A COMPUTER ASSISTED PLANNING METHOD
FOR SMALL REPRESENTATIVE FARMS
IN DEVELOPING COUNTRIES

By

FAUSTIN MWAPE

Bachelor of Agricultural Science

University of Zambia

Lusaka, Zambia

1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1981

A COMPUTER ASSISTED PLANNING METHOD

FOR SMALL REPRESENTATIVE FARMS

IN DEVELOPING COUNTRIES

Thesis Approved:

Odell L. Walker
~~Thesis Adviser~~

Joseph E. Williams

Paul D. Hummer

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author is indebted to many people for their assistance throughout the course of this study. Deepest appreciation is extended to Dr. Odell L. Walker, chairman of my graduate advisory committee, for his advice and constant encouragement. The other members of the advisory committee, Dr. Joseph E. Williams and Dr. Paul D. Hummer, also deserve special thanks for reviewing the thesis draft and their valuable suggestions during the research project.

I wish to express appreciation to the University of Zambia for the financial assistance throughout my studies at Oklahoma State University.

The other people who have contributed significantly are Jane-Frances Bakama and Emilio Mulenga. Finally, special gratitude is expressed to my mother, Kabwe Musonda, my father, Malubeni Musonda, and all my brothers and sisters for their patience, support and understanding.

TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

Table | Page

FIGURE

CHAPTER I

INTRODUCTION

Increasingly, the need to improve and expand food production in developing countries is recognized to be of highest priority. The population in most of the developing countries continues to grow faster than food production. The Food and Agriculture Organization (FAO) of the United Nations (UN) has projected that three quarters of the world's population will be in developing countries in the year 2000 and developing countries will continue to produce less than 30 percent of the world food (28). If the projections hold, then there will be a severe food imbalance in developing countries. This means that developed countries must transport more food to developing countries, probably on concessionary terms as in the past, because these countries do not have the foreign exchange to pay, or increase food production in developing countries.

The inadequate food production in developing countries has been accompanied by a growing dependence on food imports, mainly from developed countries. In the 1960's the rate of growth of the value of food imports (excluding fish) both in terms of current and constant prices of developing countries was slightly lower than that of developed countries, but in the 1970's the situation was completely reversed (see Table I). The value (at constant prices) of food imports of developing countries increased at an average annual rate which nearly

TABLE I

VALUE OF IMPORTS OF TOTAL AGRICULTURAL AND FOOD (CROPS AND LIVESTOCK) PRODUCTS AND CEREALS

Item		Averages 1961-65	Averages 1969-71	Averages 1976-78	Annual Rate of Change 1961-65 to 1969-71	Annual Rate of Change 1969-71 to 1976-78
		million $			%	
TOTAL AGRICULTURAL PRODUCTS						
Total for Developing Countries:	Actual*	7745	10631	37427	4.6	19.7
	Constant	82221	10631	16483	3.7	6.5
Total for Developed Countries:	Actual	31831	45348	55348	5.1	16.1
	Constant	34922	45348	55225	3.8	2.9
FOOD						
Total for Developing Countries:	Actual	5843	7877	28467	4.4	20.0
	Constant	6129	7877	12447	3.6	6.8
Total for Developed Countries:	Actual	17639	27314	79199	6.4	16.4
	Constant	20380	27314	35530	4.3	3.8
CEREALS						
Total for Developing Countires:	Actual	2924	3653	12556	3.2	19.3
	Constant	3039	3653	5684	2.7	6.5
Total for Developed Countries:	Actual	4052	5397	17096	4.2	17.9
	Constant	4378	5397	8184	3.0	6.1

*The constant values were obtained by deflating the current values in each case by the corresponding index of import unit values with 1969-71 base.
Source: Food and Agricultural Organization of the United Nations, 1979, pp. 1-54.

doubled from 3.6 percent between 1961-65 and 1969-71 to 6.8 percent between 1969-71 and 1976-78. However, comparable rates for developed countries fell from 4.3 to 3.8 between the two periods. The imports of cereals and other food crops continue to grow rapidly, thus further increasing dependence on external food supplies.

Most of the work force in developing countries is in agriculture. Some studies have shown that 60 to 90 percent of the population in developing countries depend on some form of farming (i.e., subsistence to commercial farming) (32). The work force in agriculture is mainly made up of small farmers with a low resource base, mostly in the form of land and family labor. The illiteracy rate among small farmers in developing countries is very high (i.e., about 61 percent of the adult population) (33). The dominant objective for managers of small farms is to insure an adequate food supply for their families throughout the year. The concern for family food production was expressed by small farmers in Nigeria where researchers at Ahmadu Bello University developed an improved cotton technology with emphasis on higher yields. However, small farmers in Nigeria rejected this technology on the grounds that a labor conflict emerged between weeding food crops and planting the improved cotton (4).

The desire to insure adequate food supply for their families is enhanced by restricted access to urban markets due to inadequate transport and a poorly developed distribution system. Thus, even if small farmers have money (cash), they cannot easily buy essential commodities. To avoid going without essential commodities, small farmers have tended to give priority to growing crops which provide staple food even if it may not be economically wise. Traditionally, production has been directed towards crops which are a source of staple food or can be used as a substitute in case of staple crop failure. The provision of food for the family is now being complemented by desire to have some extra cash to meet farm credit, school fees, medical fees and other expenses.

While there have been attempts in many developing countries to increase farm output through use of improved seeds and other forms of modern technology, little effort has been devoted to teaching farmers planning techniques which would help them allocate their limited resources efficiently. The development of planning techniques which concentrate on small farmers, since they form a big proportion of the farming community, and seek agricultural modernization would lead to increased farm output.

Poor farm management has resulted in low per unit output thus making it difficult for small farmers to obtain credit as lending institutions fear that farmers cannot repay their loans. If small farmers cannot obtain credit then it will be difficult for them to increase resource level on their farms.

Changes are needed in the administration and organization of agricultural support services to assure that information is disseminated broadly and quickly. It is important that the agricultural services be responsive to the special needs of small farmers. If the government and lending institutions want to raise production per unit of input, they need to explore ways of improving resource allocation, production efficiency and/or increasing the level of employment of resources of small farmers without incurring considerable debt. This is important because farmers rely on improvements channeled to them through the extension service. An enterprise combination consistent with the farmer's objectives and resource restrictions will lead to increased production of enterprises by focusing talent, time and money on productive projects which maximize the farmer's objectives. Restraints facing the small farmer in developing countries are poor management, dependence on family labor and lack of capital, formal education and land. Where land is scarce, the farmer may rent land from land owners. The small farmer is not able to solve most of these restraints without assistance from the government or lending institutions.

Objectives

This study was undertaken using Honduras, Central America data to develop a linear programming method for analyzing small farms. The specific objectives were:

1. To develop a linear programming model to be used in obtaining an optimum enterprise combination for a small typical farm.

2. To evaluate stability of the optimum plan.

3. To identify the most limiting resources and to suggest possible means of increasing the level of their employment.

4. To measure cash flow of the optimum plan for use in obtaining loans.

5. To determine minimum land needed for small farmers to meet their family food requirements per year, earn a specified family income and meet farm credit obligations.

6. To explore how the results from a small farm linear programming model would be communicated to farmers.

Planning Enterprise Combinations

The need for planning arises from three basic factors:

1. Individuals have various wants which they seek to satisfy. The wants are expressed as objectives. The objectives may be financial and non-financial. Some of the non-financial objectives involve preferences for certain enterprises.

2. The means available to satisfy wants or objectives are scarce. This implies that the available resources or means should be employed in their best use to meet requirements of the farmer.

3. The available resources can be put to alternative uses.

Some resources are so scarce that the use of abundant ones is limited. Where such imbalance occurs, the major concern is with those resources that are the most limiting. The most scarce resources limit the extent to which objectives can be attained. This is true in countries where land is scarce. In this case, it is difficult to buy or rent land. Then it is important that land be put to the best use under the prevailing conditions. Determining the best use for resources requires planning. Planning for an optimum enterprise combination is essential if there are alternative ways of using resources. If there were no alternative uses of resources, then there would be no need for planning, e.g. labor can be used to produce corn, rice and sugar cane. However, if labor could only be used in producing corn there would be no need to plan its allocation.

Ideally in farm planning, records provide data for use in the farm plan. The information provided by records comes from past performance but gives a good idea as to what the farmer may reasonably expect to accomplish in the future. Besides records, planning needs to consider new technology and changes in price levels. Planning is a forward looking process, therefore records must be interpreted as possible future occurrences. Steps needed to carryout planning are to:

1. Determine objective(s) of the farmer.

2. Take inventory of available resources. The inventory must include detailed characteristics of resources such as quality, grade, etc.

3. Forecast prices and yields. The price forecast can be obtained through price guarantees where such agreements exist, trends of production and consumption, government publications and agricultural literature. The yield estimates can be obtained from records, experience on the farm, neighbors with similar conditions and research stations (14).

4. Analyze the farm problem and interpret the plan.

All planning techniques need the above information. The usefulness of any optimum plan will depend on how reliable the above information is.

Under some farming systems, like those of developing nations where staple food is a must, the preferred farm organization does not change much with variations in prices. This is also true if there are no alternatives to which resources can be put or if one enterprise has a very big advantage over others or it is a staple food. In such cases, prices of commodities might drop considerably without changing the plan. Once the farmer has derived and adopted the optimum enterprise combination, he may retain it year after year.

Farming System Approach

Productivity can be improved through development of relevant technology and complimentary policies which increase the welfare of farming families in a way that is useful and acceptable to them and society as a whole. Researchers are increasingly recognizing that the best approach to solving farm problems is through a systems approach. A system can be defined as any set of elements or components that are interrelated and interact among themselves to achieve certain goals or objectives (11). The concepts of the systems approach are developed from answers to some basic questions: why, where, with what, who, how and when (16). At the center of the interaction are the farmers and their families. In order to help small farmers effectively, their full participation is important. The investigation should begin by answering the basic questions with the help of the farmer. Then the investigation should be followed by designing programs intended to consider all concerns and to raise the welfare of farmers and their families. Ignoring concerns of the farmer reduces acceptability of the new programs. The farming systems approach generates plans which consider social structure, norms, political setup and beliefs as important determinants of the economic activity of a society. A plan derived through a farming systems approach focuses on adaptive agricultural experimentation by identifying areas of management where the farmer is flexible and where improved farm management will contribute to higher productivity in the system as a whole (7).

The information used in this study was collected through interviews conducted by Oklahoma State University (OSU) on small farms and from research data in Honduras. The information obtained from the interviews and research data was analyzed and formulated into enterprise budgets by OSU. This study begins by making use of these budgets and concerns of the farmer to derive an acceptable optimum plan. Linear programming provides the means of incorporating preferences of the farmer and technology to derive an acceptable plan. The planning process cannot be completed unless the derived plans are delivered to the intended receipients (i.e., the small farmer). Thus, after deriving the optimum plan, methods of making the plans reach the small farmers are examined. This study will deal with the allocation of inputs to crop and livestock production while considering preferences and concerns of the farmer.

Assumptions

Most developing countries depend on agricultural exports for their much needed foreign exchange. Lending institutions would like to see a high repayment rate. Then it is assumed that these institutions want to see increased productivity among small farmers so that their aspirations can be fulfilled.

Small farmers in developing countries would like to lead a better life than they currently do. However, small farmers are not willing to accept better life at the expense of food security. It is assumed that small farmers in developing countries will accept change which does not threaten food security.

Developing countries have large numbers of small farmers and an inadequate transportation system. It is assumed that the area can be divided into regions with similar conditions and then programs can be designed based on a representative farm. A representative farm is here defined as a farm which approximates farm situations in the region.

Most developing countries do not have enough skilled manpower. However, this study assumes that the government and lending institutions are able to hire people who can prepare small computer programs and interpret simplified computer outputs, e.g., the optimum enterprise combination for small farmers.

In most developing countries adequate enterprise budgets are not available. It is assumed in this study that budgets have been developed for the region in which the representative farm is situated, i.e., Choluteca - Nacaome.

The preferences and concerns of small farmers are important in determination of the optimum and acceptable plan. In deriving the optimum plan for the representative farm, it is assumed that the field interviews conducted by OSU personnel were able to establish preferences and concerns of a small representative farmer.

There are cultural, beliefs, norms, social, weather and soil differences from country to country and region to region. However, this study assumes that all these factors are homogenous within one region. It means plans made for certain resource situations, preferences and concerns will hold or only be modified slightly to suit most farmers in the region.

The poor farm management among small farmers in developing countries has led to low yields. However the increasing extension services have given a new hope of raising production among small farmers to medium yield. Excellent yields are possible with good management. This study will assume medium level management because most small farmers in developing countries lack the knowledge needed to obtain high yields. The classification of farm management used in the OSU - Honduras project is based on the yield levels attained, e.g. for corn yields per manzana (i.e., one manzana ≑ 0.7 hactares = 1.73 acres):

below 30 quintals----low level management,

between 30 and 60 quintals----medium level management,

over 60 quintals----high level management (21).

Area of Study

The population of Honduras is about 3,820,000. About 61 percent of the population live in rural areas. As for the specific area of study Choluteca, the population is 300,000 with about 60,000 people living in the city.

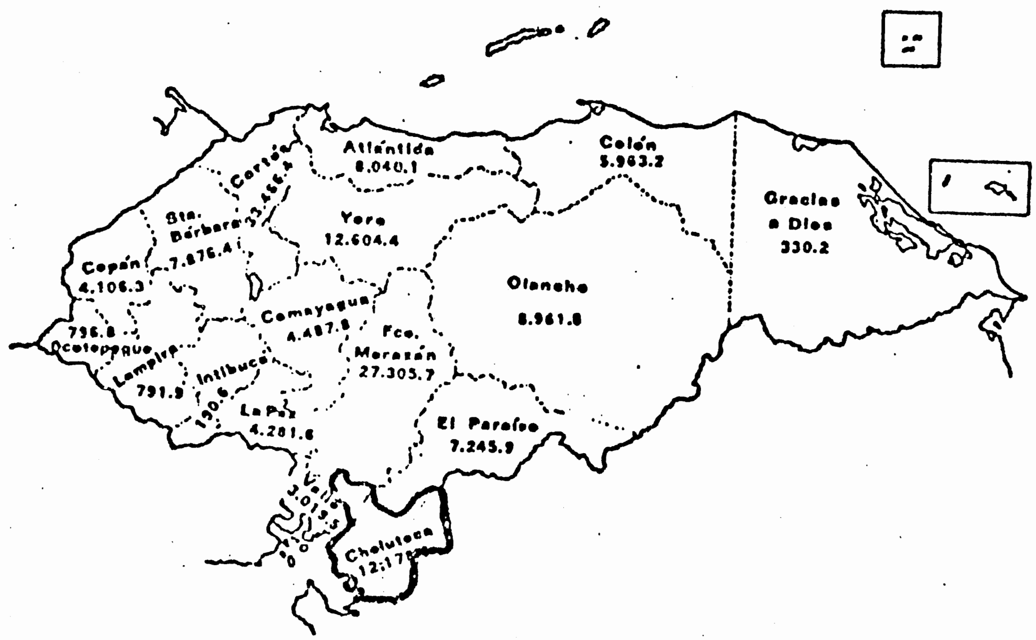
The area for which the soil, yield data and other information has been developed in the study is Choluteca - Nacaome in Honduras (Figure 1). The land resource is predominantly used for crops (especially staple food crops) with some livestock.

The climate consists of a dry period from January to May and the humid period from June to December. The mean temperatures of Honduras are between 15°C (59°F) and 24°C (74.4°F) to 30°C (86°F) on the coastal areas. The principal crops in Choluteca are sugar cane, watermelon, rice, sesame, cantaloupe and corn. Some western areas of Choluteca grow cotton.

Literature Review

Traditionally, economics is defined as the science of allocating scarce resources among competing ends to satisfy these ends as fully as possible. Two useful techniques employed in allocation of scarce resources are budgeting and linear programming. These planning techniques and their modifications are very important in farm management.

Banard and Nix (1) defined budgeting as a detailed quantitative statement of a farm plan and the forecast of its financial results. Budgeting consists of comparing expected net returns from alternative plans. Net returns in this study are defined as return to labor and land resources owned by the small farmer. Budgeting is needed when



Source: Banco Nactional De Fomento, 1974/78, pp. 45

Figure 1. Map of Honduras Showing the Area of Study: Choluteca

considering overall planning for the farm, when conditions have changed sufficiently to alter relative profitability of various alternative enterprises and also for short run adjustments.

Budgeting has been accepted in many developing countries as an appropriate way of performing farm planning. It does not require access to computers and it is thought that budgeting can be easily handled by low level manpower. McArthur (18) reported that Kenya extended the comparative approach (i.e., budgeting) to its small farmers in 1962 and still has district guidelines in the form of enterprise standards against which individual farm performance can be compared and from which farm plans can be designed. Kahlon (15) reported that India recognized farm planning as a tool for improved productivity and launched a farm planning program in several districts in 1960. Because of the large number of small farmers and the limited number of extension staff, Kahlon drew attention to the representative farm as a way of getting around individual planning.

Beneke and Winterboer (5) suggested that although budgeting is a trial and error procedure, often it is accepted more readily because it more nearly approximates the operator's approach to decision making.

Budgeting requires a lot of time to approximate the optimum plan. The arithmetic involved in budgeting is tedious and there is no guarantee that the optimum plan will be determined. The time required, insufficient skilled manpower to plan for the large number of small farmers and the inadequate transportation makes budgeting inefficient even though it has been used on a low scale in many developing nations.

Banard and Nix (1) described linear programming as a technique which, given suitably formulated data, is capable of producing optimal mathematical solutions in terms of either maximizing or minimizing some stated objective, subject to linear constraints. Linear programming leads to plans that will give maximum levels of stated objectives, given prices and production data. Linear programming may be designed to take preferences of the farmer into account. The advantages of linear programming are:

1. It specifies the best plan.
2. It handles complicated arithmetic in a short time.
3. It is easy to change certain coefficients in the matrix to show the effect on the optimal organization (i.e., perform sensitivity analysis).
4. It saves time and avoids making right decisions at wrong times. This is important where solutions are required at specific times.

Linear programming requires technical expertise and access to computers. The costs of computers have been declining since they first came on the market, thus cost is no longer a disadvantage. Computer services can be made cheaper by using representative farm planning, even though this is not superior to individual planning. Stanton (27) reported that use of average production performance data does not provide acceptable farm organizations. However, Collinson (7) reported that coverage of the small holder in developing countries is negligible and education costs per farm unit are very high because of large numbers of farms involved. Collinson concluded that research and education in less developed countries must deal with types of farms rather than the individual. That is, farm plans need to be generated for a representative farm and conveyed for general adoption by farms with objectives and conditions similar to the representative farm. In developing nations, small farmers in a given region will tend to have about the same staple food, norms and land area they can farm with their limited resources (i.e., they have more or less the same objectives and concerns). Thus a representative farm plan is a useful and cheap way of getting optimum plans for the region's farms. This is because planning costs will be spread over a good number of farmers with similar conditions.

Connor and Vincent (8) argued that the primary objective for study of linear programming is not use of computers but help for the manager in getting information he needs in performing his functions. Connor and Vincent also pointed out that computer systems will have limited application unless they are able to indicate problem areas, suggest dimensions of the problems and point to prescriptive action.

Kline and Huddleston (17) suggested that it is possible to use linear programming to estimate minimum resource requirements to attain specified incomes from farming. Many linear programs have been developed (both large and small) to handle different problems and provide different information in their outputs. Marceau (19) reported that cost of computer service is high and direct costs are reduced by design of an efficient general model and development of matrix preparation and report writing procedures which reduce cost. Marceau found that the demand for computer services increased for the United States farmers earning more than $20,000 per year and that it would be difficult to persuade the least efficient farms affected to pay the necessary fee. This is important for developing countries where small farmers form the majority of the farming population.

The interpretation of computer output from linear programming is important. Grawoig (12) noted that no additional benefits are derived from linear programming outputs unless they are interpreted properly. The interpretation must be in terms of both the broad environment in which the decision must operate and the special assumptions and simplifications in the construction of specific model. It is important to remember that mathematical techniques (models) must always be used as an aid to solving problems. The linear programming technique provides an efficient mathematical model for determining an optimal strategy where there are numerous alternative strategies which might be followed in seeking certain objectives and the picture is clouded by the fact that the various courses of action are interrelated by numerous restrictions and constraints (12).

Sherbiny and Zaki (25) reported that decisions to develop the agricultural sector in less developed countries should focus on the increase of resources and/or introduction of new technology rather than the allocation of existing resources, given production techniques. They suggested that planners can rely on the farmer's sense of optimization to allocate the additional resources efficiently as they have done with existing resources. There is no other efficient way of determining limiting resources, allocating resources and determining appropriate technology apart from planning. Optimum resource allocation is needed if waste of limiting resources is to be avoided. Contrary to Sherbiny and Zaki's report, decisions to develop the agricultural sector in developing countries should focus on the activities which enter the optimum plan.

Collinson (7) has stated that improvement of agriculture in many less developed countries remains synonymous with achieving higher yields per unit of land and that small farmers rely on improvements provided by the extension service. Emphasis on higher yields per unit of land is not enough to generate the needed agricultural progress.

Small farmers want to insure food supply for their families throughout the year because of the poor marketing and distribution system. There is no guarantee that farm families can buy food crops from local shops if they do not produce them on the farm. Hayer (13) reported that small farmers in less developed countries are very concerned with the uncertainities which threaten food supply and that more priority was placed on food production in resource allocation.

The application of linear programming as a farm planning tool in less developed countries is almost non-existent. However, linear programming has been used on big projects (e.g., linear programming was used to assess the economic implications of the Tanzania - Zambia Railway Line (Tazara) on Tanzam Highway) (23). The explanations given for the non-use of linear programming are lack of skilled manpower and computer facilities. A few professionals at the headquarters of institutions, such as the ministry of agriculture, can be used to derive simple but adequate computer programs with simplified outputs.

The studies discussed above provide a basis and background for further research. This study will expand on these studies and analyze how linear programming can be used to arrive at an optimum enterprise combination for a small representative farm, identify limiting resources and answer other questions which arise.

CHAPTER II

ANALYTICAL PROCEDURES

The analysis is based on a representative farm in the Choluteca - Nacaome area of Honduras. As mentioned earlier, developing countries have large numbers of small farms, making it difficult to deal with individual problems. Thus, the representative farm is a necessary expedient in farm management research and education.

Sources of Data

The production and financial data used were obtained from the Oklahoma State University (OSU) - Honduras project. The objective of the project was small farm data collection and analysis to improve credit use. The project staff made a field study of the objectives of small farmers, their resources, their production practices and other farm data. The project was able to establish production possibilities and environmental data (i.e., soil, climate and market) and take stock of resources (land, labor, capital and management) of the small representative farm.

Budgets

After collection of data through field interviews, adequate budgets were developed by OSU which provide information needed in planning enterprise combinations of small farmers. The ecology in Honduras differs from region to region. In order to deal with this ecological diversity, it was necessary to establish locational categories for crop production budgets. Establishing one budget per region may be inadequate due to diverse technology (ranging from subsistence to modern farming), soil and rainfall. However, by assuming medium level management and other conditions for the representative farm in Choluteca - Nacaome, these differences can be ignored.

An enterprise budget is a statement of the physical inputs and costs necessary to obtain a specified quantity of production and also includes expected revenues (21). The budgets developed for Honduras were simplified to suit the local manpower. A format of the simplified enterprise budgets developed for use in Honduras is presented in Table II. Other budgets used in the analysis appear in the Appendix. These budgets have seven sections: labor requirements, contracted services, materials, other costs, total costs, other detailed costs and profitability analysis. The budget is identified by a five digit code. The first two digits identify the region, the next two identify the crop and the last identifies the yield category, i.e., low, medium and high. For example, the corn budget (11012), the two first digits refer to Choluteca on the list of budget locations, the next two refer to corn production in Choluteca and the last one refers to the medium level management (i.e., 1 = low, 2 = medium and 3 = high level management).

The labor section shows all the labor requirements of each enterprise per manzana. Labor is measured in man-days. A man-day in this study is six hours a day. The farm enterprise operations are listed according to the month in which the operation is done. The other contracted services section includes rental of any service. The contracted

TABLE II

FORMAT OF THE ENTERPRISE BUDGETS DEVELOPED FOR USE IN HONDURAS
ENTERPRISE BUDGET NO. 11012

Enterprise: corn, medium yield 33 quintals/manzana
Region: Choluteca-Nacaome
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Per Unit (L)	Total Cost (L)
May - plant	1.0	4.0	4.0
May - apply fertilizer	1.0	4.0	4.0
May - till	1.0	4.0	4.0
June - apply urea	1.0	4.0	4.0
June - weed	4.8	4.0	19.20
June - apply pesticides	1.0	4.0	4.0
July - apply pesticides	1.0	4.0	4.0
August - harvest & transplant	9.2	4.0	36.80
September - shell	9.0	4.0	36.0
<u>Other hired services</u>			
April - tractor plowing	b	35	35.0
April - tractor harrowing	b	17	17.0
May - yoke seeding	b	10	10.0
June - yoke hilling	b	11	11.0
<u>Materials</u>			
April - seed	32.0lb	0.40	12.80
May - fertilizer	1.0	25.35	25.35
June - insecticide	1.0KL	15.00	15.00
June - urea	1.0	23.50	23.50
July - insecticide	2.7lb	3.38	3.38
Subtotal			269.03
<u>Other Costs</u>			
Interest on annual invested capital (12%)			10.65
Ownership costs: Interest (12%)			10.20
Depreciation			26.07
Maintenance			4.02
Total cost of production			319.97

TABLE II (Continued)

Detailed ownership costs

Initial information

Equipment	No. of Units	Initial Cost	Scrap Value	Useful Life (yrs.)	Manzanas Per Year
Back sprayer	1.0	225.00	15.00	2.00	120.0
Sacks (15)	1.0	36.00	0.00	2.00	1.0
Fence (4 manzanas)	1.0	480.00	48.00	15.00	4.0

Annualized costs:

	Totals			Per Manzana		
Equipment	Inter.	Deprec.	Maint.	Inter.	Deprec.	Maint.
Back sprayer	14.40	105.00	3.00	0.12	0.87	0.02
Sacks (15)	2.16	18.00	0.00	2.16	18.00	0.00
Fence (4mz)	31.68	28.80	16.00	7.92	7.00	4.00
Total per manzana (mz)				10.20	26.07	4.02

Net return analysis of the crop

	Expected possible price			
	Low	Medium	High	Farmers' Income
Price	11.00	13.00	15.00	
Gross income	363.00	429.00	495.00	
Net income*	93.97	159.97	225.97	
Net income**	43.03	109.03	175.03	
Necessary price to cover variable costs				8.15
Necessary price to cover total costs				9.69

[a]Man-day = 6 hours

[b]Fixed cost per manzana

*Gross income minus variable costs

**Gross income minus total costs

Source: Enterprise Budgets for Grains in Honduras: 1980 by Banco Nacional De Desarrollo Agricola Tegucigalpa, Honduras and Department of Agricultural Economics, Oklahoma State University, Stillwater, pp. 297-298.

services are charged by the time, by the manzana of land or by the unit of production depending on the service performed.

The materials section includes seed, fertilizer, chemicals and other production inputs. The materials section shows how much of the material is required by each unit of an enterprise.

Labor, other contracted services and materials comprise nearly all the variable costs. The annual interest on operating capital, in the other costs section, is also a variable cost. The remaining charges in the other costs section are fixed costs.

The other cost section shows a summary of the information provided on the second page of the budget. The costs include annual interest, depreciation and maintenance of equipment. The interest charge on investment is not included in the other costs section.

The detailed section, on the second page of each enterprise budget, shows a list of equipment required to produce the crop plus calculations of fixed costs which are summarized in the other costs section.

The last section on the enterprise budgets is the profitability analysis. It shows the net revenue per manzana of land that would result from selling the specified quantity of a product at each of the three hypothetical prices. The hypothetical prices for each region are based on historical price series (21).

Inventory of Objectives and Resources

It is important to assess the objectives of the farmer and the resources available to use in fulfilling the objectives.

Land

The representative farm has 14 manzanas. All of the land is level and cultivable. The soil on the representative farm is assumed to be homogenous. The farm has no irrigation facilities. Due to lack of rain during the dry season from January to May, it is not possible to double crop the land.

Labor

Labor needed to carry out production on the representative farm is provided by three full-time family men, i.e., the father and two sons. The wife's labor is reserved for housework. It is assumed that each of the family men provides six hours of work per day for six days a week. Extra labor can be hired at a wage rate of 4.2 Lempiras (one Lempira (L) = U.S. $0.50 per man-day). The wage rate for family labor is 4.0 Lempiras per day. The difference in value of labor is due to the fact that the farmer would like to employ all the family labor before hiring any extra labor. All labor costs are financed through a loan.

Equipment

The representative farm has two bullocks with a yoke, cultivator and cart. The bullocks work an average of four hours per day. The representative farm does not utilize bullock services throughout the year, thus bullocks can be rented to other farms when they are idle. The rate for renting bullocks without a driver is L10.00 per day. Bullocks can be rented out 50 days per year (i.e., 200 hours per year).

Tractor services are employed in plowing and harrowing. The tractor services can be obtained through hiring. The cost of tractor hire per manzana is fixed but may vary from operation to operation. The services not provided by tractor hire are done by bullocks. The representative farm has a back sprayer to spray insecticides.

Livestock

The representative farm has two hogs for fattening, one sow and a boar. Each hog is fed about one pound of corn per day to supplement table scraps and foraging. Thus, the amount of corn consumed by hogs is four pounds per day and the annual requirements are 1,460 lbs., i.e., 4(365).

Other animals on the representative farm are two cows, each yielding four 750 cc bottles of milk per day. All the milk is consumed by the family. The lactation period of cows is eight months per year. Calves provide meat for the family when they are twelve to eighteen months old. Female calves are sometimes kept to replace old cows. One manzana of land is left in volunteer annual grass for the cows. Grass land can be rented out for L180 per manzana per year. The carrying capacity is two cows with calves from June through February. Cows eat sorghum straw or corn stalks in remaining months. Sugar cane forage can be purchased at L25.15 per ton delivered. If fully fed on sugar cane forage, a cow consumes 36 pounds per day and a calf consumes nine pounds per day.

Capital

The farmer needs operating capital to finance production throughout the year. It is assumed that the operator of the small farm may borrow all the capital needed to carry out his operations at an annual interest rate of 12 percent. The agricultural bank will lend money so long as the farmer shows that his planned operations will enable him to repay the loans. The operating capital loan may include costs of family and hired labor. The operating capital loan is payable after the crop is harvested.

Family

The small farm family consists of six children plus parents (i.e., eight members of the family). The family consumes 10 lbs. of corn, 1.5 lbs. of beans and 0.5 lbs. of rice per day. Since the assumed planning period is one year, the family food consumption per year, based on 365 days are:

Corn = 10(365) = 3650 lbs.

Beans = 1.5(365) = 547 lbs.

Rice = 0.5(365) = 182.5 lbs.

In addition to family food requirements, cash is needed for household expenses such as medical costs, transportation and miscellaneous presented in Table III. The major item under miscellaneous is school fees as shown by the amount of extra cash demand during February, the beginning of the school year in Honduras.

Crop Enterprises for the Representative Farm

Through field interviews, discussions with farmers and information from nearby research stations, the OSU group established that the crop enterprises in Table IV are appropriate on the representative farm. The table also shows the numbers of budgets and planting and harvesting times.

Rice can be planted year after year without rotation, but a second crop in the same year is not possible without irrigation. It is not advisable to plant rice in May or June as it is too wet to harvest by the time it is ready. However, rice can be planted in July.

TABLE III

ESTIMATE OF HOUSEHOLD EXPENSES
OTHER THAN FOOD

Month	Medical (L)	Transportation (L)	Other (L)	Total (L)
January	15	15	10	40
February		15	100	100
March	10		10	20
April		15	10	25
May			10	10
June	20	10	10	40
July			10	10
August		15	30	45
September			10	10
October	10		10	20
November		20	10	30
December		15	50	65
				L 430

Source: Loren L. Parks and Daniel D. Badger, August, 1980, pp. 28.

TABLE IV

ENTERPRISES FOR THE REPRESENTATIVE FARM

Crop	Budget Number	Plant	Harvest
Sugar Cane (not irrigated)	11333	May	Continuous
Corn	11012	May	September
Sesame 1 (not irrigated	11062	September	November/ December
Sesame 2 (not irrigated)	11063	November	March
Rice (not irrigated)	11043	July	November
Watermelon	11018	November	March
Cantaloupe	11017	November	March

Sugar cane doesn't require rotation. One planting of sugar cane lasts five years. Information obtained through contacts with bank representatives and farmers in the area indicated that farmers prefer to have at least 4.6 manzanas of sesame per year. Sesame can be easily stored and has previously been a reliable cash crop in Choluteca.

General Linear Programming Model

A linear programming model was used to derive the optimum enterprise combination for a representative farm in Choluteca, Honduras. The budgets were used to determine input requirements and returns per unit of output for the enterprise. The general linear programming model is as follows:

maximize the objective function

$$C_1X_1 + C_2X_2 + \ldots + C_nX_n$$

subject to

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \leq b_2$$

$$a_{31}x_1 + a_{32}x_2 + \ldots + a_{3n}x_n \leq b_3$$

for $x_1 \geq 0$, $x_2 \geq 0$

where

$C_1 \ldots C_n$ = cost or return per unit of product or activity

$x_1 \ldots x_n$ = various activities

$b_1 \ldots b_3$ = different resource levels available

$a_{11} \ldots a_{1n}$ = different resource demands of activities

To the left of the inequalities are the coefficients of the underlying production functions represented by the budgets. The coefficients show the minimum requirements of the various resources for a unit of activity. The linear programming procedure contrains levels of activities entering the optimum organization to be greater than or equal to zero. Discussion of the linear programming matrix used in deriving the optimum organization is deferred to the next chapter.

CHAPTER III

THE SMALL FARM LINEAR PROGRAMMING MODEL

The basic operational steps in this study are:

1. Delineation of activities and restrictions needed in a comprehensive linear programming model for managerial decisions on a small farm.

2. Determination of input-output coefficients applicable for the study area.

3. Selection of the optimum plan for the small typical farm.

4. Determining stability of the optimum plan for a small farm.

The first two steps are covered in this chapter while steps three and four are deferred to the next chapter.

The Small Farm Model

A linear programming model is developed as an aid to deriving the optimum enterprise combination. Given the size (14 manzanas) of a small representative farm, the model is designed to select input and product combinations to be incorporated in the organization.

Delineation of Variables

Objective Function

The objective function (C), in Table V, maximizes residual return to land and family labor. The various coefficients of the objective

TABLE V

THE SMALL FARM LINEAR PROGRAM MATRIX USED IN DERIVING THE OPTIMUM SOLUTION

		Row Type	Constraint Symbol	Resource Available	Corn (P01) 11012 MZ	Sesame (P02) 11062 MZ	Sesame (P03) 11063 MZ	Rice (P04) 11043 MZ	Watermelon (P05) MZ	Cantaloupe (P06) MZ	Sugar Cane (P07) MZ	Hog Unit (P08)	Cow Unit (P09)	Bullock Unit (P10)	Borrow Cash for Consumption (P11) L	Borrow Short Term Capital (P12) L	Intermediate Capital (P13) L	Sell Corn QQ (P14)	Sell Sesame QQ (P15)	Sell Rice QQ (P16)
OBJ (Net Return)		N	C		-194.32	-164.15	-191.20	-646.38	-207.00	-206.00	-1012.95	-50.00	-110.28		-0.12	-0.12	0	16.33	66.33	22.42
Land (Manzana)		L	R01	14	1	1	1	1	1	1	1		1							
Short Term Capital		L	R02	0	88.75	107.08	105.83	211.25	242.57	242.57	237.92	30.00	55.64			-1				
Intermediate Capital		L	R03	0	40.29	33.57	33.51	53.57			141.90	20.00	16.00				-1			
Extra Cash L		G	R04	430																
Cash		L	R05	0											-1			-16.33	-66.33	-22.42
Labor Loan		L	R06	0	115.00	167.80	200.64	87.00	460.00	460.00	78.00	144.00	99.00							
Savings		L	R07	0																
Labor (man-days)	Jan	L	R08	78			11.60					3.00	5.50							
	Feb	L	R09	78			2.00					3.00	5.50							
	March	L	R10	78								3.00	5.50							
	April	L	R11	78								3.00	5.50							
	May	L	R12	78	3.00				23.00	23.00	5.00	3.00	5.50	10						
	June	L	R13	78	6.60			11.60	18.00	18.00	1.25	3.00	5.50	6						
	July	L	R14	78	1.00	6.00		2.00	6.00	6.00	4.75	3.00	5.50							
	Aug.	L	R15	78	9.20	12.60		15.20	10.00	10.00	4.75	3.00	5.50	12						
	Sept.	L	R16	78	9.00	9.70			10.00	10.00	4.75	3.00	5.50	6						
	Oct.	L	R17	78		8.20	8.80	1.00			1.75	3.00	5.50							
	Nov.	L	R18	78		5.40	13.00					3 00	5.50	12						
	Dec.	L	R19	78			12.80					3.00	5.50	6						

TABLE V (Continued)

		Row Type	Constraint Symbol	Resource Available	Corn (P01) 11012 MZ	Sesame (P02) 11062 MZ	Sesame (P03) 11063 MZ	Rice (P04) 11043 MZ	Watermelon (P05) MZ	Cantaloupe (P06) MZ	Sugar Cane (P07) MZ	Hog Unit (P08)	Cow Unit (P09)	Bullock Unit (P10)	Borrow Cash for Consumption (P11) L	Borrow Short Term Capital (P12) L	Intermediate Capital (P13) L	Sell Corn QQ (P14)	Sell Sesame QQ (P15)	Sell Rice QQ (P16)
Bullock Capacity	Jan	L	R20	96																
	Feb	L	R21	96																
	March	L	R22	96																
	April	L	R23	96																
	May	L	R24	96	6.00				2.00	2.00										
	June	L	R26	96	6.00															
	July	L	R27	96																
	Aug.	L	R28	96		12.00														
	Sept.	L	R29	96		6.00														
	Oct.	L	R30	96																
	Nov.	L	R31	96			12.00													
	Dec.	L	R32	96			6.00													
Bullock Rentout Restriction (hours)		L	R33	200																
Sesame Restriction		G	R34	4.6																
Corn (QQ)		L	R34	0	-33.00							3.65						1		
Sesame (QQ)		L	R36	0		-13.00	-14.00												1	
Rice (QQ)		L	R37	0				-50.00												1
Watermelons		L	R38	0					-1000.00											
Cantaloupe (box)		L	R39	0						-150.00										
Sugar Cane (ton)		L	R40	0							-65.00		2.98	5.96						
Beans (QQ)		L	R41	0																
Hog Unit (4)		G	R42	4								1.00								
Corn Unit (2)		G	R43	1									1.00							
Bullock Unit (2)		G	R44	2										1.00						
Family Corn (QQ)		G	R45	36.50																
Family Rice (QQ)		G	R46	1.83																
Family Beans (QQ)		G	R47	5.47																
Watermelon		L	R48	1.00					1.00											
Cantaloupe		L	R49	1.00						1.00										
Sugar Cane		L	R50	1.00							1.00									

TABLE V (Continued)

Row Type	Constraint Symbol	Resource Available	Sell Watermelon (each) (P17)	Sell Melon (box) (P18)	Sell Sugar Cane (ton) (P19)	Buy Corn (QQ) (P20)	Buy Rice (QQ) (P21)	Buy Beans (QQ) (P22)	Buy Sugar Cane (ton) (P23)	Transfer Borrowed Money (P24)	Transfer Cash for Consumption (P25)	Savings (P26)	Family Corn Needed (QQ) (P27)	Family Rice Needed (QQ) (P28)	Family Beans Needed (QQ) (p29)
N	C		1.46	7.33	24.65	-17.00	-23.00	-100.00	-25.00			0.01			
L	R01	14													
L	R02	0													
L	R03	0													
G	R04	430									1				
L	R05	0	-1.46	-7.33	-24.65					1	1	1			
L	R06	0								-1					
L	R07	0										-1			
L	R08	78													
L	R09	78													
L	R10	78													
L	R11	78													
L	R12	78													
L	R13	78													
L	R14	78													
L	R15	78													
L	R16	78													
L	R17	78													
L	R18	78													
L	R19	78													

Row Type	Constraint Symbol	LABOR HIRE Jan. (P30)	Feb. (P31)	March (P32)	April (P33)	May (P34)	June (P35)	July (P36)	Aug. (P37)	Sept. (P38)	Oct. (P39)	Nov. (P40)	Dec. (P41)
N	C	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20	-4.20
L	R01												
L	R02												
L	R03												
G	R04												
L	R05												
L	R06												
L	R07												
L	R08	-1											
L	R09		-1										
L	R10			-1									
L	R11				-1								
L	R12					-1							
L	R13						-1						
L	R14							-1					
L	R15								-1				
L	R16									-1			
L	R17										-1		
L	R18											-1	
L	R19												-1

Row Type	Constraint Symbol	BULLOCK RENTOUT Jan. (P42)	Feb. (P43)	March (P44)	April (P45)	May (P46)	June (P47)	July (P48)	Aug. (P49)	Sept. (P50)	Oct. (P51)	Nov. (P52)	Dec. (P53)	(P54)
N	C	10	10	10	10	10	10	10	10	10	10	10	10	
L	R01													
L	R02													
L	R03													
G	R04													
L	R05	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	
L	R06													
L	R07													
L	R08													
L	R09													
L	R10													
L	R11													
L	R12													
L	R13													
L	R14													
L	R15													
L	R16													
L	R17													
L	R18													
L	R19													

TABLE V (Continued)

Row Type	Constraint Symbol	Resource Available	Sell Watermelon (each) (P17)	Sell Melon (box) (P18)	Sell Sugar Cane (ton) (P19)	Buy Corn (QQ) (P20)	Buy Rice (QQ) (P21)	Buy Beans (QQ) (P22)	Buy Sugar Cane (ton) (P23)	Transfer Borrowed Money (P24)	Transfer Cash for Consumption (P25)	Savings (P26)	Family Corn Needed (QQ) (P27)	Family Rice Needed (QQ) (P28)	Family Beans Needed (QQ) (p29)	LABOR HIRE Jan. (P30)	Feb. (P31)	March (P32)	April (P33)	May (P34)	June (P35)	July (P36)	Aug. (P37)	Sept. (P38)	Oct. (P39)	Nov. (P40)	Dec. (P41)	BULLOCK RENTOUT Jan. (P42)	Feb. (P43)	March (P44)	April (P45)	May (P46)	June (P47)	July (P48)	Aug. (P49)	Sept. (P50)	Oct. (P51)	Nov. (P52)	Dec. (P53)
L	R20	96																										4											
L	R21	96																											4										
L	R22	96																												4									
L	R23	96																													4								
L	R24	96																														4							
L	R26	96																															4						
L	R27	96																																4					
L	R28	96																																	4				
L	R29	96																																		4			
L	R30	96																																			4		
L	R31	96																																				4	
L	R32	96																																					4
L	R33	200																										1	1	1	1	1	1	1	1	1	1	1	1
G	R34	4.6				-1							1																										
L	R34	0																																					
L	R36	0					-1							1																									
L	R37	0	1																																				
L	R38	0		1																																			
L	R39	0			1				-1																														
L	R40	0						-1							1																								
L	R41	0																																					
G	R42	4																																					
G	R43	1																																					
G	R44	2											1																										
G	R45	36.50												1																									
G	R46	1.83													1																								
G	R47	5.47																																					
L	R48	1.00																																					
L	R49	1.00																																					
L	R50	1.00																																					

TABLE V (Continued)

Key to activities and restraints in the small farm program:

Activities:

corn production	= P01
sesame #1 production	= P02
sesame #2 production	= P03
rice production	= P04
watermelon production	= P05
cantaloupe production	= P06
sugar cane production	= P07
hog unit (four hogs) feeding	= P08
cow unit (two cows) feeding	= P09
bullock unit (two bullocks) feeding	= P10
borrowing activity for cash	= P11
borrowing activity for short term capital	= P12
fixed capital needed to be covered	= P13
selling corn	= P14
selling sesame	= P15
selling rice	= P16
selling watermelon	= P17
selling cantaloupe	= P18
buying corn	= P20
buying rice	= P21
buying beans	= P22
buying sugar cane	= P23
money needed to pay for labor	= P24
extra cash needed by the family	= P25
saving extra cash activity	= P26
family corn needs per year	= P27
family rice needs per year	= P28
family beans needs per year	= P29
labor hiring activities per month	= P30 to P41
bullock rent out activities	= P42 to P53

TABLE V (Continued)

Restraints:

land	= R01
short term capital actually borrowed	= R02
fixed capital to be covered	= R03
family cash needs	= R04
labor costs per unit of enterprise	= R05
income cash (including borrowed cash)	= R06
savings	= R07
labor restrictions per month	= R08 to R19
bullock hours available per month	= R20 to R32
maximum bullock hours to be rented out	= R33
sesame minimum level	= R34
corn transfer row	= R35
seasame transfer row	= R36
rice transfer row	= R37
watermelon transfer row	= R38
cantaloupe transfer row	= R39
sugar cane transfer row	= R40
beans transfer row	= R41
hog unit restriction	= R42
cow unit restriction	= R43
bullock unit restriction	= R44
family corn restriction	= R45
family rice restriction	= R46
family beans restriction	= R47
watermelon restriction	= R48
cantaloupe restriction	= R49
sugar cane restriction	= R50

function indicate how total value of the solution will be altered by the addition of one unit of activity within resource restraints. The sign of the various coefficients is positive if the activity brings in money. The sign of the coefficient is negative if the activity demands money to buy the various resources which go into production. The coefficient is zero if the activity makes no monetary contribution to the objective function. The objective is to maximize the net return.

Restraints and Accounting Rows

The remaining rows (R01 to R50) in the small farm linear programming matrix are real restrictions, transfer or accounting rows. Restraints for the representative farm include land, labor and capital which is or can be made available on the farm for production and other activities. The land (R01) restraint consists of 14 manzanas of uniform soil. The operating capital requirements of each activity are shown in the short term capital row (R02). All the operating capital is borrowed. The fixed capital needs of each activity are shown in the intermediate capital row (R03. The extra cash requirements (L430) of the family per year are in the extra cash row (R04). The cash row (R05) shows the cash inflow from the various sources, i.e., sell and borrowing activities. The residual cash that remains after all the costs have been met is saved and the savings transfer row (R07) shows the various sources of cash to be saved. The labor requirements of the various activities are R08 to R19. A multiperiod concept is used to enable consideration of labor timing requirements. The amount of family labor available is 78 man-days per month.

Some of the restrictions reflect preferences of the farmer to have a minimum amount of food crops produced on the farm at any cost. The preferences of the farmer are at least 36.5 quintals (one quintal = 100 lbs.) of corn (R45), 1.83 quintals of rice (R46), 5.47 quintals of beans (R47), 4.6 manzanas of sesame (R34), one cow unit (two cows) to provide milk (R43), two bullocks to perform services other than those provided by tractor hiring (R44) and one hog unit (four hogs) to provide meat for the family (R42). Accounting rows provide means to pass a resource or commodity from one row or column to another. That is, using accounting rows, corn can be transferred from the corn producing activity to the corn selling activity, the hog feeding activity, or the family corn needed activity.

The other Restrictions (R20 to R32) show the amount of bullock hours available. The bullock hours can be used on the farm or rented out. However, bullock rent out (R33) is restricted to no more than 200 hours per year.

The coefficients in the rows (for restraints or accounting rows) show how the restraints will be influenced by an increase of one unit of each activity in the small farm model. In the matrix, coefficients in various rows with a positive sign indicate the demands of a unit of each activity on different resources. The coefficients with a negative sign show the various activities that supply different resources. The signs of coefficients may change if the restraints are reversed.

The restraints used in this program are less than and greater than. For a detailed list of restraints see the key to the matrix in Table V. The less than constraint specifies that no more than the available resource may be used. The greater than constraint specifies that no less than the resource level indicated should be used by the activities.

Activities and Transfer Columns

Activities in the small farm linear programming matrix consist of producing crops, feeding animals, selling crops, hiring labor, borrowing capital, saving extra cash, renting out bullocks and buying corn, rice and beans. For a detailed list of activities in the matrix, see the key to Table V.

Transfer columns are means of passing a resource from one row to another. An example of a transfer column is (P25) the transfer of cash from cash row (R05) to the family cash needs row.

The crops considered for possible inclusion in the optimum plan are corn (P01), sesame #1 (P02), sesame #2 (P03), rice (P04), watermelon (P05), cantaloupe (P06) and sugar cane (P07). Livestock feeding activities included in the plan are the hog unit (P08), cow unit (P09) and bullock unit (P10).

Also included are sell activities for crops and buy activities for corn, rice and beans. Beans cannot be produced in this part of Honduras due to unfavorable conditions. Annual capital borrowing activities are included at 12 percent per annum. Other activities are family food requirements per year. Corn and rice requirements for the family can come from corn and rice produced on the farm or buying.

Small farmers mostly depend on family labor but because of increased labor requirements during peak periods of production, hired labor is available at 4.20 Lempiras per day. Bullocks are busy on the small farm during certain times of the year and can be rented out when their services are not needed.

Input and Output Coefficients in the Matrix

The information for the matrix was obtained from the budgets developed for Honduras by OSU. The coefficients under each crop producing activity are based on one manzana of land. The information for output coefficients was obtained from farmers thought to be average with respect to the predetermined yield categories and associated production practices. The input and output coefficients were the arithmetic means of the farmers interviewed in each category (21).

All the capital coefficients which appear in the budgets are annualized so that interest is paid on operating capital up to the time the loan is repaid. That is, interest on operating capital is calculated assuming that the farmer must have all the operating capital required for a given month on the first day of that month. If the loan is drawn monthly, the farmer pays interest for the period capital is drawn and used, i.e., from the time capital is needed to the time the loan is repaid.

Labor is measured in man-days. The coefficients in the labor rows are in man-days required by each activity per month. If the man-days provided by the family are insufficient, the hiring activity provides the necessary amount.

The prices of products vary from month to month because of the storage costs of some crops. Since information is not available on how prices vary from month to month, prices used in this study are based on average prices per year.

Input prices vary from region to region due to transport costs. However, input prices are generally uniform within a region. This study utilizes the input prices in the budgets.

Design of Analysis

After constructing the small farm matrix and getting an optimum solution, some of the activities and restraints were varied to determine the effect on the optimum enterprise combination for the representative farm as shown in Table VI. This was important in deriving an acceptable optimum plan and exposing the opportunity cost of upholding the preferences of the farmer.

The first run excluded R48, R49 and R50 from the linear program matrix. Thus, the first run matrix had no restriction on levels of activities entering the optimum plan other than those expressed in the preferences of the farmer.

The second run excluded buying activities for corn (P20) and rice (P21) from the first run matrix. The corn and rice buying activities were excluded because farmers are not sure of buying food crops if they do not raise them on their farms.

The third run restricted levels of watermelon, cantaloupe and sugar cane, i.e., it used the matrix presented in Chapter III. These activities were restricted to no more than one manzana. Levels of watermelon, cantaloupe and sugar cane were restricted to no more than one manzana because small farmers do not have good storage facilities to keep fruits before they can be sold and also the time lag before sugar cane can be ready may create cash flow problems. Justification for restricting these activities to one manzana is based on lack of storage facilities and roads connecting farms to market centers and in general, a poor distribution system. The third run included buying activities for corn and rice.

TABLE VI

SUMMARY OF THE VARIOUS LINEAR PROGRAMMING RUNS USED IN THE ANALYSIS

Run Number	Design of the Linear Program Matrix
1	No restriction on enterprise levels to be included in the optimum plan.
2	No restriction on enterprise levels to be included. No corn and rice buying activities.
3	Restricted levels of watermelon, cantaloupe and sugar cane.
4	Restricted levels of watermelon, cantaloupe and sugar cane. No corn and rice buying.
5	No restriction on enterprise levels to be included in the optimum plan. No labor hiring.
6	No restriction on enterprise levels to be included in the plan. No labor hiring. No corn and rice buying.
7	Restrict levels of watermelon, cantaloupe and sugar cane. Permitted labor hiring only in November.
8	Restricted levels of watermelon, cantaloupe and sugar cane. Permitted labor hiring only in November. No corn and rice buying.
9	No restriction on enterprise levels and only November labor hiring.
10	No restriction on enterprise levels. No rice and corn buying. Labor hiring permitted only in November.

The fourth run was the same as the third run, except buying activities for corn and rice were excluded.

The fifth run had no restriction on levels of enterprises entering the optimum plan and included buying activities for corn and rice. However, the fifth run excluded all labor hiring activities. Farmers are skeptical about the availability of hired labor. Thus a plan which tends to lean towards hired labor may not be readily acceptable.

The sixth run included all activities of the fifth run but excluded buying activities for corn and rice.

The seventh run restricted watermelon, cantaloupe and sugar cane to no more than one manzana each. Labor hiring was restricted to November (P40). Corn and rice buying activities were included.

The eighth run consisted of all the requirements of the seventh run apart from corn and rice buying activities which were left out.

The ninth run had no restriction on enterprise levels in the optimum plan. Corn and rice buying activities were included and labor hiring in this run was restricted to November (P40).

The tenth run included all activities and restraints of the ninth run apart from the corn and rice buying activities which were excluded.

Labor hiring activities were excluded to determine importance of hired labor to small farmers. Most small farmers depend on family labor and labor for hire may not be available.

The MPSX/70 program was used in each of the runs. The range card was used to give the sensitivity analysis of the optimum plans.

CHAPTER IV

OPTIMUM ENTERPRISE COMBINATION

The MPSX/70 computer output provides a great deal of information. The user can specify the information set desired. For this problem, the following is important:

1. The value of the objective function (C).
2. The levels of activities included in the optimum plan.
3. The amounts or quantities of available resources that remain unused.
4. The amount of change needed in the prices of products or costs of production for excluded activities to deserve a place in the optimum plan, assuming no change occurs in any other coefficients used in the matrix.
5. The marginal value products (shadow prices) of the resources or constraints which are fully used in the solution, assuming other coefficients are not varying.
6. The amounts by which costs of production or prices of products in the solution can change before a new optimum plan with more or less of these activities can be economically justified.
7. The number of units of the resources which were fully utilized that can be added or subtracted from the amount available in the optimum plan before the marginal value product in five (above) will change.

The detailed optimum plan selected for the small representative farm is presented later in the chapter. Results from the various computer runs are presented in the next section.

Results from the Various Computer Runs

Summary results from the various computer runs are presented in Table VII. The optimum plan for the first run which had no restriction on levels of activities and included buying activities was 4.6 manzanas of sesame #2 and 8.4 manzanas of sugar cane. The other activities included in the optimum plan for the first run are preferences of the farmer, i.e., four hogs, two cows, two bullocks, 36.5 quintals of family corn, 1.83 quintals of family rice and 5.47 quintals of family beans. Corn, rice and beans were purchased. One manzana of land was left in volunteer pasture for the cows. The objective function value was L15618.94.

The second run excluded buying activities for corn and rice and had no restriction on activity levels in the optimum plan. The enterprise combination of the second run consisted of 1.55 manzanas of corn, 4.60 manzanas of sesame #2, 0.04 manzana of rice, 6.81 manzanas of sugar cane and preferred livestock activities. The objective function value for the second run was L13804.69.

The optimum plan, for the third run which had restricted levels of watermelon, cantaloupe and sugar cane, was 4.78 manzanas of sesame #1, 5.21 manzanas of sesame #2, one manzana of watermelon, one manzana of cantaloupe, one manzana of sugar cane, four hogs, two cows, two bullocks and all food crops were purchased. The objective function value was L9917.98.

The optimum plan for the fourth run, which had all conditions of the third run but corn and rice buying activities, was 1.55 manzanas of corn, 3.20 manzanas of sesame #1, 5.21 manzanas of sesame #2, 0.04 manzana of rice, one manzana of watermelon, one manzana of cantaloupe

TABLE VII

ENTERPRISE COMBINATIONS OF THE VARIOUS RUNS

Run/Activity	Corn Production	Sesame #1 Production	Sesame #2 Production	Rice Production	Watermelon Production	Cantaloupe Production	Sugar Cane Production	Hogs	Cows	Bullocks	Corn Buying	Rice Buying	Beans Buying	% Land Utilization	Objective Function Value
Run #1 No restrictions on enterprise levels.			4.60				8.40	4.00	2.00	2.00	36.5	1.83	5.47	100	15618.94
Run #2 No restrictions on enterprise levels and no corn and rice buying activities.	1.55		4.60	0.04			6.81	4.00	2.00	2.00			5.47	100	13804.69
Run #3 Restricted levels of water melon, cantaloupe and sugar cane.		4.78	5.22		1.00	1.00	1.00	4.00	2.00	2.00	36.5	1.83	5.47	100	9917.98
Run #4 Restricted levels of water-melon, cantaloupe and sugar cane. No corn and rice buying.	1.55	3.20	5.21	0.04	1.00	1.00	1.00	4.00	2.00	2.00			5.47	100	9505.87
Run #5 No restricted enterprise levels and no labor hiring.															Infeasible Solution
Run #6 No restricted enterprise levels, no labor hiring and no corn and rice buying.															Infeasible Solution
Run #7 Restricted watermelon, canta-loupe and sugar cane. Labor hiring only in November.		0.82	3.78		1.00	1.00	1.00	4.00	2.00	2.00	36.5	1.83	5.47	61.43	6859.11
Run #8 Restricted watermelon, canta-loupe and sugar cane. Labor hiring only in November and no corn and rice buying.	1.55	0.81	3.79	0.04	0.67		1.00	4.00	2.00	2.00			5.47	63.28	6070.39

TABLE VII (Continued)

Run/Activity	Corn Production	Sesame #1 Production	Sesame #2 Production	Rice Production	Watermelon Production	Cantaloupe Production	Sugar Cane Production	Hogs	Cows	Bullocks	Corn Buying	Rice Buying	Beans Buying	% Land Utilization	Objective Function Value
Run #9 No restriction on activity levels and only November labor hiring.		0.81	3.79				5.53	4.00	2.00	2.00	36.5	1.83	5.47	79.50	11413.68
Run #10 No restrictions on activity levels, no corn and rice buying. Labo. hiring only in November.	1.55	0.81	3.79	0.04			2.42	4.0	2.0	2.0			5.47	68.64	7346.78

and one manzana of sugar cane. The plan also included four hogs, two cows and two bullocks. The objective function value was L9505.87.

The optimum plan for the fifth run which had no restrictions on levels of activities, had buying activities for corn and rice and excluded all labor hiring activities was infeasible.

The optimum plan for the sixth run, which had all conditions of the fifth run but corn and rice buying activities, was infeasible.

The optimum plan for the seventh run, which allowed labor hiring only in November, was 0.82 manzana of sesame #1, 3.78 manzanas of sesame #2, one manzana of watermelon, one manzana of cantaloupe and one manzana of sugar cane. The seventh run plan also included four hogs, two cows and two bullocks. All food crops for the family were purchased. The objective function value was L6859.11.

The optimal enterprise combination for the eighth run, which had all activities of the seventh run except for corn and rice buying, was 1.55 manzanas of corn, 0.81 manzana of sesame #1, 3.79 manzanas of sesame #2, 0.04 manzana of rice, 0.67 manzana of watermelon, 1.0 manzana of sugar cane. The plan also included the following livestock activities; four hogs, two cows and two bullocks. The objective function value was L6070.39.

The optimum plan for the ninth run, which had no restriction on activity levels and allowed buying corn and rice, was 0.81 manzana of sesame #1, 3.79 manzanas of sesame #2, 5.53 manzanas of sugar cane. The plan allowed labor hiring only in November. The other activities in the optimal plan were four hogs, two cows and two bullocks. The value of the objective function was L7346.78.

The optimum plan for the tenth run, which had all requirements of the ninth run but corn and rice buying, was 1.55 manzanas of corn, 0.81 manzana of sesame #1, 3.79 manzanas of sesame #2, 0.04 manzana of rice, 2.42 manzanas of sugar cane, four hogs, two cows and two bullocks. The value of the objective function was L7346.78.

All feasible combinations included 200 hours of bullock rentout per year. It was important that all feasible combinations meet the farmer's preferences.

Discussion of the Various Combinations

The livestock activities appear in all feasible combinations at a constant level. It means the contribution of livestock activities is the same irrespective of the optimum plan considered.

The optimum plan for the first run, which has no restriction on enterprise levels entering the plan other than those preferred by the farmer allows labor hire when needed and permits buying corn and rice, gave the highest objective function value. The first run plan excludes production of food crops on the farm. Most of the land is devoted to sugar cane production. The first harvest of sugar cane occurs about eleven months after planting. Since sugar cane takes about eleven months before it can generate any cash, allocating most of the land to sugar cane production may create cash flow problems. However, once the plan is in operation, e.g., after one year, cash flow may not be a problem. Even though this plan has the highest objective function value, it may not be acceptable to small farmers. This is because small farmers cannot be sure they will be able to buy food crops if they do not produce them. Because a plan which is dependent on purchasing food crops and a crop which takes about eleven months before it can begin to generate cash may not be acceptable to risk averse farmers, other alternatives were considered.

The optimum enterprise combination for the second run, which had no restriction on enterprise levels except livestock and no corn and rice buying, gave the second highest objective function value. Excluding buying corn and rice from the matrix forced production of these crops on the farm. The production of corn and rice on the farm led to a 11.62 percent loss in the objective function value of the first run. Even though the second run objective function value is lower than that of the first run, it includes production of corn and rice for the family. Production of food is important among small farmers. The overall production is still inclined towards production of sugar cane.

The optimum enterprise combination in the third run restricted levels of watermelon, cantaloupe and sugar cane to no more than one manzana each. The third run plan allowed buying corn and rice. It is made up of mostly sesame #1 and #2. The plan includes one manzana of sugar cane, one manzana of watermelon and one manzana of cantaloupe. The optimum plan for the third run generates the fourth highest objective function value. All the family corn and rice is purchased. This plan may not be readily accepted by small farmers who are very concerned about the availability of food crops for the family.

The optimum plan for the fourth run restricted levels of watermelon, cantaloupe and sugar cane to no more than one manzana each. Corn and rice production entered the optimum plan at levels to meet family needs per year. The fourth run plan was included towards growing more manzanas of sesame. Compared to the third run, forcing corn and rice production into the plan leads to a 4.16 percent loss in the objective function value. The loss may be acceptable to the small farmer as the plan includes corn and rice production for the family. The enterprises are diversified, thus the small farmer is in a better position to withstand risks of one crop failure. The fourth run plan generated the fifth highest objective function value.

The fifth and sixth runs were infeasible because hired labor was excluded. It is not possible to achieve the objectives of the farmer without hired labor. Labor demands increase in November due to the peak labor period of enterprises which contribute to meeting the farmer's preferences. Thus, without labor hiring in November, most of the attention crops need during this period cannot be met and the solution was infeasible.

The optimum plan for the seventh run restricted watermelon, cantaloupe and sugar cane to no more than one manzana each. The plan allowed labor hiring only in November. The other enterprises in the plan included corn and rice buying, two bullocks, two cows, four hogs and sesame. The objective function value of this plan was the seventh highest. Restricting labor hiring to the peak period of labor demand left about 38.57 percent of the land uncropped. This plan excluded corn and rice production. Even though this plan is not totally dependent on hired labor, it may not be acceptable to the small farmer because food crops are purchased.

The optimum plan for the eighth run restricted watermelon, cantaloupe and sugar cane to no more than one manzana each and included corn and rice production. The buying activities for corn and rice were left out of the matrix. Labor hiring in the eighth run was restricted to

November. This plan gave the eighth highest objective function value. Forcing corn and rice production into the seventh run plan and eliminating buying activities for these crops leads to a 11.50 percent decrease in the objective function value. Corn and rice production enters the plan at levels that just provide for family needs. The cantaloupe production was left out of the eighth run plan to release labor to go into food production. The level of watermelon decreased to about half of the level in the seventh run plan. The eighth run plan leaves about 36.72 percent of the land uncropped.

The optimum plan for the ninth run had no restriction on activity levels. This plan had corn and rice buying activities. Labor hiring in this plan was confined to November. The plan gave the third highest objective function value. The plan consisted mainly of sugar cane and the minimum amount of sesame preferred by the farmer. This plan may not be acceptable as part of the land remains uncropped and it excludes corn and rice production. The plan consists of two crops, thus may not be acceptable to a risk conscious farmer who wants to diversify production.

The optimum plan for the tenth run had no restriction on activity levels in the plan. The tenth run plan excluded corn and rice buying activities to force corn and rice production in the plan. Excluding corn and rice buying activities in the ninth run leads to a 35.63 percent decrease in the objective function value. The tenth run plan leaves about 32.36 percent of the land uncropped. Land is under utilized due to limited labor hire (i.e., labor hiring is only allowed in November). The value of the objective function was the sixth highest.

Selection of the Optimum Plan

Comparing run #1 against run #2; run #3 against run #4; run #7 against run #8 and run #9 against run #10 in Table VII, reveals that generally the optimum combinations which do not have corn and rice production give the highest objective function value. It appears that corn and rice have low marginal value products under our assumptions. Then, forcing corn and rice production in the plan will reduce the objective function value. Table VII also reveals that employment of more land generally leads to high objective function value, other assumptions being the same.

The small farmer is very concerned about producing food crops on the farm. As mentioned earlier, the farmer wants to ensure food supply for the family throughout the year. Small farmers are not sure of buying corn and rice from local shops if it is not produced on their farms, thus, it is difficult to find small farmers who would be willing to follow or utilize plans which exclude food production. Then, on the basis of having no corn and rice producing activities, plans from runs #1, #3, #7 and #9 were excluded from further consideration.

Table VII also reveals that plans from runs #7 through #10 have low land utilization because these plans depend mostly on family labor. Labor hiring, in the plans from runs #7 through #10, is confined to November because the peak period for labor demand is in November. The plans from runs #7 through #10 were excluded from further consideration. The low objective function values of plans #7 through #10 are due to no labor hiring except in November.

The plans from runs #2 and #4, on Table VII, will be examined further. The two plans have corn and rice production. However, crop enterprise combinations of the two plans are different. The plan from the second run has 48.64 percent of the land under sugar cane production. Corn, rice and sesame entered the second run plan at the minimum amounts of land needed to meet the farmers preferences. Production in the second run plan is inclined towards production of sugar cane. Even though the second run plan has a higher objective function value than the fourth run plan, it lacks the flexibility of changing enterprise combination because one planting of sugar cane lasts five years. It means that if 48.64 percent of the land is under sugar cane, the plan cannot be altered even if economic conditions change so as to favor production of other crops. Thus, even though the second run plan gives a higher objective function value during the planning year, it may not be the economic plan in the years that this land would remain under sugar cane. Moreover, sugar cane would not generate any cash until after about eleven months. Therefore, on the basis of allocating almost half of the land to one crop and thereby reducing flexibility, the second run plan was dropped from further consideration.

The plan from the fourth run may be acceptable to small farmers. This plan has corn and rice producing activities and meets specified preferences of the farmer. The fourth run plan has a combination of seven crops (i.e., it is diversified). The fourth run organization has sesame #1, sesame #2, watermelon and cantaloupe as annual crops. The levels of annual crops in the plan can be easily increased or decreased to take into account the prevailing economic conditions. Because of diversified crop enterprises in the fourth run plan and the flexibility of adjusting some of these enterprises, the farmer may be in a better position to withstand crop failure. It means that the fourth run plan can be recommended for possible adoption to the small farmer. The next section will discuss the fourth run plan in detail.

Detailed Discussion of the Selected Optimum Plan

Table VIII lists activities in the selected representative farm optimum plan for Choluteca - Nacaome. Also shown on Table VIII, are the ranges over which the costs of production or prices of products in the solution could vary before an increased or decreased level of these activities can be considered. The range gives an estimate of the sensitivity of each activity to changes in the cost of the or price of output (product). For example, corn production costs (other than labor) per manzana are L194.32. Corn production costs could decrease to L85.41 or less per manzana before the level of corn production in the plan would increase. Even if the costs of producing corn per manzana increased to infinity, the level of corn production in the plan cannot be reduced as 1.55 manzanas is the minimum needed to meet family requirements per year. Thus, the corn production level in the optimum plan will not change so long as production costs fluctuate between infinity and L85.41, other conditions remaining constant. Infinity appears on range boundaries when the farmer prefers a minimum or a maximum of certain activities or resources are limited.

Another example of a price range is provided by the sesame selling activity. The total number of quintals of sesame in the optimum plan is 114.61. This amount of sesame will remain the same as long as price of one quintal is between L54.80 and 69.82. If the price of one quintal drops to L54.80 or less, then the amount of sesame in the optimum plan should be reduced. However, if price per quintal of sesame should

TABLE VIII

ACTIVITIES IN THE SELECTED OPTIMUM PLAN

Activities in Basis	Amount	Price or Input Cost (L)	Range Drop to (L)	Range Increase to (L)
Objective function value L9505.87				
Corn (manzana) P01	1.55	-194.32	-Infinity	85.41
Sesame #1 (manzana) P02	3.20	-164.15	-167.65	-118.92
Sesame #2 (manzana) P03	5.21	-191.20	-236.42	-187.70
Rice (manzana) P04	0.04	-646.38	-Infinity	-496.49
Watermelon (manzana) P05	1.00	-207.00	-815.46	Infinity
Cantaloupe (manzana) P06	1.00	-206.00	-451.33	Infinity
Sugar cane (manzana) P07	1.00	-101.95	-1000.24	Infinity
Hogs P08	4.00	-50.00	-Infinity	170.88
Cow unit (2 cows) P09	1.00	-110.28	-Infinity	686.06
Bullocks P10	2.00		-Infinity	299.58
Short term capital (Lempira) P11	1938.41	-0.12	-1.93	0.00
Intermediate capital (Lempira) P12	584.42		-8.29	
Sell sesame (quintals) P14	114.61	66.33	54.80	69.82
Sell watermelons P17	1000.00	1.46	0.81	Infinity
Sell cantaloupe (boxes) P18	150.00	7.33	5.69	Infinity
Sell sugar cane (tons) P19	53.08	24.65	10.83	24.75
Buy beans (quintals) P22	5.47	-100.00	-Infinity	0.00
Family labor costs (Lempira) P24	3437.56		-0.84	0.01
Extra family cash (Lempira) P25	430.00		-Infinity	-0.01
Family corn needs per year (quintals) P27	36.50		Infinity	24.97
Family rice needs per year (quintals) P28	1.83		-Infinity	25.64
Family beans needs per year (quintals) P29	5.47		-Infinity	100.00
August labor hire (man-days) P37	43.36	-4.20	-4.48	-0.61
September labor hire (man-days) P38	21.22	-4.20	-4.56	0.00
October labor hire (man-days) P39	13.42	-4.20	-25.01	0.00
November labor hire (man-days) P40	48.58	-4.20	-10.15	-3.74
December labor hire (man-days) P41	18.26	-4.20	-7.73	-3.93

TABLE VIII (Continued)

Activities in Base		Price or Input Cost (L)	Range Drop to (L)	Range Increase to (L)
January bullock rent-out (bullock hours) P42	24.00	10.00	10.00	Infinity
February bullock rent-out (bullock hours) P43	24.00	10.00	10.00	Infinity
March bullock rentout (bullock hours) P44	3.51	10.00	10.00	10.00
April bullock rentout (bullock hours) P45	20.68	10.00	10.00	500.66
June bullock rentout (bullock hours) P47	21.68	10.00	10.00	Infinity
July bullock rentout (bullock hours) P48	24.00	10.00	10.00	Infinity
August bullock rent-out (bullock hours) P49	14.40	10.00	10.00	11.16
September bullock rent-out (bullock hours) P50	19.20	10.00	10.00	12.33
October bullock rent-out (bullock hours) P51	24.00	10.00	10.00	Infinity
November bullock rent-out (bullock hours) P52	8.35	10.00	10.00	25.07
December bullock rent-out (bullock hours) P53	16.18	10.00	10.00	40.15

increase to L69.82, then an increase in the number of quintals sold in the optimum plan should be considered. An increase in number of quintals being sold can only take place if price per quintal is the only variable, i.e., other conditions remain unchanged.

Corn and rice producing activities are included in the selected plan even though these activities entered the plan at levels just sufficient to meet family requirements. Even if cost of producing corn and rice increase, they cannot be dropped as the farmer must produce them on the farm because of personal preferences to feed the family and animals.

Unused Resources

The plan that maximizes the objective function may not be able to utilize all resources available. Some resources are more limiting than others. Table IX shows resources which are not limiting. Forcing the optimum plan to use these resources may violate preferences of the farmer or reduce the objective function value. The resources that are not limiting can remain unused or they might be contracted to nearby neighbors who may be in need of, say, hired labor at this time. Another way to make use of unused resources would be to introduce new enterprises. It is important to ensure that the new enterprises do not conflict with those in the optimum plan.

Activities in the Linear Programming Matrix But Excluded from the Optimal Organization

Some of the activities in the linear programming matrix were left out of the selected optimal organization. Forcing these activities

TABLE IX

QUANTITIES OF RESOURCES THAT REMAIN UNUSED BY THE OPTIMUM PLAN

Resources	Amount
February family labor (man-days)	50.07
March family labor (man-days)	60.50
April family labor (man-days)	60.50
May family labor (man-days)	4.85
June family labor (man-days)	0.30
July family labor (man-days)	22.93
March bullock rentout (bullock hours)	81.95
April bullock rentout (bullock hours)	96.00

into the optimum plan would reduce the objective function value or violate preferences of the farmer.

Table X gives a list of activities which were in the linear programming matrix but left out of the selected optimum plan, the cost or price of a unit of activity, penalty or shadow prices incurred in forcing excluded activities into the plan, ranges over which the shadow prices are valid and the levels and prices or costs at which excluded activities would enter the plan. For example, selling corn activity would enter the optimum plan at 1.435 quintals if the price of one quintal of corn increased from L16.33 to L24.81. If one quintal of corn is forced in the plan before the price of one quintal rises from L16.33 to L24.81, the value of the objective function would decrease by L8.48. The penalty holds over the range of zero to 1.435 quintals. If more than 1.435 quintals are forced into the corn selling activity, the penalty would increase.

Another example is provided by labor. January labor hire would enter the optimum organization at 25.38 man-days if labor hire price was decreased from L4.20 to L3.90. Forcing one more January man-day into the labor hiring activity would decrease the value of the objective function by L0.30 and this penalty is valid over the zero to 25.38 man-days range. This section has shown that under the price and management assumptions, corn and rice (which are the food crops of small farmers in Choluteca - Nacaome) if produced at levels more than those needed to meet family food, the value of the objective function would decrease. If all the assumptions were to hold, the usual tendency of small farmers to specialize in food crop production is inefficient.

TABLE X

ACTIVITIES EXCLUDED FROM THE OPTIMUM SOLUTION

Activity	Cost or Price per Unit of Activity	Penalty or Shadow Price	Range over which Shadow Price is Valid	Cost or Price at which Activity Enters the Plan	Level at which the Activity Enters the Plan
Sell Corn	16.33	-8.48	0 to 1.435	24.81	1.435
Sell rice	22.42	2.99	0 to 1.275	25.42	1.275
Buy sugar cane	-25.00	0.10	0 to infinity	-24.90	Infinity
January labor hire	-4.20	0.30	0 to 25.38	-3.90	25.38
February labor hire	-4.20	4.20	0 to infinity	0	Infinity
March labor hire	-4.20	4.20	0 to infinity	0	Infinity
April labor hire	-4.20	4.20	0 to infinity	0	Infinity
May labor hire	-4.20	4.20	0 to infinity	0	Infinity
June labor hire	-4.20	4.20	0 to infinity	0	Infinity
July labor hire	-4.20	4.20	0 to infinity	0	Infinity
April labor hire	10.00	0	0 to 3.51	10	3.51
June labor hire	10.00	0	0 to 21.68	10	21.68

Marginal Value Products of Resources Fully Used in the Optimum Plan

Some of the resources were fully utilized in the optimum plan, limiting further expansion of the optimum plan and the level to which objectives can be fulfilled. Table XI shows the marginal value products of resources fully used in the optimum plan. Expansion of resources which were fully used by the optimum plan would lead to a higher objective function value. The higher the marginal value product of a scarce resource in relation to the cost of acquiring it, the higher the contribution to the objective function. The farmer should consider increasing levels of resources with higher marginal value products, i.e.

$$MPP_x P_y$$

where

MPP_x = marginal physical product of x

P_y = price of product y

x = resource

y = product

Table XI gives the range over which the marginal value product is relevant. For example, if one manzana of land is taken out of the optimum plan, the objective function value would decrease by L541.46. The penalty, L541.46, is valid for the range 14 to 13.22 manzanas. If the land in the optimum plan is increased by one manzana, the objective function value would increase by L541.46. The gain, L541.46, is true for the range 14.00 to 17.82 manzanas. Should land be reduced beyond 13.22, the decrease in the objective function value per unit change would increase. Beyond 17.82 manzanas, the marginal value product will decrease. Decreasing bullock rent hours would reduce the objective

TABLE XI

MARGINAL VALUE PRODUCTS OF RESOURCES FULLY USED IN OPTIMUM PLAN

Resources	Resource Level	Marginal Value Product (MVP)	Range Over Which MVP is Valid
Land (manzanas) R01	14.00	541.46	13.22 to 17.82
January family labor (man-day) R08	78.00	3.89	61.05 to 103.32
August family labor (man-day) R15	78.00	4.20	0 to 121.36
September family labor (man-day) R16	78.00	4.20	0 to 99.22
October family labor (man-day) R17	78.00	4.20	0 to 91.42
November family labor (man-day) R18	78.00	4.20	0 to 126.58
December family labor (man-day) R19	78.00	4.20	0 to 96.26
Maximum number of bullock rentout hours R33	200.00	10.10	196.49 to 220.49
Minimum number of hogs R42	4.00	220.88	0.09 to 4.08
Minimum of one cow unit R43	1.00	796.34	0 to 1.05
Minimum of two bullocks R44	2.00	299.58	0 to 2.05
Minimum family corn needs R45	36.50	24.97	0 to 37.94
Minimum family rice needs R46	1.83	25.64	0 to 3.10
Minimum family beans needs R47	5.47	100.00	0 to Infinity
Maximum restriction on watermelon R48	1.00	608.43	0 to 1.02
Maximum restriction on cantaloupe R49	1.00	245.33	0 to 1.02
Maximum restriction on sugar cane R50	1.00	898.29	0.18 to 1.24

function value by L10.10 between 196.49 and 200 bullock hours. If bullock rentout hours are increased by one hour, the objective function value would increase by L10.10 between 200 and 220.49 bullock hours.

The levels of resources fully utilized in the optimum plan can be increased through:

1. Borrowing, i.e., borrower gets credit from lending institutions without any requirement that small farmers have equity to support credit because small farmers do not have enough equity.

2. Leasing, i.e., granting use or occupation of resources for a specified period in exchange for rent.

3. Custom hiring, i.e., to engage services of a resource for a fee.

These methods can be employed to increase resource levels. It is important that farmers understand the terms of employing more resources through the above methods.

Net Return

The objective function value for the optimum plan was L9505.87, including return to family labor. To arrive at the net return to all nonlabor resources, family labor costs should be subtracted from the objective function value

Objective function value	L9505.87
Labor costs (family)	-L3437.56
Net return	L6068.31

Comments on Selected Optimum Plan

Clearly, the information from a computer output cannot be understood by poorly trained extension officers or the illiterate operators of small farms. Most of the information does not have to reach the small farmer directly. Some of the information provided is useful to planners and those who formulate the policy of the agricultural sector. It is the job of a planner to reduce the information to a form that can be easily understood. This can be done by eliminating information small farmers do not need. The information needed by small farmers is that presented in Table VIII under amount and price or input columns. In addition to these, the farmer needs enterprise budgets which were used in deriving the optimum plan. The budgets should guide timing and operation of the various activities.

The information can be passed on to farmers through group meetings. These meetings should be held when farm work is not demanding. It is important to make sure that the information reaching the farmers is adequate and minimal so as not to confuse them. Beginning with minimal and adequate information would build a base for further developments. In order to encourage small farmers to take part in these group meetings, banks might put attendance as a precondition to obtaining a farm loan. Adoption of plans from these meetings would improve resource allocation and increase chances of repaying loans. In countries where transport is inadequate, extension workers are few and there are large numbers of small farmers, group meetings are the most economical way of getting the information to small farmers.

The objective function value may appear high in comparison to levels of income reported for small farm families in Honduras. The high objective function value of the selected optimum plan could be due to the assumption of medium management and conditions in the study. Small farmers may have lower yields and the objective function value may be lower. In some cases, small farmers do not own land. Depending on the contractual arrangements between the farmer and the landlord, the objective function value would be decreased when some products are used to pay for land rent.

CHAPTER V

MINIMUM LAND NEEDED TO MEET FAMILY REQUIREMENTS OF A SMALL FARMER IN CHOLUTECA - NACAOME AREA

This chapter will focus on determining the minimum amount of land needed to meet family requirements. The requirements include family food needs and extra cash. The extra cash is used to finance urgent needs, clothes, medical and eductional costs throughout the year.

To be successful, a small farm business in developing countries should be large enough to satisfy the necessities of the family, maintain or increase investment and repay loans. The critical element in developing countries, is the need to guarantee availability of food at the right time throughout the year. In order to meet this, small farmers want to ensure that food crops are produced on the farm. Determination of minimum amount of land needed by small farmers is very important. Small farmers wnat to meet the family food requirements before they can entertain other obligations. This has important implications for the lending institutions. Lending money to small farmers who have or want to plant a land area below that needed to meet family requirements and repay the loan would only make them burdened with debt obligations and with little, if any, increase in their incomes from which to repay their loans.

The minimum amount of land needed by a small representative farmer in Choluteca - Nacaome is a function of management, enterprises under consideration and soil type. The analysis as mentioned earlier is for the representative farm, thus medium weather and management and a uniform soil type were assumed.

Determination of the Minimum Land Needed

In order to determine the minimum land needed to meet family requirements of a small representative farmer, some changes in the maximization matrix were made. The objective function in the maximization matrix was changed from residual return to labor and land resources to minimization of the land needed to meet family requirements. The amount of land available was removed from the matrix. However, a new land renting activity was created to bring in land. The cost of renting land was zero (i.e., up to 14 manzanas). Corn and rice buying activities were left out of the minimization matrix so that they can be produced on the farm. The minimization matrix also excluded the requirement that at least 4.6 manzanas of sesame be in the plan. The sesame requirement was removed from the matrix because forcing it into the plan tends to raise the minimum land needed.

After making these adjustments, the MPSX/70 program was used to determine the minimum land needed to meet family requirements per year. The first run matrix had bullock rentout activities while the second did not. Bullock rentout was varied to determine effect of bullock rentout activities on minimum land needed to meet family requirements.

Results from the Land Minimization Computer Runs

The run with bullock rentout activities gave minimum land requirements for the small representative farm in Choluteca - Nacaome area of

3.12346 manzanas. The run without bullock rentout activities gave minimum land requirements of 6.63126 manzanas. Bullock rentout activities were the only difference between the two runs. The bullock rentout activities contribute an equivalent of 3.5084 manzanas of land to meeting the family requirements of a small representative farmer. The more bullock hours rented out the less the land area needed to meet requirements of the farmer. The small representative farmer may not always find people to rent bullocks, thus bullock rentout is not a reliable source of income. Therefore, 6.63186 manzanas is taken to be a more reliable minimum land area needed to meet family food requirements of the small farmer. Income in this plan is from the sale of farm products. Discussion of the plan with minimum land of 6.63186 manzanas will be covered in the next section.

Interpretation of the Minimization Output

The value of the objective function (i.e., 6.63186 manzanas) shows the minimum land area needed by a small representative farmer in Choluteca - Nacaome area to meet family requirements when possibility of bullock rentout is excluded. The activities in the minimization solution and their shadow prices are in Table XII. The activity levels show the minimum amounts needed to just meet the requirements of the small representative farmer. The shadow prices appear on activities which were excluded from the solution. The shadow prices show land penalties incurred by forcing a unit of any of the activities which were in the matrix but not the solution into the optimum plan. The objective function value will increase by the shadow price shown if a unit of any of the activities excluded from the optimum plan is forced into the plan.

TABLE XII

ACTIVITIES IN THE MIMINUM LAND PLAN FOR A SMALL FARMER IN CHOLUTECA-NACAOME

Activity	Activity Level	Shadow Prices (manzana)
Objective function value (manzanas)	6.63186	
Corn production (manzanas)	1.54848	0
Sesame #1 production (manzanas)	0.09528	0
Sesame #2 production (manzanas)	2.76811	0
Rice production (manzanas)	0.03660	0
Watermelon production (manzanas)	1.00000	0
Cantaloupe production (manzanas)	0.0000	0.20929
Sugar cane production (manzanas)	0.18338	0
Hog production (hogs)	4.0000	0
Cow unit (cows)	2.0000	0
Short term capital (L)	910.15	0
Fixed costs (L)	282.33	0
Corn selling activity (QQ)	0.0000	0.01729
Sesame selling activity (QQ)	39.9924	0
Rice selling activity (QQ)	0.0000	0.00566
Watermelon selling activity	1000.0000	0
Cantaloupe selling activity (boxes)	0.0000	0.00140
Sugar cane selling activity (tons)	0.0000	0.0061
Beans buying activity (QQ)	5.47	0
Labor costs (L)	1901.95	0
Extra family cash (L)	430.00	0
Family corn needs per year (QQ)	36.50	0
Family rice needs per year (QQ)	1.83	0
Family beans needs per year (QQ)	5.47	0
January labor hire (man-days)	0.000	0.00808
February labor hire (man-days)	0.000	0.00808
March labor hire (man-days)	0.000	0.00808
April labor hire (man-days)	0.000	0.00808
May labor hire (man-days)	0.000	0.00808
June labor hire (man-days)	0.000	0.00808
July labor hire (man-days)	0.000	0.00808
August labor hire (man-days)	0.000	0.00808
September labor hire (man-days)	0.000	0.00808
October labor hire (man-days)	0.000	0.00808
November labor hire (man-days)	0.000	0.00633
December labor hire (man-days)	0.000	0.00808
Land hiring (manzanas)	6.63186	0

For example, if one manzana of cantaloupe is forced into the plan, minimum land area needed to just meet the requirements of the farmer would increase by 0.20929 manzanas. Activities at the nonzero levels have zero shadow prices because a reduction of a unit of the activity would not reduce the number of manzanas needed to meet family requirements.

Implications of the Minimum Land Requirement

It is clear that small farmers in developing countries will first produce crops which provide food and some extra cash for the family before devoting any of their resources to production of cash crops. Production of food crops is essential and farmers are assumed not to accept any plan which excludes food crop production.

The minimum land area should form an important base for loan approval in developing countries like Honduras. Lending institutions which provide loan amounts less than that needed to finance the minimum land plan should not be surprised if loans are not repaid. Financing crop production below the minimum land would lead small farmers to having no surplus for sale. If there is no surplus for sale, then loans cannot be repaid. The situation may be aggravated when small farmers with insufficient loans spread their fertilizers and other inputs over wide areas. Spreading inputs over wide areas leads to low yields per manzana of land, low total production and low total revenue thus increasing chances of not being able to repay the loans.

Lending institutions and extension officers should be aware of the minimum land requirements for a small representative farmer. Small farmers who own land areas below the minimum land requirement for the representative farm, should not be given loans to produce crops or enterprises which need excessive land to meet family requirements. Farmers with land areas below the minimum needed to meet family requirements should be advised to introduce plans (enterprises) which use less land, e.g. poultry production. Introduction of new enterprises which use less land should not conflict with production of food crops.

Another alternative would be to increase extension services to small farmers. Increased extension services, if utilized by small farmers, could lead to higher yields per unit of land and may override the assumption of medium management. If small farmers achieve high yields, then less land area may be needed to meet the family requirements and repay the loan.

Due to unforseen circumstances beyond the control of the farmer, e.g., unfavorable weather, the minimum land area will not meet the requirements of the farmer in some years. In order to counteract this uncertainty, the small farmer may decide to devote more land to producing food crops. Thus, the uncertainty factor may raise the minimum land area needed to meet family requirements. The uncertainty factor can be taken care of by the fact that some of the years are going to have exceptionally good weather. Good weather usually leads to crop yields beyond those expected. In this case, it would be necessary for small farmers to have storage facilities to absorb the surplus food crops from exceptionally good years. The stored surplus food crops can be used to offset poor yield during years of unfavorable weather.

The runs #5 and #6 were infeasible, however, removing the requirement of at least 4.6 manzanas of sesame in the land minimization runs produces feasible solutions. Thus runs #5 and #6 were infeasible due to the requirement of at least four to six manzanas of sesame which was compounded by having no labor hiring activities.

CHAPTER VI

CASH FLOW PLANNING FOR THE OPTIMUM ORGANIZATION

It is important to know in advance the amounts and timing of borrowed funds throughout the year and to determine ability of the farm to produce enough crops to meet family food requirements and to generate income for extra family cash and the repayment of debts. This can be done by using a cash flow plan. A cash flow plan is a written projection of the amount and timing of all cash inflows and outflows that are expected to occur throughout the coming year (24).

Small farmers in developing countries own small amounts of capital to support loans. The fact that small farmers are now being encouraged to employ modern agricultural techniques, which require increased use of capital to increase production, has led to increased risk for lending institutions. This means lending institutions need to look at the proposed outlays critically. The aim of projecting repayment capacity of the farm is to estimate how much debt can be safely obtained with adequate provisions for repayment.

Cash Flow Planning

Cash flow planning can be done by hand or computer. Estimating costs and returns of each enterprise and making calculations take a considerable amount of time. The computer program utilizes data from selected farm enterprise cost and return budgets and additional information from an input form. The cash flow plan used in this study was prepared by hand (Table XIII).

The cash flow plan developed in this study provides monthly cash data by enterprise. Monthly estimates are desirable in that it is easy to know when excess cash will be available or when it will be necessary to borrow. The rows on the cash flow plan denote individual cash inflow and outflow items. However, additional rows for determining projected cash position, borrowing, loan repayments and accumulated operating loan balance for each year were added. The column indicated as "TOTAL" shows summations of each cash inflow and outflow item for the year. The coefficients which appear in the cash flow plan are for the representative farm optimum plan in the Choluteca - Nacaome area. The crop budgets for Choluteca - Nacaome provide a necessary input for estimating future farm cash flows of enterprises in the optimum plan.

The farmer would have L6594.45 at the end of the planning period. This would be deposited in the savings account and earn one percent interest per year. One percent interest on the ending cash balance (i.e., L6594.45 in April, 1982) yields L65.94 per year. Thus total balance at the end of the planning period should be L6660.39 (i.e., L6594.45 + L65.94). If fixed costs (L584.42) are subtracted from the balance (L6660.39), the net return turns out to be L6075.97. This figure differs with the net return value earlier determined in the linear programming analysis by L7.66. This is due to rounding errors and differences in compounding interest on borrowed capital.

A cash flow plan based on this format is useful in establishing a financial plan for the year, predicting liquidity problems in advance,

TABLE XIII

SMALL FARM CASH FLOW PLAN FOR THE OPTIMUM ORGANIZATION

	1981								
	April	May	June	July	August	September	October	November	December
Receipts:									
Crops: Corn									
Sesame #1									
Sesame #2									
Rice									
Watermelon									
Cantaloupe									
Sugar cane									
Livestock: 4 Hogs									
2 Cows									
2 Bullocks									
A) Total Operating Expenses									
Bullock Rentout	206.77		216.77	240.00	140.02	192.01	240.00	83.53	161.77
Other Receipts:									
B) Total Cash Inflows	206.77		216.77	240.00	144.02	192.01	240.00	83.53	161.77
Expenses:									
Crops: Corn	100.34	73.32	118.77	11.43	56.98	55.75			
Sesame #1				76.79	546.46	159.97		104.94	69.75
Sesame #2							174.41	1019.79	313.66
Rice			15.68	0.21	2.07		6.90		
Watermelon		473.00	81.00	34.00	40.00	40.00			
Cantaloupe		473.00	81.00	33.00	40.00	40.00			
Sugar cane	36.00	53.00	166.00	59.00	39.00	66.00	7.00		
Buy beans	45.58	45.58	45.58	45.58	45.58	45.58	45.58	45.58	45.58
Livestock: 4 Hogs	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
2 Cows	9.19	9.19	5.57	5.57	5.57	5.57	5.57	5.57	5.57
2 Bullocks									
C) Total Operating Expenses	195.28	1131.26	514.77	259.80	779.83	417.04	243.53	1179.95	438.73
Household Expenses other than Food	25.00	10.00	40.00	10.00	45.00	10.00	20.00	30.00	65.00
Other Expenses									
D) Total Cash Outflow	220.28	1141.26	557.77	279.80	824.83	427.04	263.63	1209.95	503.73
Summary:									
E) Cash Difference (B-D)	-13.51	-1141.26	-341.00	-39.80	-680.81	-235.03	-23.03	-1126.42	-341.96
F) Beginning Cash Balance		-13.65	-1166.46	-1522.53	-1577.95	-2271.12	-2531.54	-2580.39	-3743.88
G) Ending Cash Balance (E+F)	-13.51	-1154.91	-1507.46	-1562.33	-2258.76	-2506.15	-2554.84	-3706.81	-4085.85

TABLE XIII (Continued)

		January	February	March	April	Activity Level	Totals
		1982					
Receipts:							
Crops:	Corn						
	Sesame #1			2759.33		41.5922 QQ	2959.33
	Sesame #2				4847.40	73.01728 QQ	4847.40
	Rice						
	Watermelon		1460.00			1000.00 Watermelons	1460.00
	Cantaloupe			1099.00		150.00 Boxes	1099.00
	Sugar cane	1308.42				53.07999 Tons	1308.00
Livestock:	4 Hogs						
	2 Cows						
	2 Bullocks						
A) Total Operating Expenses		1308.42	1460.00	3858.83	4847.40		11474.65
Bullock Rentout		240.00	240.00	34.13		200 Bullocks Hours	2000.00
Other Receipts:							
B) Total Cash Inflows		1548.42	1700.00	3893.96	4847.40		13474.65
Expenses:							
Crops:	Corn					1.54848 Manzanas	416.59
	Sesame #1					3.19440 Manzanas	957.91
	Sesame #2	229.90	130.81			5.21552 Manzanas	1868.57
	Rice					0.03660 Manzanas	24.86
	Watermelon					1.00 Manzana	668.00
	Cantaloupe					1.00 Manzana	667.00
	Sugar cane				513.50	1.00 Manzana	939.50
	Buy beans	45.58	45.58	45.58		5.47 QQ	546.96
Livestock:	4 Hogs	4.17	4.17	4.17		4.00 Hogs	50.04
	2 Cows	9.19	9.19	9.19		2.00 Cows	88.56
	2 Bullocks					2.00 Bullocks	0.00
C) Total Operating Expenses		288.84	189.75	58.94	513.50		5207.99
Household Expenses other than Food		40.00	115.00	20.00			430.00
Other Expenses							
D) Total Cash Outflow		328.84	304.75	78.94	513.50		6657.99
Summary:							
E) Cash Difference (B-D)		1219.58	1395.25	3815.02	4333.90		
F) Beginning Cash Balance		-4126.70	-2936.19	-1556.35	2260.55		
G) Ending Cash Balance (E+F)		-2907.12	-1540.94	2258.67	6594.45		

indicating when cash is available for additional investment, planning family living and purchase of inputs.

Lending institutions can use computer routines to make cash flow plans for their clients. The result can be used as basis on which to draw loans and make repayments. For example, the negative coefficients in the "ENDING CASH BALANCE" row show amounts of money borrowed in various months and positive amounts indicate cummulative balance. This would enable farmers to draw only necessary funds and thus avoid paying interest on money not needed.

It is important to realize that small farmers cannot make cash flow plans on their own. Small farmers need services like this, if they are to avoid unnecessary costs, improve loan repayment and obtain higher incomes.

The cash flow balance can be used in financing further investment, such as introducing irrigation facilities which can enable double cropping and offsetting drought risks.

CHAPTER VII

SUMMARY, CONCLUSIONS AND LIMITATIONS

In many less developed countries improvement of agriculture is synonymous with higher yields per unit of input but this is not enough to generate the needed agricultural progress. Some developing countries have used budgeting at low levels to make representative farm plans without much success, while most have ignored possibilities of improving the resource allocation of small farmers. The specific objectives of this study were to:

1. Derive representative farm optimum plans which include preferences of the farmer.
2. Evaluate stability of the optimum plan if some assumptions change.
3. Estimate the minimum land needed for a small farm to earn a specified family income and meet farm credit obligations.
4. Develop a cash flow plan for the selected optimum plan to show cash inflows and outflows.
5. Explore a method of getting representative farm plans to small farmers.

The present study showed how linear programming (MPSX/70) may be used to generate representative farm optimum plan and answer questions which arise.

Even in the United States of America (USA), where computer programs are readily available at low fees, it has not been possible to do individual planning with a majority of farms. Farmers do not need to know how to construct the matrix and do computer programming. All that farmers need to do is provide data and see the final plan which will maximize their objectives subject to the constraints.

Unlike in the USA, developing countries are characterized by a high illiteracy rate, poor communication system, insufficient computer services and a sparse, poorly trained extension staff in contact with farmers. As mentioned earlier, little or no planning is done among small farmers in developing countries. In order to determine an optimum enterprise combination, farmers have had to depend on their food need as a gauge to determine levels of food crops and other enterprises. Many small farm managers embark on a policy of producing as much family food crops as possible. The selected optimum plan for a small representative farm developed in this study has shown that under the price and other assumptions used, food crops enter the plan only at minimum levels needed to meet family requirements. Thus, farmers who devote most of the resources to production of food crops may be allocating resources inefficiently.

To improve resource allocation, extension and loan officers need to help farmers plan their enterprise combination. The action needed is establishment of planning unit(s) by the government as a public service or by lending institutions. The planning units would be able to make optimum enterprise combinations for different resource situations and regions, as was done for Choluteca, Honduras. These optimum enterprise combinations could be available to farmers as part of the loan service provided by lending institutions or by the government. A small fee could be used to partially offset cost of maintaining planning units. Banks and other lending institutions would use representative farm enterprise combinations as a gauge on which to base loan approval. This may eliminate costly custom-made (individual) optimum combinations. Plans may require some adjustments to suit individual needs.

The representative farm plan may not be suitable for large farms. Large farms look for large loans, thus warranting detailed assessment of the planned investments. However, in developing countries, the majority of the bank loans are of small amounts. The loans with small amounts are relatively expensive to administer. The cost of administering these loans may be reduced through representative farm planning.

The plans for the various resource situations should reach the farmer through extension or loan officers. After interviewing the farmer and taking inventory of resources owned, the loan officer would simply recommend one of the enterprise combinations closest to the situation at hand. If there is reason to believe that the farmer's expected costs and returns are significantly different from the representative farm optimum enterprise combinations, then some detailed questioning, analysis and adjustment of standard enterprise combinations would be necessary. Should the differences be minor, the loan officer will simply use standard enterprise combinations to calculate the expected farm credit needs and loan repayment capacity. The loan officer can decide whether the loan would be made or not depending on the cash flow projected.

Representative farm planning would not only reduce the time the extension or loan officer spends on one farmer but also make the work easier for the poorly trained staff. This is due to the fact that preparation of individual enterprise combinations can lead to delays and work may not be thoroughly done in some cases because of insufficient time and skilled manpower. If representative farm optimum plans are used by small farms, the role of the extension officer would only be to interpret the results and not get involved in tedious arithmetic of which they know little. The information from representative farm enterprise combinations must be presented in a form that can be easily adapted to each individual farm. The extension or loan officer can interpret the representative farm plans at group meetings of farmers with more or less the same resources and objectives. In order to visit with many small farmers, transport needs to be reliable.

It is anticipated that the farmer would improve his management as the amount of extension services made available increases. If technology, economic, management and weather conditions change, the optimum enterprise combinations for the various resource situations should be reviewed. Representative farm optimum enterprise combinations should be reviewed every year by analysts in the planning unit.

If planning units are established by lending institutions, then the loan approval should be based on the optimum enterprise combination closest to the farmer's resources and objectives. It should be made clear to the farmer that only crops in the applicable enterprise combination would be allowed if the loan is approved and may be followed by pointing out the important points of the optimum plan, such as when to plow, plant, weed, harvest and sell the crop.

Small farmers tend to expand farm acreages as means to fight disasters, e.g., a flood may damage only a portion of the field if the acreage is expanded (22). Expansion of farms leads to spreading managerial talent, time and money over a wide area before small farmers can realize the full potential of resources. Banks should critically evaluate loan requests of farmers who want to expand farm acreages as failure to do so would only push small farmers into a situation where they fail to repay loans. The limiting resources could be financed by the banks once resources on the farm are efficiently allocated. Expansion of enterprise sizes should be accompanied by increase in efficiency. Agricultural policies could stress intensive use of existing cultivated area until farm management ability of small farmers improves.

Ignoring preferences and concerns of farmers in planning tends to drop or minimize enterprises with low marginal value products, e.g., food crops in this study, or possibly expand enterprises with high marginal value products, e.g., non-food crops. Small farmers cannot be expected to drop enterprises with low marginal value products because they provide food crops which the farmer must produce on the farm. It is clear that so long as food crops are not available in local shops, small farmers will not adopt programs which exclude food production. The most practical way of helping small farmers in developing nations is to encourage them to allocate resources efficiently while considering their preferences which may not be economic. Efficient resource allocation should be coupled with the improvement of the marketing and distribution system to increase availability of essential commodities in both rural and urban areas. Once this is done, it will be easy to convince small farmers to utilize the principle of comparative advantage, i.e., advise them to produce crops in which they enjoy an edge over others and buy food crops from shops. If food is not available in shops, it is easy to find that a significant percentage of the best land is producing basic food crops under more traditional production systems. Most of the best land could be producing valuable crops or yielding high levels of food crops under improved management and technology.

Lending institutions have tended to overlook the principle of the minimum land requirement of small farmers. Small farmers want to meet their income objectives before attending to loan payment. Therefore, lending institutions should not give loans to somebody intending to farm land area below the minimum needed to meet family requirements unless it is a social aid program. If lending institutions followed this principle their chances of recovering loans could be increased.

Greater emphasis on programs to support small farmer development would reduce rural poverty. In agriculture, sustained programs of institutional, technical and infrastructural support for small farmers offer the best hope for increasing employment and alleviating poverty. Small farmers are not laggards in adopting high yielding varieties and associated techniques, once they are assured of food supply for their families and granted ready access to essential inputs such as credit, fertilizers, extension advice and reliable markets for their produce. Too often, the distribution of government supported services is skewed in favor of larger farms or is otherwise inadequate. For example, while the Zambia's extension has been effective in serving 300 commercial farmers, it has failed to reach the estimated 500,000 small farmers (11). Increased agricultural production and incomes generate new demands for non-agricultural output and employment. In most developing countries, more than 70 percent of the labor force is directly dependent on agriculture and will remain so, for the foreseeable future; thus improving the productivity and purchasing power of these people is vital. In addition, many millions of jobs in small scale rural enterprises depend on agricultural production and incomes. These factors call for policies to accelerate growth through efficient use of resources and ensuring that aggregate growth leads to rising income levels for the small farmers. The idea should be to seek technology that will permit wide extension of services at low unit cost. Equally important are the problems of administration associated with implementing new technology.

Clearly the small farmer in developing countries needs help to improve resource allocation. Small farmers need substantial government assistance of financial and managerial aid to bring them to a level where they can be self-sustaining. This means, there should be concerted effort to employ more loan or extension officers. Then, this should be followed by using loan or extension officers efficiently and a commitment to data collection efforts which would make them more effective. Very often researchers have overlooked ability of extension workers and small farmers to absorb new information. This had led to little or no adoption of new technologies, thus it is important not to generate an excess of information on each optimum plan. The more complex the final plan, the less it would be understood and used.

Conclusions

Representative farm planning apparently improves efficiency as shown by the high net return, L6068.31, and is an inexpensive method of dealing with a large number of small farms.

Representative farm planning must include concerns and preferences of small farmers if plans are to be acceptable. Small farmers cannot be expected to utilize the principle of comparative advantage unless food availability, distribution and marketing is improved.

The minimum land needed to meet requirements of a small representative farm in Choluteca - Nacaome area is 6.63 manzanas. Small farmers tend to plant more food crops than found in the optimum organization partly because of yield uncertainty and possibly due to lack of knowledge about other alternatives.

Most of the managers of small farms in developing countries are illiterate and cannot be expected to do linear programming as outlined in this study, thus small farmers will continue to rely on information channeled to them through the extension service. In order to carry out representative farm planning, a planning unit could be established by banks or the government. Representative farm plans generated by the planning unit should be reviewed every year to take into the changing economic conditions.

Loan or extension officers can interpret representative farm plans at group meetings of managers of small farms with similar conditions, thus need to employ more loan or extension officers.

Loan approval could be based on the minimum land needed to meet requirements of a small farm family to insure loan repayment unless it is a social aid program.

Limitations

There were some limitations in the study. The definition of a small farm depends on the country you are looking at. A more exact method of defining a small farm would greatly help in designing appropriate computer programs.

Transport needs to be available and reliable if extension or loan officers are to visit with a large number of small farmers. Most developing countries do not have adequate and reliable transport, thus a study to improve transportation could contribute to the dissemination of information and marketing of agricultural products.

Most of the small farmers in developing countries are illiterate, thus may need setting up of demonstration plots to interpret all steps in the representative farm plans. Setting up of demonstration plots requires time and may lead to reduced coverage of small farmers. A study of methods to improve dissemination of information to small farmers would enhance adoption of representative farm plans.

SELECTED BIBLIOGRAPHY

(1) Banard, C.S. and J.S. Nix. Farm Planning and Control. 1st Ed. London: Cambridge University Press, 1973, pp. 305-364.

(2) Banco Nacional De Fomento. Datos Basicos dela Economia de Honduras (Basic Data of the Economy of Honduras). Tegucigalpa, Honduras: Banco Nacional De Fomento, 1974/78, p. 45.

(3) Banco National De Desarrollo Agricola and Department of Agricultural Economics. Enterprise Budgets for Grains in Honduras. Stillwater, Oklahoma: Oklahoma State University, August, 1980, pp. 295-311.

(4) Beeden, P., D.W. Norman, D.H. Pryor, W.J. Krocker, H.M. Hays and B. Huizing. The Feasibility of Improved Sole Crop Cotton Production Technology for Small Farmers in Northern Nigeria, Samura. Samaru, Nigeria: Institute for Agriculture Research, Ahmadu Bello University, Miscellaneous Paper No. 61, 1976.

(5) Beneke, Raymond R. and Ronald Winterboer. The Linear Programming Applications to Agriculture. 1st Ed. Ames: The Iowa State University Press, 1973.

(6) Cimmyt, Eastern Africa. Demonstration of an Interdisciplinary Approach to Planning Agricultural Research Program. Report No. 3. Nairobi, Kenya: Cimmyt, December, 1978.

(7) Collinson, Michael. "Agrarian Change: The Challenge for Agricultural Economists." (Paper presented at the 17th Conference for International Agricultural Economists, Banff, Canada, September, 1979.) Nairobi, Kenya, 1979.

(8) Connor, L.J. and W.H. Vincent. "A Framework for Developing Computerized Farm Management Information." Canadian Journal of Agricultural Economics, Vol. 18, Part 1 (1970). pp. 70-75.

(9) Food and Agricultural Organization of the United Nations. The State of Food and Agriculture. New York: Food and Agriculture Organization Series No. 8, 1977.

(10) __________. The State of Food and Agriculture. New York. Food and Agriculture Organization Series No. 10, 1979, pp. 1-54.

(11) Gilbert, E.H., D.W. Norman and F.E. Winch. Farming Systems Research: A Critical Appraisal. East Lansing, Michigan: Michigan State University Rural Development Papers No. 6, 1980.

(12) Grawoig, D.H. and A. Hughes. Linear Programming: An Emphasis on Decision Making. Massachusetts: Addison Wesley Pub. Co., 1973. pp. 1-10.

(13) Heyer, J. "Analysis of Peasant Farm Production Under Uncertainty Conditions." Journal of Agricultural Economics, Volume XXIII, Part 2 (1972).

(14) Hopkins, J.A. and E.O. Heady. Farm Records and Accounting. 5th Ed. Ames, Iowa: Iowa State University Press, 1962, pp. 317-344.

(15) Kahlon, A.S. An Analysis of Farm Planning Structure in Ludhiana District. New Delhi, India: Indian Society of Agricultural Economics. Farm Production Planning Seminar Series IV, 1962.

(16) Kircher, P. and O.R. Mason. Introduction to Enterprise: A System Approach. California: Melville Publishing Company, 1975, p. 16.

(17) Kline, R.G. and J.S. Huddleston. "Minimum Resource Requirements to Attain Specified Incomes from Farming." World Agricultural Economics and Rural Sociology Abstracts, Volume 13 (1971) p. 189.

(18) MacArthur, J.D. "The Economic Study of African Small Farms: Kenya Experiences." Journal of Agricultural Economics, Volume XIX, Part 2 (1968).

(19) Marceau, I.W. "A Computer Assisted Planning Method for Individual Farms." Special-Publication Collection on Agriculture, University of Illinois, Urbana, Champaign, No. 18, 1979, p. 106.

(20) Norman, David W. The Farming Systems Approach: Relevancy for the Small Farmer. East Lansing, Michigan: Michigan State University Rural Development Papers No. 5, 1980, p. ix.

(21) Parks, Loren L., Kurt A. Rockeman and Odell L. Walker. Enterprise Budgets: A Multiple Use Data Base for Agricultural Banks in Developing Countries. Stillwater, Oklahoma: Oklahoma State University, August, 1980, pp. 10-21.

(22) Parson, K.H. "Agrarian Reform in Southern Honduras." (Unpub. Ph.D. dissertation, Library, University of Missouri, Columbia, 1977.)

(23) Pouliquen, L.Y. Risk Analysis in Project Appraisal. 1st Ed. Maryland: World Bank Occasional Papers, No. 11, 1973.

(24) Roush, Clint E. Cash Flow Planning: How? Stillwater, Oklahoma: Oklahoma State University Extension Facts No. 708, p. 1.

(25) Sherbiny, W.A. and M.Y. Zaki. "Programming for Agricultural Development: The Case of Egypt." American Journal of Agricultural Economics, Volume 56, Part 1 (August, 1974), pp. 114-121.

(26) Stanton, L.A. "Comparison of Selected Linear Programming Techniques for Planning Farms: Using Louisiana Farm Business Analysis Records." (Unpub. Ph.D. dissertation, Library, University of Michigan, Ann Arbor, 1970, p. 291.)

(27) Talbort, R.B. The World Food Problem and U.S. Food Politics and Policies. World Food Conference, A Readings book. 1st Ed. Ames, Iowa: Iowa State University Press, 1978, p. 13.

(28) Thomas, Kenneth, N. Weigle and Richard Hawkins. Where Do I Want to Be? Appraising Your Long Range Farm Opportunities. Madison, Wisconsin: University of Wisconsin Cooperative Extension Programs, January, 1973.

(29) Tubbs, Alan R. and Kenneth Wegenhoft. Cash Flow Planning: Why? Stillwater, Oklahoma: Oklahoma State University Facts No. 707.

(30) Tweeten, Luther G. Foundations of Farm Policy. 2nd Ed. Lincoln, Nebraska: University of Nebraska Press, 1979.

(31) World Bank. World Development Report. Development of Agriculture. Washington, D.C., August, 1978.

(32) __________. World Development Report. Prospects for Development. Washington, D.C., August, 1979.

(33) Young, D.F. and P.A. Richards. Agriplan: User's Manual for Small Farm Analysis. Rome, Italy: Food and Agriculture Organization of the United Nations, July, 1978.

APPENDIX

TABLE XIV

RICE ENTERPRISE BUDGET NO. 11043

Enterprise: Rice, dryland, medium yield 50 qq/mz
Region: Choluteca
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Per Unit (L)	Total Cost (L)
June - clear brush	11.6	3.0	34.80
July - seed/fertilizer	2.0	3.0	6.0
August - weed	11.6	3.0	34.80
August - apply fertilizer	1.4	1.4	1.96
August - apply fungicide and herbicide	2.2	2.2	4.84
October - protect crop from birds	1.0	1.0	1.0
Other contracted services			
June - plow (1 time)	c	30.0	30.0
June - disc (4 times)	c	12.0	48.0
August - apply herbicide	c	7.5	7.5
August - apply fungicide	c	7.5	7.5
October - combine harvester	b	3.75	187.5
Materials			
June - seed	2.0 qq	42.0	84.0
June - fertilizer (formula)	2.0 qq	23.5	47.0
June - urea	2.0 qq	23.5	47.0
June - herbicide stam LV-10	1.5 qq	32.5	48.75
June - Dipterex	1.1 qq	30.0	33.0
June - Lannate	1.0 qq	30.0	30.0
June - Benlate	1.0 lb	26.0	36.0
Subtotal			679.65
Other Costs			
Interest on annual operating capital (12%)			23.35
Ownership costs: Interest on investment (12%)			11.64
Depreciation			38.07
Maintenance			4.02
Total production cost/manzana			758.77

[a]Man-day = 6 hours

Table XIV (Continued)

Detailed ownership costs

Initial information

Equipment	Units	Cost	Value	Useful Life (yrs.)	Man-zanas Per Year
Back sprayer	1.0	225.00	15.00	2.00	120.0
Sacks (25)	1.0	60.00	0.00	2.00	1.0
Fence (4 manzanas)	1.0	480.00	48.00	15.00	4.0

Annualized costs:

	Totals			Per Manzana		
	Inter.	Deprec.	Maint.	Inter.	Deprec.	Maint.
Back sprayer	14.40	105.00	3.00	0.12	0.87	0.02
Sacks (25)	3.60	3.00	0.00	3.60	30.00	0.00
Fence (4 manzanas)	31.68	28.80	16.00	7.92	7.20	4.00
Total per manzana (mz)				10.20	26.07	4.02

Profitability Analysis

	Possible price per unit			
	Low	Medium	High	Client's Income
	17.00	20.00	22.00	
Gross Revenue	850.00	1000.00	1100.00	
Net income[b]	170.25	320.35	420.00	
Net income[c]	91.27	241.27	341.27	

Necessary price to cover variable costs	13.59
Necessary price to cover total costs	15.17

[a]Man-day = 6 hours

[b]Gross income minus variable costs

[c]Gross income minus total costs

TABLE XV

SUGAR CANE ENTERPRISE BUDGET 11333

Enterprise: Sugar cane (dryland), yield 65 tons/mz, maintenance
Region: Choluteca
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Per Unit (L)	Total Cost (L)
May - fence maintenance	2.50	4.00	10.00
M-y - apply herbicide	2.50	4.00	10.00
June - apply fertilizer	1.25	4.00	5.00
June-October - rat control[d]	1.25	4.00	5.00
July-September - canal cleaning[d]	6.00	4.00	24.00
July-September - road maintenance	6.00	4.00	24.00
July-October - weeding	6.00	4.00	24.00
<u>Other contracted services</u>			
April - deep plow[e]	c	36.00	36.00
June - cultivate	c	18.00	18.00
June - replant	c	37.00	37.00
July - furrow	c	18.00	18.00
July - cultivate	c	18.00	18.00
August - control borer	c	10.00	10.00
September - control borer	c	10.00	10.00
April - cut	b	3.20	208.00
April - crane lift	b	1.00	65.00
April - handling cut cane	b	0.50	32.50
April - fees	b	0.50	32.50
April - haul	b	2.70	175.50
<u>Materials</u>			
May - herbicides	3 lbs.	11.00	33.00
June - fertilizer (formula)	2 qq	22.00	44.00
June - urea	3 qq	22.00	66.00
August - Parathion	1 lit	6.00	6.00
September - BHC	25 lbs.	1.32	33.00

TABLE XV (Continued)

Other Costs	Total Units	Total Cost (L)
Interest on operating expenses (12%)		
Establishment	f	28.55
Maintenance	f	46.70
20% of establishment costs	g	95.20
Total cost/Mz		L 1,114.95

[a] Man-day = 8 hours
[b] Fixed cost per quintal
[c] Fixed cost per manzana
[d] Equally distributed each month
[e] From second year on
[f] See Budget No. 11339
[g] Interest on average investment

TABLE XVI

WATERMELON ENTERPRISE BUDGET NO. 11018

Enterprise: Watermelon, medium yield 1000 watermelons/mz
Region: Choluteca
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Per Unit (L)	Total Cost (L)
May - seeding	4.00	4.00	16.00
May - fertilizer application	3.00	4.00	12.00
May - fungicide and insecticide application	4.00	5.00	20.00
May - watering (2)	4.00	4.00	16.00
May - weeding	8.00	4.00	32.00
June - watering (2)	4.00	4.00	16.00
June - urea application	3.00	4.00	12.00
June - two applications of fungicides and insecticides	4.00	5.00	20.00
June - weeding	7.00	4.00	28.00
July - watering (1)	2.00	4.00	8.00
July - two applications of fungicides and insecticides	4.00	5.00	20.00
August-September - harvesting	20.00	4.00	80.00
Other contracted services			
May - plowing (tractor)	c	50.00	50.00
May - planting (bullock)	2.00	10.00	20.00
Materials			
May - seed	2 lbs.	22.00	44.00
May - fertilizer	3 qq	30.00	90.00
May - urea	2 qq	31.00	62.00
May - Dithane	10 lbs.	4.60	46.00
May - Tamaron	2	30.00	60.00
May	2	30.00	6.00
June	2	3.00	6.00
July	1	3.00	6.00
Sub-total			L 667.00
Interest 14%			L 33.96
Total cost			L 700.96

[a]Man-day = 8 hours
[c]Fixed cost per manzana

TABLE XVII

CANTALOUPE ENTERPRISE BUDGET NO. 11017

Enterprise: Cantaloupe, medium yield 150 boxes/mz
Region: Choluteca
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Per Unit (L)	Total Cost (L)
May - seeding	4.00	4.00	16.00
May - fertilizer application	3.00	4.00	12.00
May - fungicide and insecticide application	4.00	5.00	20.00
May - watering (2)	4.00	4.00	16.00
May - weeding	8.00	4.00	32.00
June - watering (2)	4.00	4.00	16.00
June - urea application	3.00	4.00	12.00
June - two applications of fungicides and insecticides	4.00	5.00	20.00
June - weeding	7.00	4.00	28.00
July - Watering (1)	2.00	4.00	8.00
July - two applications of fungicides and insecticides	4.00	5.00	20.00
August-September - harvesting	20.00	4.00	80.00
<u>Other contracted services</u>			
May - plowing (tractor)	c	50.00	50.00
May - planting (bullocks)	2.00	10.00	20.00
<u>Materials</u>			
May - seed	2 lbs.	22.00	44.00
May - fertilizer	3 qq	30.00	90.00
May - urea	2 qq	31.00	62.00
May - Dithane	10 lbs.	4.60	46.00
May - Tamaron	2 lit	30.00	60.00
May	2.0	30.00	6.00
June	2.0	3.00	6.00
July	1.0	3.00	6.00
Sub-total			L 667.00
Interest 14%			L 33.96
Total cost			L 700.96

[a] Man-day = 8 hours
[c] Fixed cost per manzana

TABLE XVIII

SESAME #1 ENTERPRISE BUDGET NO. 11062

Enterprise: Sesame #1, medium yield 13qq/mz
Region: Choluteca - Nacaome
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Unit (L)	Total Cost (L)
July - clearing brush	6.00	4.00	24.00
August - seeding	2.00	4.00	8.00
August - weeding and removing budgs	9.60	4.00	38.40
August - urea application	1.00	4.00	4.00
September - insecticide application	1.80	4.00	7.20
September - second weeding	6.10	4.00	24.40
September - insecticide application	1.80	4.00	7.20
November - cutting and tying plants together	8.20	4.00	32.80
December - removing grains	5.40	4.00	21.80
Other contracted services			
August - plowing (tractor)	c	34.00	34.00
August - harrowing (tractor)	c	24.00	24.00
August - seeding (bullocks)	c	11.20	11.20
August - hill (bullocks)	c	11.20	11.20
September - hill (bullocks)	c	11.20	11.20
Materials			
August - seeds	6 lbs.	1.50	9.00
August - urea	1 qq	23.50	23.50
August - insecticide	1 lb.	7.50	7.50
Sub-total			L 299.40
Other costs			
Interest on annual capital (12%)			12.85
Ownership costs: Interest on investment (12%)			9.48
Depreciation			20.07
Maintenance			4.02
Total costs of production			345.82

TABLE XVIII (Continued)

Detailed ownership costs

Initial information

Equipment	No. of Units	Initial Cost	Scrap Value	Useful Life (yrs.)	Manzanas Per Year
Back sprayer	1.0	225.00	15.00	2.00	120.00
Sacks (10)	1.0	24.0	0.00	2.00	1.00
Fence (4 manzanas)	1.0	480.00	48.00	15.00	4.00

Annualized costs:

	Totals			Per Manzana		
Equipment	Inter.	Deprec.	Maint.	Inter.	Deprec.	Maint.
Back sprayer	14.40	105.00	3.00	0.12	0.87	0.02
Sacks (10)	1.44	12.00	0.00	1.44	12.00	0.00
Fence (4mz)	31.68	28.80	16.00	7.92	7.20	4.00
Total per manzana (mz)				9.48	20.07	4.02

Profitability Analysis

	Possible price per unit		
	Low	Medium	High
Price	40.00	50.00	65.00
Gross Revenue	520.00	650.00	845.00
Net income[a]	220.60	350.60	545.60
Net income[b]	174.18	304.18	499.18

Necessary price to cover variable costs	23.03
Necessary price to cover total costs	26.60

[a]Man-day = 6 hours

[b]Fixed cost per manzana

[c]Gross income minus variable costs

[d]Gross income minus total costs

TABLE XIX

SESAME #2 ENTERPRISE BUDGET NO. 11063

Enterprise: Sesame #2, medium yield 14qq/mz
Region: Choluteca - Nacaome
Prepared by: Date:

Labor (man-days)[a]	Total Units	Cost Unit (L)	Total Cost (L)
October - clearing brush	8.80	3.80	33.44
November - seeding	1.80	3.80	6.84
November - first weeding	7.80	3.80	29.64
November - urea and fertilizer application	2.00	3.50	7.60
November - pesticide application	1.40	3.80	5.32
December - second weeding	6.60	3.80	21.36
December - removing buds	7.20	3.80	27.36
January - cutting and tying plants together	11.60	3.80	44.08
February - removing grains	6.60	3.80	25.08
Other contracted services			
November - plowing (tractor)	c	31.66	31.66
November - harrowing (tractor)	c	15.00	30.00
November - seeding (bullocks)	c	11.50	11.50
November - hill (bullocks)	c	11.50	11.50
December - hill (bullocks)	c	11.50	11.50
Materials			
November - seed	6 lbs.	1.50	7.50
November - urea	1 qq	23.50	23.50
November - fertilizer	1 qq	25.35	25.35
November - insecticide	6.4 lbs.	0.80	5.12
Sub-total			L 358.27
Other costs			
Interest on annual capital (12%)			12.70
Ownership costs: Interest (12%)			9.48
Depreciation			20.07
Maintenance			4.02
Total cost of production			404.54

TABLE XIX (Continued)

Detailed ownership costs

Initial information

Equipment	No. of Units	Initial Cost	Scrap Value	Useful Life (yrs.)	Manzanas Per Year
Back sprayer	1.00	225.00	15.00	2.00	120.00
Sacks (10)	1.00	24.00	0.00	2.00	1.00
Fence (4 manzanas)	1.00	480.00	48.00	15.00	4.00

Annualized costs:

Equipment	Totals			Per Manzana		
	Inter.	Deprec.	Maint.	Inter.	Deprec.	Maint.
Back sprayer	14.40	105.00	3.00	0.12	0.87	0.02
Sacks (10)	1.44	12.00	0.00	3.60	30.00	0.00
Fence (4mz)	31.68	28.80	16.00	7.92	7.20	4.00
Total per manzana (mz)				11.64	38.07	4.02

Profitability Analysis

	Possible price per unit		
	Low	Medium	High
Price	40.00	50.00	65.00
Gross Revenue	560.00	700.00	910.00
Net income[a]	196.41	336.41	546.41
Net income[b]	150.14	290.14	500.14

Necessary price to cover variable costs	25.97
Necessary price to cover total costs	29.27

[a]Man-day = 6 hours

[b]Fixed cost per manzana

[c]Gross income minus variable costs

[d]Gross income minus total costs

VITA

Faustin Mwape

Candidate for the Degree of

Master of Science

Thesis: A COMPUTER ASSISTED PLANNING METHOD FOR SMALL REPRESENTATIVE FARMS IN DEVELOPING COUNTRIES

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Kawambwa, Zambia, April 4, 1954, the son of Mr. Malubeni and Mrs. Kabwe Musonda.

Education: Attended primary school at Mawaya, Kawambwa; attended Junior Secondary School at St. Charles Lwanga, Mansa; attended Senior Secondary School at Nchelenge, Nchelenge; graduated from Nchelenge Secondary School in December, 1973; attended the University of Zambia, Lusaka; graduated from the University of Zambia with a major in Agricultural Science in 1978; completed requirements for Master of Science degree at Oklahoma State University in December, 1981.

Professional Experience: Employed by Loan Consolidated Mines, Luanshya Division, as a Staff Learner, January to May, 1974; employed by the Agricultural Finance Company as Loans Officer, August to December, 1978; employed by the University of Zambia, Lusaka, as a Staff Development Fellow, January, 1979 to present.