, two land situations and four capital situations are used in the programme. Tables 15 and 16 summarize the results of the linear programming.

In the first run of the programme a fixed land of 10 acres is assumed. The programme is then run with all the four capital situations, namely, ¢200, ¢300, ¢500 and ¢1,000, the results are summarized in Table 15. A new land situation of 25 acres is assumed and the programme run again with all the four capital levels and the results summed up in Table 16.

Table 15

REVENUE MAXIMIZING PLAN, GIVEN
DIFFERENT LEVELS OF CAPITAL AND A FIXED LAND OF 10 ACRES

| Capital Level (£) | Crop Activity | Activity Level (Acres) | Capital Unutilized (£) | Land Unutilized (Acres) | Gross Margin (£) |
|---|---|---|---|---|---|
| 200 | X2 | 6 | - | 4 | 541.80 |
| 300 | X3 | 3 | - | 2 | 750.90 |
| | X2 | 5 | | | |
| 500 | X3 | 1 | 36.95 | - | 901.40 |
| | X2 | 6 | | | |
| | X9 | 3 | | | |
| 1,000 | X3 | 1 | | | |
| | X2 | 6 | 536.95 | - | 901 |
| | X9 | 3 | | | |

Table 15 indicates that, if land is limited to 10 acres, given the set of assumptions made, the farmer needs capital up to the value of ¢463.05 to develop all theland. This conclusion could easily be arrived at from the Table by looking at the working capital level of ¢500 row. When the working capital is ¢500, ¢36.95 are left unutilized. In other words, ¢463.05 are utilized and all the available land is exhausted. The enterprise combination and their intensity are as follows: Maize/Yam enterprise (X3) 1 acre; Maize/Cassava enterprise (X2) 6 acres; and Maize/Maize employing the recommended practice with no mechanization (X9) 3 acres. The gross margin to be realized from this combination is ¢901.40.

It would also be seen that the Maize/Cassava enterprise (X2) was the first to enter the optimal plan. Though this enterprise does not have the highest gross margin, the low capital requirement of this enterprise (see Table 13) makes it relatively profitable to be undertaken. This no doubt explains why this enterprise remains part of all the optimal plans summarized in Table 15. The Maize/Yam enterprise (X3) has the highest gross margin its capital requirement is about double that of the Maize/Cassava (X2) enterprise (see Table 13). Apparently, it is for this reason that when X3 becomes part of the optimal plan its intensity is less than that of X2.

When the capital level is raised to ¢500 in Table 15, the Maize/Maize enterprise using the recommended practice with no mechanization (X9) beccomes part of the optimum solution. The reason for this is the constraint imposed by July family family labour on enterprises X2 and X3. At this level capital is not limiting so that the high capital requirement of the X9 enterprise (see Table 13) does not prevent it from entering the final plan. Enterprise X9 does not require any July family labour (X26) (see Table 14) which is completely used up by enterprises X2 and X3 at their intensities portrayed in the final plan. Therefore the next most profitable enterprise, X9, is brought into the plan in order to exhaust the available land.

After ¢500 capital level, any addition to capital becomes idle because all the available land has been utilized.

In the results summarized in Table 16, capital is limiting in all the capital levels portrayed in the plan, while some land is left idle in all cases.

The Maize/Cassava activities (X2) is the first to enter the final plan at a capital level of ¢200. This remains in all successive maximization plans. As capital is increased to ¢300, the Maize/Yam enterprise (X3) becomes part of the final plan. However, a further

Table 16

REVENUE MAXIMIZING PLAN, GIVEN DIFFERENT LEVELS OF CAPITAL AND LAND LIMITED TO 25 ACRES

| (¢) Capital Level | Crop Activity | Activity Level (Acres) | Capital Unutilized (¢) | Land Unutilized (Acres) | Gross Margin (¢) |
|---|---|---|---|---|---|
| 200 | X2 | 7 | - | 12 | 632.10 |
| 300 | X3 | 3 | - | 17 | 750.90 |
| | X2 | 5 | | | |
| 500 | X7 | 6 | | | |
| | X2 | 6 | - | 12 | 1,107.70 |
| | X1 | 1 | | | |
| 1,000 | X1 | 5 | | | |
| | X7 | 7 | - | 7 | 1,156.70 |
| | X2 | 2 | | | |
| | X6 | 4 | | | |

increase of capital to ¢500 eliminate X3 from the final plan. This is the result of the constraint imposed by July family labour (X26) and capital (X33) on this activity. The severe limitation imposed by capital on the programme causes crop activities which are not the most profitable to be included in the final plan. For example, in the ¢500 working capital row of Table 16, Maize/Groundnuts enterprise, using the recommended practice for Maize (X7) and Maize/Maize enterprise using traditional methods and entirely family labour (X1) are included in the final plan.

As X3 is eliminated from the plan because of the unavailability of sufficient quantities of July family labour (X26), the next most profitable enterprise is Maize/Maize using the recommended practices and no mechanization (X9) (see Table 13) but its capital requirement per acre is so high that it is also excluded from the plan. (Note the limitation imposed on capital). The next most profitable enterprise Maize/Groundnuts using the recommended practices (X7) is brought into the plan. This activity has relatively smaller capital requirement per acre. Maize/Maize enterprise using the traditional methods and only family labour (X1) becomes part of the optimum solution though it has the least gross margin. The reason is that after expending part of the working capital on the other activities in the final plan the capital left is so small that it can undertake an activity with a very

small per acre capital requirement and X1 has the least per acre capital requirement (see Table 13). As the capital level is increased to ¢1,000 the next most profitable enterprise Maize/Maize recommended practice and some mechanization (X6) becomes part of the final plan.

CHAPTER V

# CONCLUSION

Maize is the most important staple cereal in terms of quantity consumed and as a source of calories in Ghana. The production of this important crop has been taking place against the background of rising prices mainly as a result of inadequate supplies. This underscores the fact that, the present mode of production, which is the use of traditional methods has failed to produce enough quantities to satisfy the market and, therefore, calls for the need to introduce improved methods or recommended practices in order to increase production.

Since the introduction of the improved methods in recent times , it has not made any sizeable impact on the farmers in the area this study was conducted. The farm management tool of linear programming has been employed in the present study in an attempt to find reasons for the limited adoption of the improved methods.

The results of the linear programming indicate that, given the set of assumptions made, at working capital levels not more than ¢300, the traditional method of cultivation is more profitable to undertake (see Tables 15 and 16). Since most farmers interviewed denied that they could afford this amount for farming purposes during any

particular season, it would seem that the most rational behaviour is to reject the improved methods of cultivation.

At working capital levels over and above ¢300, however, the use of the improved methods becomes part of the optimal plan but in all cases the final plan includes some activities which use traditional methods, so that the improved methods have been unable to eliminate the traditional methods altogether. The reason for this state of affair is the high per capital requirements of the improved methods. In order to make the improved methods attractive to farmers it is imperative that ways and means of reducing the per acre capital requirements is found. In absence of this, it is only fair to conclude that farmers will always be encouraged to stick to their traditional methods of production which at present is cheaper, especially, at low capital levels than the use of the recommended practices.

14. Wallace, D. (1961) 16(1), "Farm Accounts and How to Use Them", 2nd Impression. A Farm and Stock-Breeder Publication, London, Ilitte Books Limited.

15. Wharton, C.R. Jnr. (1969), "The Green Revolution Cornicopia or Pandora's Box?", Foreign Affairs (An American Quarterly Review), p.464 - 476.

16. Wills , J.B. (1962), "Agriculture and Land Use in Ghana, Oxford University Press, London.