PROFITABLE REORGANIZATIONS OF REPRESENTATIVE FARMS
IN LOWER MICHIGAN AND NORTHEASTERN INDIANA
WITH SPECIAL EMPHASIS ON FEED GRAINS AND LIVESTOCK

Thesis for the Degree of Ph. D.
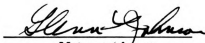MICHIGAN STATE UNIVERSITY
Curtis Franklin Lard
1963

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FARMS IN LOWER MICHIGAN AND NORTHEASTERN
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Curtis Franklin Lard

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ABSTRACT

PROFITABLE REORGANIZATIONS OF REPRESENTATIVE
FARMS IN LOWER MICHIGAN AND NORTHEASTERN INDIANA WITH
SPECIAL EMPHASIS ON FEED GRAINS AND LIVESTOCK

by Curtis Franklin Lard

The principal objective of this study was to determine optimal farm organizations that would indicate profitable adjustments for representative lower Michigan and northeastern Indiana farms having potential for producing feed grains, beef cattle and hogs. Linear programming was used to ascertain optimal farm organizations under varying prices for corn, hogs and beef cattle subject to the resource restrictions found on the representative farms in a survey covering 1960 data. Three price levels, low, medium and high were assumed for corn, hogs and beef cattle in the analysis.

Representative farms were delineated by size and type of farm. Size of farm was defined in terms of total acres operated, while type of farm was determined by the enterprise contributing the greatest percentage of gross income in 1960. Farms were classified as Large, Medium and Small farms and as Livestock, Cash Crop, Cash Grain and Dairy farms.

The analysis was performed for two phases and for two geographic areas. Phase 1 was the traditional linear programming model with land and associated durable resources assumed fixed. Phase 2 permitted variation where profitable in land and durable resources whose acquisition prices and salvage values differ. Separate analyses for the Thumb-Saginaw Valley and for the South Central (including south central Michigan and northeastern Indiana) areas took into account differences in soil productivity, urbanization, land prices and crops grown in the two areas.

The general conclusion of the study was that farms in the studied areas similar to the representative Cash Crop. Cash grain and Dairy farms could profitably specialize in beef and hog production under the conditions assumed in the study. More specific results were as follows:

1. The representative farms studies were not organized to maximize profits.

2. Many resources were not fully utilized on the representative farms in 1960.

3. It would be profitable for a large number of Michigan and northeastern Indiana farms to increase their production of beef and pork and feed their home produced feed grains to such livestock rather than selling feed grains.

4. The results indicate expansion in feed grain acreages in the Thumb-Saginaw Valley area and a reduction in forage crops and dairying.

5. The indicated expansion in beef and hogs would require large investments in livestock facilities. Also, the indicated expansion in beef implies a very large increase in demand for feeders.

6. Further use of credit on farms similar to the representative farms would be profitable.

Since this study only considered the production side of the picture at the individual farm level, all the above conclusions must be conditioned by the undetermined price impacts of widespread adoption of the conclusions. A later phase of the NC-54 Study, of which this thesis is a part, will consider these price impacts.

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CHAPTER I

INTRODUCTION

Many perplexing problems are encountered by feed grain and live-stock farmers. Specialization, technological advance, and the possible overcommitment of resources to production are some of the most significant developments facing feed grain and livestock farmers. The causes and effects of these developments vary considerably from one state to another and even from one farm to the next. The usual effects are lower farm product prices, maladjustments in production, and non-optimal allocation of resources that lead to lower incomes to farmers.

In order to help define, alleviate and/or solve some of the above mentioned problems, several states in the North Central region are obtaining basic information with respect to underlying factors which affect the supply of feed grain and livestock. The investigation reported in this thesis is a portion of the effort put forth in Michigan to search out some of the crucial aspects which affect the potential for feed grain and live-stock production in this state.

The Regional Study[1] of which this thesis is a part is concerned with supply and demand problems associated with the feed grain-livestock complex. The primary objectives of the Regional Study are: (1) to estimate optimal farm resource use and supply responses of hogs and beef in representative farm situations; (2) to estimate total production of

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[1] The North Central Regional study entitled, "Supply Response and Adjustments for Hog and Beef Cattle Production" (hereafter referred to as NC-54).

hogs and beef and patterns of resource use for the North Central states and for the nation; and (3) to determine the production situations and the areas or states in which specified quantities of pork and beef would or could be produced most efficiently under various projected levels of demand and prices with a given level of technology.

For similar agricultural areas that cross state lines, cooperative efforts among these states have been developed. Michigan State University (M.S.U.) cooperated with Purdue University in the south central part of Michigan and the northeastern part of Indiana. M.S.U. is responsible for analyzing the data from this area. Also, M.S.U. cooperated with Ohio State University (O.S.U.) in the southeast corner of Michigan and northwestern Ohio. In this area, M.S.U. personnel were responsible for taking Michigan schedules, while O.S.U. had responsibility for analyzing the data.

The study reported in this thesis is an extension of the NC-54 effort; nevertheless, it is only a part of M.S.U.'s contribution to the study of the problems associated with the feed grain-livestock complex and adjustments in this sector of Michigan agriculture. In addition to this study, a functional analysis of feed grain and livestock farms is being carried out, a time series analysis of the national feed grain-livestock complex is being conducted, an aggregative study of the results reported in this thesis is planned, and "outlook type" work is being carried out.

Definition of the Research Problem

Since 1952, large quantities of feed grains have been added to government storage and the North Central region has been partially responsible for this surplus feed grain production. Michigan is a contributor to this feed grain surplus area. Farmers have been producing more

feed grains than utilized by feed grain consuming units. In 1960, Michigan farmers sold 38 million bushels of their 91 million bushel corn crop. In 1961, they sold 41 million bushels of corn from a total crop of 102 million bushels.[1] Some of this corn was purchased by Michigan farmers, but most of it left the state.

The acuteness and the complexity of the national feed grain problem were brought into focus during 1961. At that time, a U.S. Feed Grain Program was initiated to reduce surplus production. The Feed Grain Program has been and is a step toward reducing: (1) the stock-piling of surplus feed grains and (2) the costs of storing and storage facilities. Nevertheless, present stock-piling and storage costs give rise to several problems and questions which must be faced by the feed grain producer, the livestock producer, the consuming public, grain handlers, agricultural policy makers, and others.

In Michigan and northeastern Indiana where labor is quite expensive, some of the relevant questions are: (1) Should these areas produce their meat requirements or should they produce and export grains and import meat produced with cheaper labor in other areas of the United States? (2) Since Michigan is in the "channel of flow" for beef and pork to the Eastern markets and since it has a surplus of feed grains, would it not be economically feasible for the feeder livestock to stop off in Michigan to be fattened out on their way east? (3) What are some of the economic adjustment potentials for the feed grain-livestock complex?

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[1]U. S. Department of Agriculture, Field and Seed Crops Production, Farm Use, and Sales Value, by States, 1960-61, Statistical Reporting Ser., Crop Reporting Board, Washington, D. C., May, 1962.

Farms in Michigan have been changing rapidly, particularly in recent years and in the southern part of the state. Farms have been sold, rented, expanded and taken over for urban uses. Some farmers have started working off the farm while renting or selling their farmland, while other farmers have become part time farmers while holding down industrial jobs.[1]

Several other sectors, in addition to the feed grain-livestock sector, of Michigan agriculture are involved in this complex of problems. The dairy sector is a market for the feed grains, as well as a competitor with the hog and beef sectors for factors of production. Several crops are competitive with feed grains for the land and other resources. Some crops under certain conditions may either compete with feed grains and/or supply by-products which are used as livestock feed. For example, sugar beets in the Thumb and Saginaw Valley produce by-products which are used for livestock feeds while they compete with feed grains and other crops for land and other resources. A study of sugar beet production is being carried out by M.S.U. under a U.S.D.A. contract.[2] These aspects indicate the interrelatedness and interdependencies which exist in agricultural problems.

Earl Heady and Alvin Egbert made a study of the interregional competitive production of wheat and feed grains.[3] They state, "....a methodological

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[1] H. S. Wilt, "Part-Time Farming," Michigan Farm Economics, Department of Agricultural Economics, April and May, 1955, and Ralph Loomis, "Part-Time Farming in Michigan," Quarterly Bulletin, Vol. 44, pp. 644-53, Michigan Agricultural Experiment Station, May, 1962.

[2] Robert A. Young, An Economic Study of the Eastern Beet Sugar Industry, Ph.D. thesis in preparation, Department of Agricultural Economics, Michigan State University.

[3] Earl O. Heady and Alvin C. Egbert, "Programming Regional Adjustments in Grain Production to Eliminate Surpluses," Journal of Farm Economics, Vol. XLI, pp. 718-33, November, 1959.

appraisal such as that reported here"[1] to indicate that their study was methodological; however, they also state, "Later in the article we provide empirical indication of the regional shifts in grain production which might be desirable if annual output were brought in line with an assumed level of demand."[2] They reported in the section, "Empirical Indications of Regional Production Patterns," of their article that their models specified that Michigan withdraw from grain production. They divided the grain producing area of Michigan into two regions (one included the Thumb and Saginaw Valley area) and both areas were shown to have few possibilities for grain production. However, their conclusions appear questionable because of the assumed conditions and data used in the analysis. This is particularly true of the region which included the Thumb-Saginaw Valley area. By contrast, other studies have shown cash grain farming to be a profitable endeavor in this area. Hildebrand[3] found feed grain production to be profitable in this area. Dvorak's[4] and Brooke's[5] findings agree with those of Hildebrand for the Thumb and Saginaw Valley area.

The present investigation is a more intensive and detailed study of the Thumb and Saginaw Valley area, south central Michigan area, and northeast

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[1]Ibid., p. 719.

[2]Ibid., p. 719.

[3]Peter E. Hildebrand, Farm Organization and Resource Fixity: Modifications of the Linear Programming Model, unpublished Ph.D. thesis, Department of Agricultural Economics, Michigan State University, 1959.

[4]Frank E. Dvorak, Programming the Organization and Capital Use for a Cash-Crop Farm in the Saginaw Valley and Thumb Area of Michigan, unpublished M.S. thesis, Department of Agricultural Economics, Michigan State University, 1959.

[5]David M. Brooke, Marginal Productivities of Inputs on Cash Crop Farms in the Thumb and Saginaw Valley Area of Michigan, unpublished M.S. thesis, Department of Agricultural Economics, Michigan State University, 1958.

Indiana which should aid in answering some of the above mentioned questions.

Objectives and Procedures

The main objectives of this study can be outlined as follows: (1) to determine optimal organizations of representative farms in certain parts of Michigan and Indiana; (2) to evaluate the competitive relationships of various enterprises; (3) to assess the effects of the adjustments indicated by the programmed solutions; and (4) to provide data and conclusions (a) to help derive supply relations for representative farm situations and (b) for aggregation over an enlarged area encompassing the major production areas in the North Central region.

The analytical technique employed in an effort to accomplish the above mentioned objectives involve the use of linear programming analysis. The procedures involved in carrying out the study included: (1) surveying specified farming areas in Michigan and Indiana; (2) using the data collected in the field survey to define representative farm situations; (3) programming representative farms using two different models; and (4) assessing the results of the study.

Areas Studied

The NC-54 Study for Michigan includes more areas than are reported in this thesis. The areas (totaling 21 counties) included in the entire study are: Thumb and Saginaw Valley area of Michigan (hereafter referred to as the Thumb area), south central area of Michigan, southeast corner of Michigan, and the northeastern part of Indiana (see Figure 1). The main emphasis of this thesis is on (1) the Thumb area and (2) the south central part of Michigan and the northeast part of Indiana, treated as one area. The resulted presented for the South Central area include the northeastern

THUMB–SAGINAW
VALLEY AREA

SOUTH

CENTRAL

MICHIGAN

AREA

INDIANA

OHIO

FIGURE I – LOCATION OF GEOGRAPHIC AREAS STUDIED

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Indiana area. The fruit area in western Michigan and the dairy area near Detroit which are potential grain producing areas were omitted. Also, the northern part of the lower peninsula and the upper peninsula were not included.

The climate does not vary a great deal over the areas studied. The amount and frequency of rainfall during the growing season is just slightly greater as one moves north from Indiana to the Thumb.[1] The growing season is about 2 weeks shorter (about one week in both the spring and fall) for the Thumb than for the extreme southern edge of Michigan, but this makes little difference since crop varieties grown are adapted to such weather. However, there is usually one extra cutting of alfalfa for hay or silage in the South Central area. This is taken into account in the model. The difference in the severity of the winter is debatable, but no real significant differences exist between the Thumb and South Central areas which would affect techniques of production. Winter is about 10 days longer in the Thumb if one uses the date of the last freezing temperature in the spring as an indicator.

The real differences between the Thumb and the South Central areas are soils[2] and extent of urbanization. The Thumb area has dark colored Humic-Gley soils which require tile drainage but have high natural fertility. These soils include Sims, Kawkawlin, Capac, Iosco, Wisner and Essexville.

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[1] North Central Regional Publication No. 115, Precipitation Probabilities in the North Central States, published by University of Missouri, Agricultural Experiment Station, Columbia, Missouri, July, 1960.

[2] The following references were used in studying the soils of Michigan: (1) Soils of the North Central Region of the United States, North Central Regional Publication No. 76, Published by Agricultural Experiment Station, University of Wisconsin, Madison, Wisconsin, June, 1960; (2) J. C. Veatch, A Map of Michigan Soils, on file in Glenn L. Johnson's office; and (3) E. P. Whiteside, I. F. Schneider and R. L. Cook, Soils of Michigan, Special Bulletin 403, Michigan Agricultural Experiment Station, 1956.

The soils included are very similar to Brookston and Conover in their soil management and drainage problems. They are clay loams or loams that are imperfectly or poorly drained. The major type of farming is cash crop. In the South Central area there are light colored Podzolic soils, with Miami, Conover and Hillsdale being the main ones of this group. These soils are much less productive than the Thumb soils but have fewer drainage problems. Thus, one finds less intensive cropping programs. In the South Central area, the major types of farms are general, dairy and livestock.

The South Central area is much more influenced by urbanization and industrialization than the Thumb area. Land values in the South Central area tend to be bid up as a result, whereas in the Thumb area the land price is more affected by high valued cash crops which can be grown on the land. Earnings from high valued cash crops such as sugar beets and dry beans are capitalized into the value of the land.

The differences in productivity of the soils, the crops which can be grown in the two areas, urbanization and land prices made it necessary to make substantial changes in the linear programming model from one area to the other.

The farms in the South Central area tend to be larger in land area than the Thumb farms. Based on the data collected in the survey for this study, the South Central farms averaged 204 acres of total land and 172 acres of cropland, while the Thumb farms averaged 162 total acres and 150 acres of cropland in 1960.

Order of Presentation

In Chapter II, a brief resume of previous studies employing linear programming and other models is presented along with a general description

of the model used in this investigation. The two phases of the linear programm-
ing analysis of this study are defined. Also, the assumptions made for this
programming model, criticism of previous applications of linear programming,
and the research methodology of this study are presented in Chapter II.

Chapter III presents the representative farm situations delineated in
this study and the variables used to stratify the farms. Special attention
is given to the variables used in setting up representative farm situations
and to the use of such farms in the linear programming analysis. The kinds
and levels of enterprises and resources found on the representative farms are
presented in this chapter.

The linear programming model is described in Chapter IV. This
chapter presents the activities and coefficients used for the Thumb and South
Central areas. The distinctions are also made between the model for each
area and for each phase in this chapter.

The programmed optimal solutions for the representative farms are
presented in Chapter V. Attention is given to the major factors which
influence the kinds and extent of the programmed adjustments in the organiza-
tion of farms. In this chapter, comparisons are made between the resulting
optimal organizations of the representative farms for Phase 1 and for Phase
2. In the last part of the chapter, an assessment is made of the effects of
varying certain durable resources on the optimal organization of farms.

The study is summarized and the conclusions are drawn in Chapter
VI. In the final section of the chapter, implications are indicated for
farmers in the study areas and further uses of the results of this study
are suggested.

CHAPTER II

THE GENERAL MODEL, ASSUMPTIONS, AND RESEARCH METHODOLOGY

Linear programming is used in this study to work with the theory of the firm, with special emphasis on resource fixity. The programming model uses profit (gross income less variable cost) as the goal to be maximized. Profit is not the only goal important to farmers; nevertheless, in general it is a major motive inciting farmers to produce. The individual farmer's desires, resources owned and/or controlled, type of farm, management abilities, family, etc., have very important effects upon profit maximizing and optimal organization or adjustments of farms. Richard Day[1] refers to profit maximizing under the above mentioned conditions as "constrained profit maximization."

The programming model is patterned after the Lakes States Dairy[2] model with more detail on hog and beef production and less on dairy. There are two major differences: (1) Private credit is added in the first phase of the model and (2) acquisition and salvage of major durable resources are added in the more complete second phase of the model. Glenn L. Johnson[3] and

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[1]Richard Day, "An Approach to Production Response," _Agricultural Economics Research_, Vol. XIV, No. 4, U.S. Dept. of Agriculture, Econ. Res. Ser., October, 1962, pp. 134-148.

[2]Dean E. McKee, "Input-Output Data, Linear Programming Model and Optimal Organization of Representative Farm Situations in Lower Michigan," Department of Agricultural Economics, Michigan State University, East Lansing, July, 1961.

[3]Glenn L. Johnson, "Supply Function - Some Facts and Notions," _Agricultural Adjustment Problems in a Growing Economy_, Edited by E. O. Heady, _et. al._ (Ames: The Iowa State College Press, 1958).

Clark Edwards[1] have developed the idea of resource fixity. V. E. Smith[2] first attempted to apply the theory in a programming model. The idea of endogenous determination of resource fixity was treated in more detail by Hildebrand.[3] The differences between the programming model in this study and others will become more apparent as this chapter proceeds.

Formulating the Model

The general research program for the Michigan NC-54 project makes use of a farm survey, linear programming, functional analysis, time series analyses, and "outlook type" work. The first two are reported in this thesis and the others will be combined with these at a later date and reported elsewhere.[4]

The details of the farm survey will be discussed after a presentation of the general model within the context of which the survey was developed.

The Linear Programming Phases

The linear programming model in this study is referred to as Phase 1 and Phase 2. Phase 1 includes activities for crops, labor, hogs, beef cattle, dairy, and credit with land fixed at the levels indicated by the 1960 survey data for the representative farms. Phase 2 allows the farm size and

[1]Clark Edwards, Resource Fixity, Credit Availability and Agricultural Organization, unpublished Ph.D. thesis, Michigan State University, 1958.

[2]V. E. Smith, "Perfect vs. Discontinuous Input Markets: A Linear Programming Analysis," Journal of Farm Economics, Vol. 37, Aug. 1955, p. 538.

[3]P. E. Hildebrand, op. cit.

[4]Michel Petit and Glenn L. Johnson are responsible for the other parts of the over-all study.

associated assets to vary, while an extension of Phase 2 allows further variation in the land resource. The model as defined in Phase 2 differs from Phase 1 only in that land, labor, and machinery resources are allowed to vary and the model selects the optimal level of these resources in Phase 2. This procedure allows the levels (supplies or stock) of these resources to be determined endogenously rather than following the more usual method of arbitrarily assuming them fixed. In other respects, the model for Phase 1 is identical to those for Phase 2.

The theory of fixed assets[1] incorporated into Phase 2 is as follows: An asset or resource becomes fixed when the following condition is met:

$$P_x \text{ acquisition} \gtreqless MVP_x \gtreqless P_x \text{ salvage,}$$

where x is the resource, P_x acquisition is the price for acquiring more of the resource, P_x salvage is the disposal price, and MVP_x is the marginal value product of x in production. When the MVP_x is greater than the acquisition price for x, it is profitable to expand the use of x (or quantity of x varies upward). When the MVP_x is less than the salvage price, it is profitable to reduce the use of x (or the quantity of x varies downward).

Hildebrand[2] used this procedure and modifications in examining the stock-flow problem and the discrete unit problem involved when considering the possibilities of varying durable resources.

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[1] Glenn L. Johnson, "The State of Agricultural Supply Analysis," Journal of Farm Economics, Vol. 42, 1960, pp. 441-451, and Clark Edwards, "Resource Fixity and Farm Organization," Journal of Farm Economics, Vol. 41, 1959, pp. 747-759.

[2] P. E. Hildebrand, op. cit.

Assumptions and Background

The NC-54 analyses are being carried out with 1970 as the target date and 1966 the focal point. Hence, the prices and conditions are assumed to be those expected to exist on the average for the period 1963-1970.

The usual linear programming assumptions were made.[1] In addition, the following assumptions were made for the model in this study: (1) Farm managers' present average managerial ability will be improved; (2) the currently known and commercial applicable level of technology is assumed rather than just currently used technology; (3) the current credit institutions and methods of financing used for agriculture will continue; (4) all prices except those varied in the analysis (corn, hogs and beef prices) are projected to 1966 on the basis of current trends; (5) the input-output coefficients involved are consistent with the assumptions concerning managers and technologies; (6) government price support, production control, and demand expansion programs will continue in essentially their 1962 forms; and (7) problems of inflation and deflation will not be considered.

Different Approaches

The problems associated with supply responses and adjustments in agriculture can be and should be attacked from several angles. Many approaches have been employed by investigators to seek answers to such problems. Among those techniques used, the following are the most important ones: linear programming, budgeting, aggregate time series, functional analysis, and outlook and projected trends. Linear programming is the one examined in the

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[1]E. R. Swanson, "Programming Optimal Farm Plans: in Farm Size and Output Research," Southern Reg. Coop. Series, Bull. 56, June, 1958, pp. 47-57.

paragraphs which follow. What are some of the strengths and weaknesses of this approach to studying supply and adjustment problems in agriculture? The brief critique which follows is not necessarily aimed at the linear programming technique itself but at previous applications of the technique.

Careful study and evaluation of past studies, which have employed this technique, warrant the general conclusion that many studies have been unrealistic. How have studies using linear programming been unrealistic? The following is a partial list of the shortcomings and some suggested improvements in the application of this technique.

1. Many inputs or resources (at the micro level) have been assumed fixed when in reality it would be economic to vary their use. Among the variables (inputs) which researchers have assumed unrealistically fixed are: land, capital assets, and working capital. Also, applications have not made sufficient allowance for hiring different kinds of labor (including managerial labor) and selling different kinds of labor (operator and family labor). This problem can be overcome, in part, if the program is permitted to determine endogenously which inputs should be fixed.

2. Applications have not taken into account the full range of credit opportunities and the cash flows within the year (period of time in which the farm operations are carried out) for the farm firm. When the use of these resources is restricted, the adjustment potential is limited.

3. Applications have been based on commercially available modern technologies and methods but not necessarily those that farmers, in general, were adopting and using.

4. The magnitude of the solutions for many activities goes beyond the assumptions of the model and the coefficients, i.e., output levels are not in the range assumed for the input-output coefficients.

5. The optimal organizations as indicated by linear programming analyses often result in fractions of inputs and enterprise levels which are impractical, i.e., the problem of non-integer solutions. There is a method, integer programming, which is being developed that will partially overcome this problem.

6. Many of the activities used in programming problems are mutually dependent, which may lead to impractical combinations of enterprises in the programmed optimal organizations.

This list is not exhaustive, but is an indication of some of the more perplexing and important shortcomings. Clark Edwards[1] has presented some of the shortcomings of linear programming and classified them according to their origin. The first two of the above list are partially treated in Phase 2 of the model, defined in Chapter IV.

Research Methodology

The problem under investigation and the objectives of this study were delineated in Chapter I. In order to answer questions and attain the objectives, it was necessary to collect and/or assemble the data needed to analyze the situation.

Sources of Data

Although the problem being studied determines the kinds of data needed, the form and extent of the data may vary with the type of analytical techniques employed to do the analyzing. Since linear programming techniques are used in this study, data were required on farm organization, production,

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[1]Clark Edwards, "Shortcomings in Programmed Solutions to Practical Farm Problems," Journal of Farm Economics, Vol. 43, May, 1961, pp. 393-401.

and resources. There are several sources for some of these data such as:
Michigan Farm Mail-in-Account records, previous farm adjustment studies,
farmers themselves, etc. Major reliance had to be placed on surveys as this
was the only source of current data on representative farm situations that had
a measure of statistical accuracy. The farm resource, production and organi-
zation information were obtained by surveying farmers located within the
study areas. (See Figure 1 for the delineation of the areas studied.)

The extensive and detailed enterprise budgeting information needed
for constructing the input-output coefficients was difficult to obtain. Thus,
budgets and technical coefficients underlying the linear programming model
were either (1) assembled and synthesized from information gained from meet-
ings with personnel from the applied and technical agricultural sciences or
(2) obtained from research publications (the credits and sources for such
information are given in Chapter IV under the specific information presented).

Sample and Sampling Procedures

The population from which the Thumb and South Central samples were
drawn was defined to include economic class I through IV farms as defined by
the U.S. Census[1] in 1959, excluding specialized poultry, truck, fruit and
horticultural farms. The farms surveyed from this population furnish the
information for defining the representative farms used for programming in
this study. The population was stratified before the samples were drawn
on the basis of geographic area for the purpose of taking into account dif-
ferences that exist in soils, type of farming, and metropolitan influence on

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[1]These included all farms with value of gross sales exceeding $2,500.
Poultry, fruit, truck and horticultural farms were excluded if over 50 per-
cent of their farm sales were of these products.

agriculture. These and associated factors are assumed to have significant effects upon adjustments in the feed grain-livestock complex.

The _Thumb_ area population from which the sample was drawn consisted of a set of townships that met certain soil specifications. The general criterion for inclusion in the survey was that the soils be adapted to cash crop farming (see Chapter I, Areas Studied). Selection of the soil series to be included was made in consultation with personnel of the Soil Science Department of Michigan State University. If at least 70 percent of the farm land area (exclusive of urban areas) in the township were adapted to cash crop farming, the township qualified for the universe.

The sampling rate or quota was set by the NC-54 Research Methodology Subcommittee. In order to describe adequately the farm population for any sub-area in a state, the Subcommittee stated that at least 100 farms would be required. Since the number of townships needed to meet this sample quota was very small, the townships meeting the soil specifications were divided into four groups of equal numbers. This permitted uniform geographic sampling of the area. From each group of townships, two townships were drawn at random, i.e., eight in all. Within each selected township, two area segments comprising two contiguous square miles each were drawn at random. All farm operators whose farmsteads fell within this sampling unit and whose operations met the other criteria, outlined above, were interviewed. Another specification allowed further sampling if the 100 farms were not completed by the time these sampling units were surveyed. This specification was to repeat the same sampling procedure used to obtain the first sampling units. The qualifying townships are listed by county in Table 1 in Appendix A.

The _South Central_ population, from which the sample was drawn, consisted of counties with soils adapted to growing feed grains and cash grains

(see Chapter I, Areas Studied, for the soils included). The specification necessary for the counties to quality was the same as for townships to qualify in the Thumb area except that the percentage of farmland adapted to cash crops was set at 60 percent instead of 70 percent. The qualifying counties are listed by state in Table 1 in Appendix A.

The area sampling procedure was not used for the South Central area. The Thumb survey was coordinated with another M.S.U. study, and the South Central survey was coordinated with the Indiana NC-54 study. The sampling procedure for the South Central area could have been used for the Thumb area; however, A.S.C.[1] records were used for the South Central area sampling to be consistent with the sampling procedure used by Purdue for the northeastern Indiana area.

In the South Central area the farm unit basis sampling procedure was used. A list of farms by counties was available from the A.S.C. records. These records are arranged alphabetically by townships moving from the north-east corner back and forth to the southeast corner of the county. The town-ship in which to start was selected at random, as well as the first farm to sample within the township. The number of schedules or farms needed, by size category, was specified before the samples were drawn. In order to meet the Regional specification (that farms should be stratified by size and type and no cell (size-type) should have less than 10 farms) 1954 and 1959 U.S. Census of Agriculture data were inspected. That inspection indicated (1) a scarcity of farms over 200 acres in size in the South Central area, (2) that farms were approximately equally divided among cash crop, dairy,

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[1]Refers to Agricultural Stabilization and Conservation Service, U.S. Dept. of Agriculture Records are in the county offices.

and livestock, and (3) the size distribution of farms varied by counties.
It was decided to draw a random, disproportionately stratified sample with
respect to size of farm but proportionate with respect to type of farm.

The disproportionate sample was to be drawn by first sampling propor-
tionally until the expected required number of farms was obtained for the
two smallest farm size strata, less than 100 acres and 100 to 200 acres,
respectively. After these strata were filled, further sampling was to con-
tinue until the expected minimum number of farms was obtained for the statum
above 200 acres in size. However, as the surveying progressed it was found
in most counties that, unexpectedly, the large farm strata filled first and
the small strata filled last. This indicates that farm consolidation has
been progressing rather rapidly in the South Central area of Michigan.

The South Central sample quota or size was determined to be a minimum
of 150 farms, with 100 from Michigan and 50 from Indiana. One hundred qualify-
ing farms were drawn from Michigan and 58 from Indiana.

Schedule and Interviewing

A survey schedule[1] was developed to be used in collecting farm manage-
ment and production information from the farmers. The main data needed were
resource inventories, production patterns and expenses. The questions were
open-ended and arranged according to major resources. These data were col-
lected by personal interview with the farm operators. The interviewing was
done by this researcher and other Department of Agricultural Economics per-
sonnel in the summer of 1961 for 1960 data. Schedules were completed and
edited in the field. If a farmer were not at home or could not grant the

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[1]A copy of the schedule used in this study is included in Appendix C.

interview at that particular time, the interviewer was to make three return calls. If the schedule had not been completed by then, that farm would not be a part of the sample. Refusals had more effect on the sample in the Thumb area than in the South Central area because there was no procedure for replacing farmers in the Thumb area who refused to be interviewed. Also, a farmer who refused could affect responses from others in that two square miles sample segment. Since the farms were close to each other, the farmers who refused might talk to other farmers and influence their answers to questions and/or their decision to cooperate with the survey. In the South Central sample, if a farmer refused to be interviewed, the next farmer on the list was interviewed. A refusal rate of approximately 5 percent was experienced in the Thumb sampling. In the South Central area, the refusal rate was much lower but was not calculated.

Coding, Tabulating, and Use of Computers

After the schedules were completed and the surveying done, the data were coded and tabulated for IBM punch card operations. The resource inventory information was used to derive resource restrictions for representative farms. The production patterns and major enterprise information were used to classify farms by type. The production, inventory, investment and expense data will be used in performing functional analysis. The information on punch cards concerning major farm characteristics was compared in order to seek further stratification of farms.

The linear programming computing was carried out on the Control Data Corporation 1604 computer at Minneapolis.

CHAPTER III

DEFINING REPRESENTATIVE FARM SITUATIONS

This chapter presents justifications for using representative farms
in this linear programming analysis which is followed by a discussion of
variables used in delineating representative farms. In the next section,
some cautions are indicated that should be helpful in setting up representa-
tive farm situations. In the final section of this chapter, the representa-
tive farms delineated in this study and their 1960 resource bases and enter-
prises are presented.

In carrying out the linear programming analysis in this study, it
was necessary to define representative farm situations. The method of programm-
ing representative farms was chosen because: (1) The cost of programming
every farm would be prohibitive; (2) even though the solution to a represent-
ative farm may not be applicable to a specific farm, the representative farm
probably has characteristics that allow the solution to be an approximation
for many farms; (3) it allows a questionable degree of aggregation of results;
and (4) it can be used to estimate points on a supply relation which can be
aggregated with others to furnish some information about the aggregate supply
relation.

Important Variables

When defining the representative farm situations, it was essential
that the farms be grouped on the basis of the most crucial factors that
affect adjustment.

A priori stratification of farms in this study was made on the basis of land area since the quantity of land was believed to restrict adjustment possibilities. The Thumb sample was classified by total acres of land operated in 1960 into the following size groups: 120 acres or less, 121 to 180 acres, and over 180 acres. The South Central sample was stratified by size of farm before sampling, also. The size of farm for this area was based on total acres operated in 1960, using the following breakdown: less than 100 acres, 100 to 200, and over 200 acres. The differences in the farm size categories for the Thumb and South Central areas stem from the institutional arrangement of 40, 80, etc., parcels of land in the Thumb and the Census classification of farm sizes used for the South Central area in developing the sampling procedure.

Initial type of farm also restricts adjustment possibilities for farms since resources, skills and information are not perfectly substitutable from one enterprise to another.

Several other variables are important when defining representative farms such as: age of operator, education, family labor force, operator off-farm job, net worth, etc. In addition to the above mentioned variables, credit, preference of the farmer, etc., are important. If one decided in advance of sampling that some other variables were more important, a more detailed classification than used in this study might permit more accurate estimation of responses. Nevertheless, the method of defining representative farms would still have the problems of applicability and aggregation of the results. Orlan Buller[1] in his study of fruit farms in southwest and

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[1]Orlan Buller, The Effects of Changes in Technology and Increasing Wage Rates on the Organization of Tree Fruit Farms in Michigan, Ph.D. thesis in preparation, Dept. of Ag. Econ., Mich. State Univ., 1963.

western lower Michigan has used other variables than those used in this study to classify the farms. He stratified farms by age of operator, size of family labor force, and net worth as a major determinant of farm size in order to obtain representative farm situations. His central objective was to evaluate the effects of changes in technology and increasing wage rates on the organization of tree fruit farms.

Using Representative Situations in Analyses

Even though the use of the representative farms permits limited statistical aggregation and flexibility in application, there are many unrealistic aspects associated with its use. It becomes impossible to group farms such that no important factors vary significantly within the class. For example, consider a Large Cash Crop representative farm (classified by size and type). The farms making up this "statistical average" farm may vary in such ways as (1) one farm may have 100 acres of sugar beets and the necessary equipment and none of the other farms making up the representative farm has any, or (2) five farmers in the stratum may be over 65 years old and the others less than 30, or (3) two farmers may have 100 tons of silo capacity and the others have none, or (4) net worth may vary widely and, hence, ability to finance adjustment varies, etc.[1] Unrealistic situations which result and response information may need careful interpretation. When essential variables that would have the greatest effect on responses are omitted while classifying farms by size and type alone, the answer or response given by the programs will be incorrect. Hence, the usefulness of such representative farms in analysis is limited for predicting agricultural

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[1]In many cases, these situations can be removed or "averaged out" by increasing the sample size.

adjustment. Thus, such considerations must be taken into account when interpreting the programming results of this study.

Representative Farms Delineated in This Study

The representative farm situations defined in this study are: Small, Medium and Large Livestock farms; Small, Medium and Large Cash Crop farms; and Small, Medium and Large Dairy farms. Farms (by U.S. Census classification) were grouped into the three types on the basis of the main enterprise or the enterprise contributing the largest percentage of gross income in 1960. In all other situations, if at least 50 percent of the 1960 gross income came from livestock or cash crops or dairy, the farm was classified as that particular type.

The above classification of farms by size and type outlines the representative farms in this study. Data from farms making up these classes (cells or strata) were used to determine the initial resource restrictions which define the representative farm situations. Thus, the representative farms delineated in this study are defined by size and type, while the resource restrictions are the statistical averages of the resources used by the farms falling in the size-type classification. Another defining characteristic used was the enterprises found on these farms in 1960.

In the Thumb area, not enough observations were obtained on livestock farms to have a class of such farms. Only four livestock farms occurred in the sample. The dairy cells (size by type) had only seven farms each which was less than the specified miniumum of 10 (every representative farm stratum was supposed to contain at least 10 farms to be adequate to describe the agriculture for that group). With this being the case, the Small and Medium Dairy cells were grouped to form a representative farm situation. The

size-type classification for all qualifying farms is presented in Table 1 which follows below.

TABLE 1.--NUMBER OF FARMS IN EACH SIZE-TYPE-AREA CLASSIFICATION

Type of Farm	Thumb-Saginaw Valley Area Size of Farm, Acres			South Central Area Size of Farm, Acres		
	120 or less	121-180	over 180	less than 100	100-199	200 and over
Cash Crop	30	24	21	10	18	16
Livestock	1	1	2	12	17	18
Dairy	7	7	7	10	27	30

Many enterprises and farms were considered to be atypical and would not have any appreciable effects upon supply responses of hogs, beef cattle and feed grains. These were dropped from the analysis. The enterprises not considered were specialty crops, poultry, sheep, nursery crops and specialty livestock. Likewise, specialty farms were excluded. When inventories of specialty crops and livestock occurred on the qualifying farms, these were liquidated and their value was made available as cash for that farm in the programming analysis.

Enterprises and Resources

The enterprises on the various representative farms are related to the type of farm. There were differences with respect to crops grown in 1960 from one type of farm to another. In the Thumb area, the largest crop acreages on cash crop farms were (in order): (1) dry beans, (2) wheat, (3) corn, (4) sugar beets and (5) small grains. The Dairy farms had higher proportions of their land in corn and hay than did the Cash Crop farms. A comparison of crop and livestock enterprises by representative farm situations for the Thumb area is presented in Table 2.

TABLE 2.--ENTERPRISE LEVELS BY REPRESENTATIVE FARMS IN 1960 - THUMB AREA

	Unit	Cash Crop			Dairy	
		Small	Medium	Large	Medium	Large
Crops						
Corn	Acre	9	14	41	22	73
Sugar Beets	Acre	6	13	18	1.5	10
Other Row Crops	Acre	0	1	2	1	0
Soybeans	Acre	4	3	6	4	0
Dry Beans	Acre	39	64	91	7	53
Wheat	Acre	15	22	39	11	32
Small Grains	Acre	6	14	16	10	29
Hay & Rotation Meadow	Acre	3	10	15	41	111
Livestock						
Dairy Cows	Number	1	1	6	21	41
Sows	Number	1	1	1	2	0
Feeder Cattle	Number	0	2	4	2	7
Beef Cows	Number	0	0	0	0	0
Laying Hens	Number	59	19	58	72	0
Land						
Rented In	Acre	19	58	154	30	101

In the South Central area, the principal crops (measured in acres) on the Cash Crop farms were, in order: (1) corn, (2) soybeans, (3) wheat, (4) hay and (5) small grains. Again, the Dairy farms, as well as the Livestock farms had higher proportions of their cropland in corn and hay than did the Cash Crop farms. The data for crop and livestock enterprises for the representative farms in the South Central area are presented in Table 3.

The resource inventories on these representative farms are considered to be more important than their enterprises. It is not too difficult to shift from growing corn and hay to growing more soybeans, but it is difficult to convert dairy facilities to beef or hog facilities. Thus, the resource inventories are expected to have a substantial influence upon the extent and

TABLE 3.—ENTERPRISE LEVELS BY REPRESENTATIVE FARMS IN 1960 FOR THE SOUTH CENTRAL AREA

Enterprises	Unit	Livestock			Cash Crop			Dairy		
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large
Crops										
Corn	Acre	26	43	114	13	32	114	19	36	73
Other Row Crops	Acre	0	2	0	4	1	1	0	0	1
Soybeans	Acre	3	3	11	13	18	39	5	3	3
Drybeans	Acre	0	0	3	2	9	1	0	0	1
Wheat	Acre	7	13	32	15	23	29	9	15	23
Small Grains	Acre	8	15	27	6	13	17	6	15	30
Hay & Rotation Meadow	Acre	13	32	75	5	10	49	28	44	91
Livestock										
Dairy Cows	Number	0	2	3	1	2	2	12	15	29
Sows	Number	12	13	16	1	2	2	3	3	4
Feeder Cattle	Number	10	11	48	0	0	8	0	1	4
Beef Cows	Number	3	7	4	1	0	1	0	0	0
Laying Hens	Number	92	122	308	18	21	106	31	29	29
Land										
Rented In	Acre	6	39	161	8	26	196	21	32	107

kind of adjustments which can be made. The resource situations, by representative farms, are presented in Table 4 for the Thumb area and in Table 5 for the South Central area.

Both the quantity of a resource and when the resource is available are important. Thus, labor is broken down into periods 1 to 6 where:

Period 1 - December, January, February and March

Period 2 - April and May

Period 3 - June and July

Period 4 - August

Period 5 - September to October 15

Period 6 - October 15 through November 30

This breakdown is based on the seasonal work pattern of farms growing cash crops. An attempt was made here to group the labor such that crucial and slack periods would be more distinct. Periods 2 and 3 are the planting, cultivating and wheat harvest times. Periods 5 and 6 make up the harvest season and fall planting time. Periods 1 and 4 are usually the slack periods.

The levels of the resources in every case, except for hog and beef facilities in the Thumb area, are based on farm averages. In the cases of hog and beef facilities for the Thumb area, the restrictions were calculated on the basis of the buildings and facilities present on the farms, because in most all instances, there were no livestock (other than dairy) but there were always buildings and facilities.

The annual cash restriction is the net available for farm operations. Appropriate charges have been deducted for living expenses, annual short term and long term debt payments, and real estate taxes. The labor restrictions have been reduced by the amounts of labor used for overhead in

TABLE 4.—RESOURCE RESTRICTIONS FOR REPRESENTATIVE FARMS - THUMB AREA

Resource Restrictions	Unit	Cash Crop Farms			Dairy Farms	
		Small	Med.	Large	Small-Medium	Large
Bean Acreage Limit	Acre	31	44	52	38	121
Corn Acreage Limit	Acre	31	44	52	38	121
Permanent Pasture	Acre	2	3	16	8	46
Sugar Beet Acreage Limit	Acre	6	9	9	2	9
Wheat Acreage Limit	Acre	14	15	17	11	25
Annual Cash Account	$	272	2,237	8,228	2,393	7,837
Real Estate Mortgage	$	14,169	16,623	17,624	12,466	40,358
Chattel Mortgage	$	2,272	2,605	4,685	4,472	10,707
Private Credit	$	2,300	2,100	5,300	2,300	3,800
Farm Labor Period 1	Man hrs.	1,053	1,252	1,646	1,348	1,969
Farm Labor Period 2	"	514	608	795	609	891
Farm Labor Period 3	"	618	670	870	654	972
Farm Labor Period 4	"	311	350	487	329	469
Farm Labor Period 5	"	384	429	572	422	600
Farm Labor Period 6	"	375	422	581	429	622
Operator Off-farm Work	Hours	1,264	563	613	446	0
Family Off-farm Work	"	201	683	1,556	340	934
Cropland	Acre	62	89	105	76	242
Power & Tillage Capacity	Acre Cap.	243	278	427	282	411
Grain Harvest Capacity	"	81	108	121	76	113
Corn Picking Capacity	"	27	28	61	57	95
Silage Harvesting Capacity	"	2	6	12	14	29
Hay Harvest Capacity	"	13	29	29	71	100
Sugar Beet Harvest Capacity	"	10	25	38	19	14
Sugar Beet Transport Capacity	"	9	16	23	10	27
Silo Capacity	Tons	10	27	64	103	242
High Moisture Crop Capacity	Tons	0	0	27	27	119
Beef Housing	Animal	6	9	10	5	5
Beef Feeder Low Mechanization	"	6	9	10	5	5
Beef Feeder High "	"	0	0	0	0	0
Beef Cows	Head	0	0	0	0	0
Milk Cows	"	1	1	10	22	41
Dairy Facilities	Cow	0	0	4	25	38
Central Farrow	Sow	2	3	3	3	2
Portable Farrow	Sow	0	0	0	0	0
Confinement Finish	Head	14	18	54	14	12
Portable Finish	Head	4	4	8	0	0
Milking Labor	Man hrs.	1,253	1,418	1,868	1,442	2,048
Managerial Labor	Oper. hrs.	2,604	2,948	3,879	2,995	4,253
Land Rented In Limit	Acre	19	58	154	30	101

TABLE 5.--RESOURCE RESTRICTIONS FOR REPRESENTATIVE FARMS – SOUTH CENTRAL AREA

Resource Restriction	Unit	Livestock Farms			Cash Crop Farms			Dairy Farms		
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large
Bean Acreage Limit	Acre	19	26	49	20	34	36	20	32	52
Corn Acreage Limit	Acre	26	33	97	20	34	50	20	32	54
Permanent Pasture	Acre	15	26	33	10	13	39	5	20	43
Small Grain Limit	Acre	28	39	73	30	50	54	29	47	78
Wheat Acreage Limit	Acre	7	13	25	15	19	15	9	15	16
Annual Cash Account	$	4,290	7,676	12,974	365	3,788	7,137	1,535	4,138	7,420
Real Estate Mortgage	$	9,503	11,028	19,996	10,270	14,536	15,198	7,985	10,573	20,805
Chattel Mortgage	$	1,113	2,824	4,532	1,169	1,590	4,957	2,162	2,913	6,117
Private Credit	$	2,600	2,400	6,600	2,800	2,700	4,100	4,900	2,100	2,900
Farm Labor Period 1	Man hrs.	973	1,057	1,127	1,157	1,087	1,423	1,058	1,150	1,605
Farm Labor Period 2	"	465	490	557	560	566	671	513	564	732
Farm Labor Period 3	"	448	468	531	588	589	698	520	650	773
Farm Labor Period 4	"	223	238	252	296	292	339	259	299	377
Farm Labor Period 5	"	320	334	336	378	395	478	353	407	516
Farm Labor Period 6	"	330	342	358	395	403	477	357	389	527
Operator Off-Farm Work Hours	"	1,040	489	366	1,456	1,387	780	624	693	430
Family Off-Farm Work	"	404	273	282	458	347	691	0	291	695
Cropland	Acre	55	78	145	59	100	107	58	94	155
Power & Tillage Cap.	"	156	213	312	140	218	342	141	216	379
Grain Harvest Cap.	"	37	69	115	56	107	112	56	82	98
Corn Picking Cap.	"	57	98	123	50	95	138	62	68	95
Silage Harvesting Cap.	"	0	6	17	0	3	6	5	6	25
Hay Harvest Capacity	"	17	18	67	10	22	63	30	41	70
Row Crop Limit	"	37	52	97	39	67	71	39	63	103
Rent Land in Limit	"	6	39	161	8	26	196	21	32	107
Silo Capacity	Tons	30	64	213	0	48	57	42	56	199
High Moisture Crop Capacity	Tons	20	0	62	0	0	24	17	23	102
Beef Housing	Animal	20	30	66	5	6	14	0	5	5
Beef Feeder Low Mechanization	"	20	30	66	5	6	14	0	5	5
Beef Feeder High Mechanization	"	0	0	0	0	0	0	0	0	0
Beef Cows	Head	3	7	4	1	0	1	0	0	0

TABLE 5.—continued

Resource Restriction	Unit	Livestock Farms			Cash Crop Farms			Dairy Farms		
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large
Milk Cows	Head	0	2	3	1	2	2	12	15	29
Dairy Facilities	Cow	1	2	4	2	4	3	14	18	38
Central Farrow	Sow	3	3	6	0	1	1	1	1	1
Portable Farrow	Sow	12	10	5	3	3	3	3	3	4
Confinement Finish	Head	77	39	49	6	12	4	21	8	10
Portable Finish	Head	48	68	65	0	24	19	4	15	29
Milking Labor	Man hrs.	996	1,044	1,020	1,301	1,253	1,517	1,136	1,283	1,658
Managerial Labor	Oper. hrs.	2,069	2,168	2,118	2,700	2,600	3,148	2,357	2,663	3,443

operating the farms (see Table 2 in Appendix A for the overhead labor require-
ments).

The initial resource restrictions for cash and different sources of
credit were estimated as follows. The annual cash resource was composed of
cash on hand, near cash assets, and feeder livestock and crop inventories
valued at current prices. Value of breeding herds was excluded from this
variable. Also, any debts against crop and feeder livestock inventories were
subtracted from the annual cash resource. The initial amount of the real
estate mortgage resource was estimated at 50 percent of the current value
of land holdings minus any outstanding debts against such assets. If the
farm were owned outright, the model allowed real estate credit equal to 100
percent of the land holdings if only other real estate were purchased. The
initial level of the chattel mortgage resource was defined as 60 percent of
the current value of breeding livestock plus 50 percent of the current value
of the machinery inventory less outstanding debts against such livestock and
machinery. The private credit resource was defined as the funds that farm
operators thought they could borrow from individuals, exclusive of public
credit institutions "over and above" amounts that could be obtained from all
public sources of credit. The initial level of this restriction was the
simple average of the private credit that farmers thought they could acquire.
The level of the restriction on land contract credit was determined by the
value and characteristics of land for sale by land contract. A further
explanation and the functioning of these credit resources will be presented
in Chapter IV.

CHAPTER IV

THE LINEAR PROGRAMMING MODEL

Farm adjustments involve changes in farm size, as well as changes in enterprises. Two general types of adjustments may occur: (1) intensive and (2) extensive, and a third may be more likely, which is a combination of both 1 and 2. The intensive adjustments involve investment and expansion in livestock enterprises. These adjustments entail the use of capital for expanding the hog, dairy and beef cattle enterprises on existing land area.

At the extensive margin, adjustment is made by expanding land operated or farm size. Farmers may increase farm size (land area) by renting additional land and/or by purchasing additional land. Whether or not a farmer can and will acquire additional land depends upon several economic and non-economic variables that surround the acquisition of land. Land may be unobtainable by a farmer. First, tracts must be reasonaly accessible to the farmer to farm and economic to acquire. Second, the mobility of land associated durable resources is also an important factor in farm expansion and contraction. There are many other important factors which influence changes in farm sizes. When one farm expands, another or other farms must be contracted or disappear. Thus, farm adjustment studies involve changes in farm size and farm numbers.

Adjustments along the intensive margin, where the land area per farm is fixed, are studied in Phase 1. Phase 2 considers the same activities as Phase 1 plus additional ones dealing with varying the land area. The only essential difference between the two phases relates to the activities and

restrictions associated with acquisition and disposal of land and associated durable resources. This will become more apparent as this chapter progresses.

This chapter continues with a discussion of price projections and products studied. Following that, activities, coefficients and resource requirements are presented and discussed (by major groups of activities) for each phase and each area. In each section of the chapter, some of the deletions and differences in the model for each phase are discussed by areas.

Products and Price Projections[1]

The principal products being studied are corn, hogs and beef cattle. The prices of all products and inputs, except corn, hogs and beef cattle, are projected prices for the period 1963 to 1970, with 1966 the focal point. These projections were made on the basis of current trends. The prices for inputs and products are presented in Table 5 in Appendix A.

The corn price was used as a basis in estimating hog and beef prices. On the basis of current feed grain supplies, the position of the Federal Government with respect to corn prices and the positions taken by various farm groups, it seemed unlikely that the corn price would rise above the 1961 support price level of $1.20 per bushel. The high corn price (average national price) was set at $1.20. The low corn price was set at $.80 per bushel; this is near the free market price projections contained in the Ellender Report, Senate Document No. 77.[2] The middle price for corn was set

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[1]J. N. Ferris of the Dept. of Agricultural Economics of Michigan State University was very helpful in the process of developing these projected prices.

[2]Report from the U.S. Dept. of Agriculture and a Statement from the Land Grant Colleges, IRM 1 Advisory Committee on Farm Price and Income Projections, 1960-65, Senate Document, 77, 86th Congress, 2nd Session (Jan. 20, 1960).

half-way between these two extremes, at $1. Using these national prices, prices for each studied geographic area were computed on the basis of the differentials. The 1961 price support for corn in the Thumb area was four cents above the national support price. Thus, the three assumed price levels for this area are $1.24, $1.04 and $.84 per bushel. The 1961 price support for the South Central area was two cents above the national support price which leads to prices of $1.22, $1.02 and $.82 per bushel for this area.

Hog prices were derived by using the above projected corn prices times the 1955-60 average hog-corn price ratio of 14.8 to 1 (based on Chicago prices for barrows and gilts). This period was chosen for two reasons: (1) The period reflects one complete corn-hog cycle and (2) the period reflects recent seasonal marketing and price patterns. The hog prices were then adjusted by seasonal, quality, class and geographic differences based on historical patterns. In addition, adjustments were made for marketing charges. The resulting prices were $16.57, $13.73 and $10.89 per cwt. for the Thumb area and $16.82, $13.98 and $11.14 per cwt. for the South Central area.

The projected beef prices were derived by the same procedure with an average beef-corn ratio of 20.8 to 1 based on the 1950 to 1960 period. The national average corn price and the Chicago price for choice steers were used to calculate the ratio. Seasonal, class, marketing charges and geographic differentials were used to adjust the prices. The resulting prices were $24.31, $20.20 and $16.08 per cwt. for the Thumb area and $24.56, $20.45 and $16.33 per cwt. for the South Central area.

Phase 1 of the Model

Phase 1 of the model treats land and associated resources as fixed. The linear programming model used for the Thumb area differs from the one used

for the South Central area in the activities associated with crop production and the sale prices of corn, hogs and beef. The costs of renting land and hiring seasonal labor differ, also. Since this is the case, the model for the Thumb area (hereafter referred to as Thumb model) will be presented and only the differences in the model for the South Central area (hereafter referred to as South Central model) will be given.

Thumb Area

The model is presented by the major activity groups such as crops, etc. The activities, resource requirements and net revenues are discussed and presented by sections of the linear programming Tableau (the Model). These sections are presented as numbered tableaus throughout this chapter. All blanks in the tableaus refer to zero entries or coefficients.

Crop Activities[1]

The crop and crop transaction activities included in the Thumb model are dry beans, corn (which can be harvested for grain, as high moisture corn, or as silage), buy corn, sell corn, produce meadow (which can be grazed by livestock or harvested as hay), substitute hay for pasture, buy hay, sell hay, product oats, sugar beets, and wheat. The activities and their resource requirements and net revenues are presented in Tableau I. In all tableaus, negative signs in front of revenues indicate incomes and no signs indicate costs, while negative signs preceeding the coefficients within the tableaus refer to adding to the resource and no signs indicate using the resource.

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[1]The crop enterprises and input-output coefficients were developed through seminars and consultations with K. T. Payne, M. H. Erdmann and S. C. Hildebrand of the Farm Crops Department and L. S. Robertson of the Soil Science Department, Michigan State University.

TABLEAU 1.--CROP ACTIVITIES FOR PHASE 1 – THUMB AREA

Equation No.	Description	Unit	Standing: Beans P1	Standing: Corn P2	Harvest Corn: Grain P3	Harvest Corn: High Moisture P4	Harvest Corn: Silage P5	Buy Corn P6	Sell Corn P7	Soil: Rotation Meadow P8
			Acre	Acre	Acre	Acre	Acre	Bu.	Bu.	Acre
	Revenue	$	-93.30	20.09	3.87	4.20	4.75	Var.	Var.	9.10
1	Bean Acreage Limit	Acres	1							
2	Corn Acreage Limit	Acres		1						
3	Standing Corn Transfer	Acres		-1	-.56	-.56	1			
4	Corn Equivalent	Cwt.				-56		-.56	.56	
5	Corn Silage	Tons					-18			
6	Corn Sales Limit	Bu.			-100				1	
7	Permanent Pasture	Acres								
8	Rotation Meadow	Acres								-1
9	Hay Equivalents	Tons								
10	Hay Sales Limit	Tons								
11	Oat Acreage Limit	Acres								
12	Sugar Beet Contract	Acres								
13	Wheat Acreage Limit	Acres								
14	Capital	$	4.89	10.05	3.87	4.20	4.75	1.09		
15	Cash	$	4.89	10.05	3.87	4.20	4.75	1.09		
24	Annual Labor	Man Hrs.	10.71	5.59	2.73	3.22	8.05			
25	Pd. 1	"								
26	Pd. 2	"	2.83	3.65						
27	Pd. 3	"	4.09	1.94						
28	Pd. 4	"	1.79							
29	Pd. 5	"	2.00							
30	Pd. 6	"			2.73	3.22	8.05			
34	Cropland	Acres	1	1						1
35	Row Crop Limit	Acres	1	1						
50	Silo Capacity	Tons				3.36	18			
51	High Moisture Storage	Tons				3.36				

TABLEAU 1.--continued

Equation No.	Description	Unit	Graze Meadow P9 (Acre)	Harvest Hay P11 (Acre)	Hay for Pasture P12 (Ton)	Buy Hay P13 (Ton)	Sell Hay P14 (Ton)	Oats P15 (Acre)	Sugar Beets P16 (Acre)	Wheat P17 (Acre)
	REVENUE	$	0	5.15	0	20.30	-18.00	15.69	-169.61	-75.42
1	Bean Acreage Limit	Acres								
2	Corn Acreage Limit	Acres								
3	Standing Corn Transfer	Acres								
4	Corn Equivalents	Cwt.						-25.20		
5	Corn Silage	Tons								
6	Corn Sales Limit	Bu.						-46		
7	Permanent Pasture	Acres	-2		-1					
8	Rotation Meadow	Acres	1	1						
9	Hay Equivalents	Tons		-3	1	-1	1			
10	Hay Sales Limit	Tons		-3			1			
11	Oat Acreage Limit	Acres						1		
12	Sugar Beet Contract	Acres							1	
13	Wheat Acreage Limit	Acres								1
14	Capital	$		5.15		20.30			35.97	18.58
15	Cash	$		5.15		20.30			35.97	18.58
24	Annual Labor	Man hrs.		14.23		1.30		7.36	16.74	3.79
25	Pd. 1	"								
26	Pd. 2	"		10.47				4.75	2.28	.60
27	Pd. 3	"						1.63	2.34	1.95
28	Pd. 4	"						.98		.34
29	Pd. 5	"		3.76					6.27	.90
30	Pd. 6	"							5.85	
34	Cropland	Acres						1	1	1
35	Row Crop Limit	Acres							1	
50	Silo Capacity	Tons								
5	High Moisture Storage	Tons								

Bean acreage (equation 1) was restricted to 50 percent of the cropland on the representative farms due to the assumed rotation for the Thumb area. The row crop limit (equation 2) was estimated on the basis of current rotation and cropping practices of the farmers. Corn acreage was restricted to one-half of the cropland or the 1960 acreage, whichever was greater. The wheat acreage was limited to 15 acres or the 1960 acreage, depending upon which was greater. The initial levels for the capital restriction and the cash restriction were the same for a given representative farm, but the distinction between these two restrictions is made when the production and credit activities affect these restrictions. The capital equation is defined as the cash on hand plus borrowed credit from which full purchase prices for inputs and other resources are drawn. The cash equation operates as a liquid cash resource from which current operating expenses and only the down payment, in the case of investments, are drawn.

In the Thumb model the bean activity (P_1) refers to dry beans. This activity nets $93.30 and uses one acre of the bean limit, $4.89 capital and cash (equations 14 and 15), 10.71 man hours of labor for the year (which is distributed by periods used), one acre of cropland, and one acre of the row crop limit.

One acre of standing corn (P_2) uses one acre of the corn acreage limit, $10.05 capital and cash, 5.59 hours of labor, one acre of cropland, one acre of row crop limit, and furnishes one acre of standing corn which can either be harvested for grain (P_3) or high moisture corn (P_4) or silage (P_5). These activities use up resources and furnish some dry grain, high moisture grain and silage which can be consumed by the livestock enterprises. Only dry corn can be sold. All other crop activities use and furnish resources in a similar way. Thus, similar interpretations apply.

Credit Activities

The group of credit activities for the Thumb model includes: surplus cash to savings account, borrowing real estate mortgage, borrowing chattel mortgage, and borrowing private credit. These activities are stated in Tableau 2.

TABLEAU 2.--CREDIT ACTIVITIES FOR PHASE 1

Equation No.	Description	Unit	Savings Account P_{18}	Borrow Real Estate Mortgage P_{19}	Borrow Chattel Mortgage P_{20}	Borrow Private Credit P_{23}
			$	$	$	$
	REVENUE	$	-.04	.055	.07	.047
14	Capital	$	1	-.945	-.93	-.953
15	Cash	$	1	-.945	-.93	-.953
16	Real Estate Mortgage	$		1		
17	Chattel Mortgage	$			1	
19	Private Credit Limit	$				1
23	All Chattel Mortgage	$			1	

The savings activity (P_{18}) returns four cents per dollar deposited and uses $1 of capital and $1 of cash. The real estate mortgage credit (P_{19}) costs $.055 per dollar of credit and adds $.945 capital and cash while using up $1 of the credit limit. Chattel credit (P_{20}) costs $.07 per dollar borrowed and furnishes $.93 to capital and cash. This activity uses one unit of the chattel mortgage (equation 17) and one unit of the all chattel mortgage limit (equation 23).

The real estate mortgage borrowing is limited to 50 percent of the gross real estate value less all outstanding debts against real estate. The initial chattel mortgage restriction limits the representative farm to 50 percent of the value of machinery, equipment and to 50 percent of the value of livestock except feeder stock and hogs. The all chattel mortgage limit

equals the initial chattel credit limit (equation 17) plus the chattel which can be borrowed against corn produced on the farm. This restriction was introduced to prevent the representative farm from acquiring 100 percent credit on feeder stock unless the farm had the corn or feed to feed the stock. Such credit availability is not unusual.

Labor Activities

The labor activities in Phase 1 of the model provide for hiring seasonal labor by periods of the year. These activities hire labor to add to the family labor (equations or restrictions 24-30) if the family labor supply is used up and it is profitable to do so. The units are defined in terms of man hour equivalents or operator hours. It was assumed that on the average, one hour of seasonal labor would equal .6 hour of operator labor. These activities are presented in Tableau 3.

TABLEAU 3.--SEASONAL LABOR HIRING ACTIVITIES - THUMB AREA

Equa-tion No.	Description	Unit	Hire Seasonal Labor (man hour)					
			Pd. 1 P_{25}	Pd. 2 P_{26}	Pd. 3 P_{27}	Pd. 4 P_{28}	Pd. 5 P_{29}	Pd. 6 P_{30}
	REVENUE	$	2.02	2.02	2.02	2.02	2.02	2.02
14	Capital	$	2.02	2.02	2.02	2.02	2.02	2.02
15	Cash	$	2.02	2.02	2.02	2.02	2.02	2.02
24	Annual Labor	Man hrs.	-1	-1	-1	-1	-1	-1
25	Period 1 Labor	Man hrs.	-1					
26	Period 2 "	Man hrs.		-1				
27	Period 3 "	Man hrs.			-1			
28	Period 4 "	Man hrs.				-1		
29	Period 5 "	Man hrs.					-1	
30	Period 6 "	Man hrs.						-1

Land Activity

In Phase 1 land was held constant at the 1960 acreages. However, the

farm is allowed to rent land by a land rent-in activity. The farm is allowed
to rent in the same quantity of land as it was in 1960.

The land rent-in activity costs per unit varies with the price of the
crops grown since the rent is on a share basis of one-third and two-thirds
(one-third to the landlord for rent). One acre of the land rent in activity
is treated the same as one acre of owned cropland in all other respects in
Phase 1.

Beef Cattle Enterprise[1]

The possible beef enterprises included in the model are presented in
Tableau 4 by activities (P_{64} through P_{95}). There are essentially two sets
of beef activities with one using silage and the other not using silage.
They differ only in the coefficients of the corn equivalent, roughage equiva-
lent and corn silage equations. One set of these livestock activities is
based on rations which include only corn equivalents and roughage equivalents,
and completely omits corn silage. The second set is based on rations includ-
ing corn equivalents, roughage equivalents, and corn silage in which the sub-
stitution of corn silage for both corn and roughage equivalents is taken into
account in the specification of the coefficients.

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[1]The budgets for the beef activities were developed from the follow-
ing sources: (1) "Beef Coefficients for NC-54," assembled and prepared by
G. E. Schuh, Agricultural Economics Department, University of Purdue,
Lafayette, Indiana, 1962; (2) K. T. Wright, "Cattle Feeding Economics,"
Quarterly Bulletin, Vol. 44, No. 4, Agricultural Experiment Station, Michi-
gan State University, East Lansing, Michigan, May 1962; (3) "Nutrient Require-
ments in Beef Cattle," Publication 579, prepared by the Committee on Animal
Nutrition of the National Academy of Sciences-National Research Council,
Washington, D.C., 1959; and (4) Hugh E. Henderson, "Beef Feeding Programs--
Annual Feed Requirements," Fact Sheet for Michigan Agriculture, Michigan
Agricultural Experiment Station, East Lansing, Michigan. These activities
were presented to applied agricultural scientists for their evaluation.
J. A. Hoefer and H. W. Newland of the Animal Husbandry Department of Michi-
gan State University were very helpful in setting up these activities. Also,
Farm Management personnel of the Dept. of Agricultural Economics at M.S.U.
were very helpful in formulating these activities.

TABLEAU 4.—BEEF CATTLE ACTIVITIES

Equation No.	Description	Unit	Beef Cow Herd P64 (cow)	Low Mechanization Without Silage — Calf Systems — Drylot P65 (head)	Pasture P66 (head)	Deferred P67 (head)	Drylot Yearlings Period 1 P68 (head)	Period 2 P69 (head)	Low Mech. Silage — Calf Drylot P70 (head)	Yearlings Pd. 1 P71 (head)	Pd. 2 P72 (head)
	REVENUE	$	11.54	17.70	7.94	8.23	8.96	8.96	21.80	11.55	11.55
4	Corn Equivalents	Cwt.	2.69	35.00	30.35	30.58	21.50	21.50	26.76	16.77	16.77
5	Corn Silage	Tons							3.68	2.11	2.11
7	Permanent Pasture	Acres	3		1	2					
9	Hay Equivalents	Tons	2	.94	.74	.97	.21	.21	.39		
14	Capital	$	11.54	17.70	7.94	8.23	72.26	71.50	21.80	73.55	72.80
15	Cash	$	11.54	17.70	7.94	8.23	72.26	71.50	21.80	73.55	72.80
16	Real Estate Mort.	$									
17	Chattel Mortgage	$	-266.89				-67.77	-67.02	-67.02	-67.77	-67.02
24	Annual Labor	Man hrs.	20.00	9.58	7.73	7.86	5.28	5.28	9.58	5.28	5.28
25	Period 1 Labor	"	10.44	2.32	2.94	3.02	3.52		2.32	3.52	
26	Period 2	"	3.86	2.62	1.29	1.21	.22	1.54	2.62	.22	1.54
27	Period 3	"	1.04	1.96	1.03	.97	1.76	1.76	1.96		1.76
28	Period 4	"	.62	.90	.51	.54	.90	.90	.90		.90
29	Period 5	"	1.32	.89	.93	1.02	1.08	1.08	.89		1.08
30	Period 6	"	2.72	.89	1.03	1.10			.89		
52	Beef Housing Pd. 1	Animal	1	.65	.65	.65	1.54				
53	" Pd. 2	"		.65	.65	.65	.65	.65			
54	Low Mech. Fac. Pd.1	"							.65	1.54	
55	" Pd.2	"							.65	.65	.65
56	High " Pd.1	"									
57	" Pd.2	"									
58	Beef Calves	Head	-.79	1	1	1			1		
59	Beef Sales	Cwt.	-.98	-11.39	-10.67	-10.49	-4.15	-4.11	-11.39	-4.15	-4.11
60	Beef Cow	Head	1								

TABLEAU 4.—continued

Equation No.	Description	Unit	Dairy Beef Without Silage				Dairy Beef With Silage		
			Calf DryLot P73	Pasture P74	Drylot Yearlings Period 1 P75	Period 2 P76	Calf DryLot P77	Drylot Yearlings Period 1 P78	Period 2 P79
			head	head	head	head	head	head	head
	REVENUE	$	2.41	4.61	2.51	2.51	24.65	11.55	11.55
4	Corn Equivalents	Cwt.	16.20	18.90	9.72	9.72	7.56	4.95	4.95
5	Corn Silage	Tons							
7	Permanent Pasture	Acres		1					
9	Hay Equivalents	Tons	2.52	1.38	1.53	1.53			
14	Capital	$	71.42	73.62	57.80	57.17	93.66	62.32	61.69
15	Cash	$	71.42	73.62	57.80	57.17	93.66	62.32	61.69
16	Real Estate Mortgage	$	-69.01	-69.01	-56.55	-55.91	-69.01	-56.55	-55.91
17	Chattel Mortgage	$	9.58	7.09	5.28	5.28	9.58	5.28	5.28
24	Annual Labor	Man hrs.							
25	Period 1 Labor		2.32	2.94	3.52	1.54	2.32	3.52	1.54
26	Period 2 Labor		2.62	1.04	.22	1.76	2.62	.22	1.76
27	Period 3 Labor		1.96	.64		.90	1.96		.90
28	Period 4 Labor		.90	.51		1.08	.90		1.08
29	Period 5 Labor		.89	.93	1.54		.89	1.54	
30	Period 6 Labor		.89	1.03	.65		.89	.65	
52	Beef Housing Pd. 1	Animal	.65	.65			.65		
53	Beef Housing Pd. 2		.65	.65	.65	.65	.65	.65	.65
54	Low Mech.Fac.Pd. 1		.65	.65			.65		
55	" " " Pd. 2		.65	.65	.65	.65	.65	.65	.65
56	High " " Pd. 1								
57	" " " Pd. 2								
58	Beef Calves	Head							
59	Beef Sales	Cwt.	-5.15	-5.33	-2.94	-2.91	-5.15	-2.94	-2.91
60	Beef Cow	Head							

TABLEAU 4.—continued

Équation No. / Description	Unit	High Mechanization Without Silage — Calf Systems — Drylot : Pasture — P80	Pasture — P81	Deferred: Period 1 — P82	Period 2 — P83	Drylot Yearlings 1: Period 1 — P84	High Mech. With Silage — Drylot : Calf — P85	Drylot Yearlings 1: Period 1 — P86	Period 2 — P87
		head	head	head	head	head	head	head	head
REVENUE	$	18.54	8.83	30.58	9.49	9.49	22.64	12.08	12.08
4 Corn Equivalents	Cwt.	35.00	30.35	30.58	21.50	21.50	26.76	16.77	16.77
5 Corn Silage	Tons			2			3.68	2.11	2.11
7 Permanent Pasture	Acres								
9 Hay Equivalents	Tons	.94	.74	.97	.21	.21	.39		
14 Capital	$	18.54	8.83	9.16	72.55	71.76	22.64	73.81	73.06
15 Cash	$	18.54	8.83	9.16	72.55	71.76	22.64	73.81	73.06
16 Real Estate Mortgage	$								
17 Chattel Mortgage	$				-67.77	-67.02		-67.77	-67.02
24 Annual Labor	Man hrs.	6.42	5.18	5.27	3.54	3.54	6.42	3.54	3.54
25 Period 1 Labor		1.55	1.97	2.02	2.36	2.36	1.55	2.36	2.36
27 Period 2 Labor		1.75	.87	.81	.15	.15	1.75	.15	.15
28 Period 3 Labor		1.32	.69	.65			1.32		
29 Period 4 Labor		.60	.34	.36			.60		
30 Period 5 Labor		.60	.62	.69	1.03	.60	.60	1.03	.60
Period 6 Labor		.60	.69	.74	.65	.73	.60	.65	.73
52 Beef Housing Pd. 1	Animal	.65	.65	.65	1.03	.65	.65	1.03	.65
53 Beef Housing Pd. 2		.65	.65	.65	.65		.65	.65	
54 Low Mech.Fac. Pd. 1									
55 Pd. 2									
56 High Pd. 1		.65	.65	.65	.65	.65	.65	.65	.65
57 Pd. 2		.65	.65	.65			.65		
58 Beef Calves	Head	1	1	1	.65	.65	1	.65	.65
59 Beef Sales	Cwt.	-11.39	-10.67	-10.49	-4.15	-4.11	-11.39	-4.15	-4.11
60 Beef Cow	Head								

TABLEAU 4.—continued

Equa- tion No.	Description	Unit	Buy Beef Cow P88 : head	Sell Beef Cow P89 : head	Buy Feeder Calf P90 : head	Sell Feeder Calf P91 : head	Sell Beef P92 : cwt.	Beef Housing P93 : animal unit	Investment Low Mech. Feed. Fac. P94 : animal unit	High Mech. Feed. Fac. P95 : animal unit
	REVENUE	$	20.48	-20.48	0	0	0 Var.	3.81	1.42	6.43
4	Corn Equivalents	Cwt.								
5	Corn Silage	Tons								
7	Permanent Pasture	Acres								
9	Hay Equivalents	Tons								
14	Capital	$	290.50	-237.50	95.89			77.66	13.54	89.26
15	Cash	$	290.50	-237.50	95.89			19.42	3.38	22.32
16	Real Estate Mortgage	$						-27.18	-10.16	-66.94
17	Chattel Mortgage	$	142.50	-95.89	95.89					
24	Annual Labor	Man hrs.								
25	Period 1 Labor	"								
26	Period 2 Labor	"								
27	Period 3 Labor	"								
28	Period 4 Labor	"								
29	Period 5 Labor	"								
30	Period 6 Labor	"								
52	Beef Housing, Pd. 1	Animal						-1		
53	" Pd. 2	"						-1		
54	Low Mech.Fac. Pd. 1	"							-1	
55	" " " Pd. 2	"							-1	
56	High " " Pd. 1	"								-1
57	" " " Pd. 2	"								-1
58	Beef Calves	Head			-1	4.63				
59	Beef Sales	Cwt.				-4.63	1			
60	Beef Cow	Head	-1	1		4.63	1			

Within each set, there are two levels of mechanization or feeding facilities; low and high, allowed in the model. Low mechanization corresponds to the conventional methods (by and large the ones found on surveyed farms in 1961) of feed handling used in conjunction with beef feeding enterprises (P_{65} through P_{79}). High mechanization (activities P_{80} to P_{87}) corresponds to metered feed handling and conveyor systems for distribution to the feedlot.

The beef activities provide for the possibility of a beef cow-calf enterprise (P_{64}) and several alternative methods of feeding out these calves and/or purchased feeder calves or yearlings. The various feeding systems include: (1) Calves fed on drylot; (2) calves fed on pasture; (3) calves fed on a deferred feeding system; (4) dairy calves on drylot; (5) dairy calves on pasture; and (6) two possible drylot yearling (beef steers and dairy steers) feeder systems that differ only by time of year the animals are fed out. In the model, the possibilities for the purchase of feeder calves is included (P_{90}) and to sell raised feeder calves (activity 91) or these raised feeder calves can be fed out through one of the possible calf feeding systems. Activity P_{92} refers to the sale of a specific grade of beef (choice steers) marketed at a specific point in time within the year. Beef cow herd expansion and liquidation are handled by activities P_{88} and P_{89}, respectively.

Equation 59 is in effect an intermediate product equation for beef which accounts for the production of beef from all the alternative beef activities. In order for one equation and one activity to handle beef sales, the beef is measured in a standard unit. Price was used as the weight to convert the output of the various activities to the standard unit. In cases where feeder calves or yearlings are purchased, only the net gain put on the animal is counted as beef produced and for sale. However, the purchase price of the purchased feeder is included in the model since the opportunity costs of the capital must be taken into account.

Dairy Enterprise[1]

Phase 1 includes dairy activities representing the (a) stanchion milking system, currently most prevalent, (b) parlor-loose housing arrangement, (c) expansion and contraction of the dairy herd, and (d) investment in new capacity or facilities for both types of milking systems. The Grade A production alternatives, parlor and stanchion, differ only with respect to labor and investment requirements. The dairy activities are presented in Tableau 5.

Each unit (1 cow) of the Grade A production activity produces 11,500 pounds of milk (3.5 percent fat corrected milk), .475 of a deacon, .225 of a cull heifer, .25 replacement heifer, and 300 pounds of a cull cow (a 95 percent calf crop, 2.5 percent death loss on replacement heifers until first lactation, and a 25 percent culling rate for cows were assumed).

The Grade A stanchion and parlor systems were not alternatives in the same problem since in reality mixed facilities are not a common practice. Also, stanchion systems are not recommended for farmers going into dairying. In addition, it was agreed by the NC-54 Committee that dairying would not be treated in detail since the Lake States Dairy Study was in progress. If the representative farm had Grade A stanchion dairy facilities, it was allowed the choice of producing under a stanchion system and investing in more stanchions. If there were no Grade A facilities on the representative farm, the parlor alternative was the system introduced into the model.

One unit of the dairy production activity (P_{96}) uses 38 cwt. of corn

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[1]The budgets for the dairy production activities were derived from the following sources: (1) H. J. Aune and L. M. Day, "Effects of Herd Size on Dairy Chore Labor," Bull. 449, Minn. Agri. Expt. St., St. Paul, Minn.; (2) E. I. Fuller and H. R. Jensen, "Alternative Dairy Chore Systems in Loose Housing," Bull. 457, Minn. Agri. Expt. St., St. Paul, Minn., Feb. 1962; (3) K. T. Wright, "Dairy Feed Costs and Returns," Agri. Econ. Mimeo. 874, Dept. of Agr. Econ., Mich. State Univ., East Lansing, Mich., July, 1962; and (4) consultations with K. T. Wright and C. R. Hoglund of the Agr. Econ. Dept., and L. D. Brown, D. Hillman and W. J. Thomas of the Dairy Dept. of M.S.U.

TABLEAU 5.--GRADE A DAIRY ACTIVITIES

Equa-tion No.	Description	Unit	Dairy Stanchion: Parlor P96	Dairy Stanchion: Parlor P97	Dairy Cow Buy P98	Dairy Cow Sell P99	Investment Stanchion P100	Investment Parlor P101	Transfer Housing P106
			cow	cow	cow	cow	cow	cow	animal unit
	REVENUE	$	-396.33	-396.33	38.12	-38.12	87.68	77.43	0
4	Corn Equivalents	Cwt.	38	38					
5	Corn Silage	Tons	5.40	5.40					
7	Permanent Pasture	Acres	2.77	2.77					
9	Hay Equivalents	Tons	3.28	3.28					
14	Capital	$	-198.00	-198.00	442.50		729	632	
15	Cash	$	-198.00	-198.00	442.50	-374	182	158	
16	Real Estate Mortgage	$			-221.25	-374	-365	-316	
17	Chattel Mortgage	$				187			
24	Annual Labor	Man hrs.	79.27	62.81					
25	Period 1 Labor	Man hrs.	31.95	23.14					
26	Period 2 Labor	Man hrs.	13.43	10.68					
27	Period 3 Labor	Man hrs.	10.29	9.24					
28	Period 4 Labor	Man hrs.	5.23	4.70					
29	Period 5 Labor	Man hrs.	7.69	6.92					
30	Period 6 Labor	Man hrs.	10.68	8.13					
59	Beef Sales	Cwt.	-3.55	-3.55					
61	Milk Cows	Head	1	1	-1	1			
62	Dairy Capacity	Cow	1	1			-1	-1	1

equivalents, 5.4 tons silage, 2.77 acres permanent pasture, 3.28 tons hay

equivalents, 79.27 man hours of labor (distributed by periods 1 through 6),

one cow, and one unit of dairy capacity. One unit of the activity nets

$396.33 and furnishes $198 which can be used for operating expenses (increases

capital and cash by $198) and 3.55 cwt. of beef to be sold through the stan-

dard unit beef activity. Activity (P_{97}), parlor system, differs from (P_{96})

in the labor requirements. Activities (P_{98}) and (P_{99}) provide the possibility

for expansion or contraction of the dairy herd. The net revenue in these

activities is the average annual depreciation of the cow, not including the

young stock. The entries in the cash and capital equations in these activities

include the requirements for the young stock as well as the cow.

The investment in new stanchion or parlor facilities is provided for

in activities $(P_{100}$ and $P_{101})$. These activities have net costs or revenues

which are composed of annual charges, and the full cost per unit is given in

the capital equation with only the down payment occurring in the cash equa-

tion. Activity (P_{106}) provides for the transfer of dairy housing, without

additional costs, to beef housing when dairy housing is not used by the

dairy production activities.

Swine Enterprise[1]

In the model, the hog activities include (1) different combinations

(activities P_{108} through $P_{119})$ of central and portable one-litter sow systems,

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[1]The budgets for the hog production activities were prepared from the following sources: (1) "Hog Coefficients," assembled and prepared by E. R. Swanson, Agr. Econ. Dept., Univ. of Ill., Urbana, Ill., 1962; (2) "Funda-mentals of Swine Nutrition," by J. A. Hoefer, Animal Husbandry Dept., Mich. State Univ., East Lansing, Mich., Feb. 1961; (3) K. T. Wright, "Hog Feeding Costs and Returns," Agr. Econ. Mimeo. 869, Dept. of Agr. Econ., Mich. St. Univ., E. Lansing, Mich., May 1962; and (4) R. A. Bailey and J. H. Sitterley, "Man Labor on the Commercial Hog Enterprise," Research Bull. 792, Ohio Agr. Expt. St., Wooster, Ohio, Sept. 1957. Seminars and consultations with J. A. Hoefer, J. N. Ferris and K. T. Wright of M.S.U. were very helpful in setting up these hog activities, as were farm management personnel.

(2) **activities** for investment in different types of farrowing and finishing facilities (activities P_{120} to P_{123}), (3) a hog sales activity (P_{124}), and (4) a series of feeder pigs activities (P_{125} through P_{132}) which provide for the alternatives of purchasing and feeding of feeder pigs separate from the farrowing phase of the enterprise. See Tableau 6 for the details of these activities.

The production activities (P_{108} through P_{119}) are stated as series of one-litter hog systems which include both the farrowing and finishing phases of the enterprise. The activities differ as to the time of the year that sows are farrowed and type of facilities and equipment used. The model permits the possibility of a continuous hog program involving a maximum of four different farrowings within the year. The model permits complete flexibility as to the number of sows farrowed in any one quarter of the year (within the other restrictions). All farrowings occur at the middle of each quarter of the year. Both permanent and portable facilities are included in the model.

Activities (P_{108} to P_{111}) provide for quarterly hog production under a central farrowing and central finishing system. For example, one unit of (P_{108}) uses 61.71 cwt. of corn equivalents, \$50.27 capital and cash, 13.34 man hours labor (distributed by periods on the basis of farrowings occurring at the midpoint of each quarter), one unit of confinement farrowing facilities, and eight units of confinement finishing facilities in quarters one and two. The activity has a net revenue of \$71.72 and contributes \$33.57 chattel credit and 19.75 cwt. of hogs for sale per unit of the activity. The hogs for sale include seven hogs at 210 pounds each and a cull sow weighing 400 pounds which are all sold through the hog sales activity in a standard unit (average of U.S. 1, 2 and 3 hogs). Activities (P_{112} through P_{119}) can be interpreted in a similar way.

TABLEAU 6.--HOG ACTIVITIES

Equa-tion No.	Description	Unit		Central Farrowing & Finishing				Central Farrow. & Portable Finishing			
				Qu. 1 P103 sow	Qu. 2 P109 sow	Qu. 3 P110 sow	Qu. 4 P111 sow	Qu. 1 P112 sow	Qu. 2 P113 sow	Qu. 3 P114 sow	Qu. 4 P115 sow
	REVENUE	$		71.72	71.72	71.72	71.72	70.98	70.98	72.50	72.20
4	Corn Equivalents	Cwt.		61.71	61.71	61.71	61.71	61.90	61.71	65.45	63.49
8	Rotation Meadow	Acres						.13	.13	.13	.13
14	Capital	$		50.27	50.52	52.44	52.39	49.40	50.14	52.83	51.63
15	Cash	$		50.27	50.52	52.44	52.39	49.40	50.14	52.83	51.63
16	Real Estate Mortgage	$									
17	Chattel Mortgage	$		-33.57	-29.28	-29.76	-33.65	-33.57	-29.28	-29.76	-33.65
24	Annual Labor	Man hrs.		13.34	13.34	13.34	13.34	14.38	14.68	13.63	13.34
25	Period 1 Labor	"		5.30	1.10	4.23	6.50	6.35	2.00	4.23	6.50
26	Period 2 "	"		3.25	3.23	.54	2.50	3.25	3.68	.84	2.50
27	Period 3 "	"		3.00	3.50	.99	.46	3.00	3.50	.99	.46
28	Period 4 "	"		1.00	1.50	2.56	.32	1.00	1.50	2.56	.32
29	Period 5 "	"		.34	2.25	2.64	.05	.34	2.25	2.64	.65
30	Period 6 "	"		.44	1.75	2.37	2.90	.44	1.75	2.37	2.90
66	C. Farrowing Cap. Qu.1	Sow		1				1			
67	C. " Qu.2	Sow			1				1		
68	C. " Qu.3	Sow				1				1	
69	C. " Qu.4	Sow					1				1
70	Portable Far. Qu.1	Sow									
71	" " Qu.2	Sow									
72	" " Qu.3	Sow									
73	" " Qu.4	Sow									
74	Central Feed. Qu.1	Head		8			8				
75	" " Qu.2	Head		8	8						
76	" " Qu.3	Head			8	8					
77	" " Qu.4	Head				8	8				
78	Portable Qu.1	Head						8			8
79	" Qu.2	Head						8	8		
80	" Qu.3	Head							8	8	
81	" Qu.4	Head								8	8
82	Hog Sales	Cwt.		-19.75	-17.88	-17.59	-19.56	-19.75	-17.88	-17.59	-19.56

TABLEAU 6.--continued

Equa-tion No.	Description	Unit	Portable Farrowing & Finishing: Qu. 1 P116 (Sow)	Qu. 2 P117 (Sow)	Qu. 3 P113 (Sow)	Qu. 4 P119 (Sow)	Invest in Facilities: Farrowing Cent. P120 (Sow)	Farrowing Port. P121 (Sow)	Finishing Cent. P122 (head)	Finishing Port. P123 (head)
	REVENUE	$	70.89	70.98	72.50	70.20	24.55	27.72	3.66	2.45
4	Corn Equivalents	Cwt.	61.90	61.71	65.45	63.49				
8	Rotation Meadow	Acres	.16	.16	.16	.16				
14	Capital	$	49.40	50.14	52.83	51.63	272.80	130	40.70	17.46
15	Cash	$	49.40	50.14	52.83	51.63	68.20	65	10.18	5.82
16	Real Estate Mortgage	$					-204.60		-29.52	
17	Chattel Mortgage	$	-33.57	-29.28	-29.76	-33.65		-132		-11.64
24	Annual Labor	Man hrs.	14.72	15.02	13.97	13.67				
25	Period 1 Labor	Man hrs.	6.69	2.00	4.23	6.60				
26	Period 2 "	Man hrs.	3.25	3.83	.83	2.50				
27	Period 3 "	Man hrs.	3.00	3.69	.99	.46				
28	Period 4 "	Man hrs.	1.00	1.50	2.82	.32				
29	Period 5 "	Man hrs.	.34	2.25	2.72	.65				
30	Period 6 "	Man hrs.	.44	1.75	2.37	3.14				
66	C. Farrowing Cap. Qu.1	Sow					-1			
67	C. " " Qu.2	Sow					-1			
68	C. " " Qu.3	Sow					-1			
69	C. " " Qu.4	Sow					-1			
70	Portable Far. " Qu.1	Sow	1					-1		
71	" " Qu.2	Sow		1				-1		
72	" " Qu.3	Sow			1			-1		
73	" " Qu.4	Sow				1		-1		
74	Central Feeding Cap. Qu.1	Head							-1	
75	" " Qu.2	Head							-1	
76	" " Qu.3	Head							-1	
77	" " Qu.4	Head							-1	
78	Portable " Qu.1	Head	8							-1
79	" " Qu.2	Head		8						-1
80	" " Qu.3	Head			8					-1
81	" " Qu.4	Head				8				-1
82	Hog Sales	Cwt.	-19.75	-17.88	-17.59	-19.56				

TABLEAU 6.--Continued

Equa-tion No.	Description	Unit	Sell Hogs P_124	Purchase and Finishing Feeder Pigs — Confinement Finishing				Purchase and Finishing Feeder Pigs — Portable Finishing			
				Qu.1 P_125	Qu.2 P_126	Qu.3 P_127	Qu.4 P_128	Qu.1 P_129	Qu.2 P_130	Qu.3 P_131	Qu.4 P_132
		($)	var.	7.50	7.50	7.50	7.50	7.46	7.46	7.59	7.38
			cwt.	head	head	head	head	head	head	head	head
	REVENUE	$	var.								
4	Corn Equivalents	Cwt.		5.61	5.61	5.61	5.61	5.63	5.61	5.95	5.76
8	Rotation Meadow	Acres						.015	.015	.015	.015
14	Capital	$		6.70	6.18	6.22	6.71	6.72	6.15	6.25	6.67
15	Cash	$		6.70	6.18	6.22	6.71	6.72	6.15	6.25	6.67
16	Real Estate Mortgage	$									
17	Chattel Mortgage	$		-4.20	-3.66	-3.72	-4.21	-4.20	-3.66	-3.72	-4.21
24	Annual Labor	Man hrs.		.88	.88	.88	.88	.88	.88	.88	.88
25	Period 1 Labor	Man hrs.		.60			.47	.60			.47
26	Period 2 "	Man hrs.		.28	.41			.28	.41		
27	Period 3 "	Man hrs.			.37	.22			.37	.22	
28	Period 4 "	Man hrs.			.10	.19			.10	.19	
29	Period 5 "	Man hrs.				.28	.11			.28	.11
30	Period 6 "	Man hrs.				.19	.30			.19	.30
66	C. Farrowing Cap. Qu.1	Sow									
67	C. " Qu.2	Sow									
68	C. " Qu.3	Sow									
69	C. " Qu.4	Sow									
70	Portable Far. " Qu.1	Sow									
71	" " Qu.2	Sow									
72	" " Qu.3	Sow									
73	" " Qu.4	Sow									
74	Central Feeding Cap. Qu.1	Head		1			1				
75	" " Qu.2	Head		1	1						
76	" " Qu.3	Head			1	1					
77	" " Qu.4	Head				1	1				
78	Portable " Qu.1	Head						1			1
79	" " Qu.2	Head						1	1		
80	" " Qu.3	Head							1	1	
81	" " Qu.4	Head								1	1
82	Hog Sales	Cwt.	1	-1.43	-1.24	-1.26	-1.43	-1.43	-1.24	-1.26	-1.43

Activities (P_{120}) and (P_{121}) provide for expansion of central and portable farrowing facilities, respectively. For an example, (P_{120}) furnishes one unit of central farrowing capacity for quarters one through four and has an annual cost of $24.55 with a full purchase price of $272.80 and $68.20 as a down payment per unit. The investment activities (P_{122}) and (P_{123}) for feeding facilities are interpreted similarly except they are on a per pig basis. It is assumed in the model that the central facilities contribute real estate mortgage credit, and the portable facilities contribute chattel mortgage credit.

The hog sales activity (P_{124}) operates the same way as the beef sales activity. It accounts for all the pork sold and uses cwts. of hogs contributed to the hog sales equation by the different producing activities. It is stated in terms of a standard unit based on U.S. 1, 2 and 3 barrow and gilt prices.

Activities (P_{125} and P_{128}) are purchased feeder pig systems using confinement finishing facilities. These activities are stated on a per head basis and the cost of purchasing is handled similarly to purchased beef feeder cattle, i.e., only the net gain put on the pig is counted in the hog sales equation and activity, while the capital and cash expenses (on a year equivalent basis) occur in the capital and cash equations. For an example of how these activities are interpreted, (P_{125}) has a net cost of $7.50 and uses 5.61 cwt. of corn, $6.70 of capital and cash, .88 hours of labor, and one unit of central feeding capacity for quarters 1 and 2. Activities (P_{129} through P_{132}) are portable finishing of purchased feeder pigs. These activities are interpreted similarly to activity (P_{125}) except these use some rotation meadow.

South Central Area

Phase 1 for the South Central area differs from that for the Thumb model in the crop activities and prices for seasonal hired labor, private credit, rented land, corn, beef cattle and hogs. In addition, Grade B

dairy production is permitted on existing Grade B dairy farms which were a little more common on the small and medium dairy representative farms than was Grade A. These farms were also permitted the opportunity to salvage their Grade B operations and expand Grade A since many of the farms making up the representative farm had Grade A facilities already. Since the Small and Medium representative Dairy farms were treated this way, their optimal organizations will require special interpretation because of the possible non-practical organization that may result.

This section presents the differences between the South Central model and the Thumb model, by major activity groups. Those parts of the Thumb model not presented are the same for both areas.

Crop Activities[1]

The crop activities for the South Central area differ from those for the Thumb mainly because of the differences in soils and adaptability of crops. Many of the inputs are similar but the yields and machinery used are considerably different. For crops grown in both areas, yields in the Thumb are much greater. For example, the assumed corn yields are 100 bushels and 80 bushels for the Thumb and South Central areas, respectively.

Dry beans, high moisture corn harvest (P_4) and sugar beet (P_{16}) activities were not included in the South Central model. All legume roughage production and transfer activities were assumed to be the same for both areas since in one area the production advantage is off-set by a somewhat shorter growing season. All other crop activities are different for the South Central area. These crop activities are presented in Tableau 7.

The soybean activity (P_1) nets $35.32 and uses one acre of the bean

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[1]The budgets for the crop activities were developed from seminars and consultations with personnel from the Soil Science and Farm Crops Departments at Michigan State University.

TABLEAU 7.—CROP ACTIVITIES SPECIFIC TO THE SOUTH CENTRAL AREA

Equation No.	Description	Unit	Soy-beans P_1	Stand. Corn P_2	Harvest Corn Grain P_3	Harvest Corn Silage P_5	Buy Corn P_6	Sell Corn P_7	Oats P_{15}	Wheat P_{17}
	REVENUE	$	-35.32	22.52	2.91	4.75	var.	var.	20.79	-48.32
1	Bean Acreage Limit	Acres	1							
2	Corn Acreage Limit	Acres		1						
3	Standing Corn	Acres		-1		1				
4	Corn Equivalents	Cwt.			-44.8		-.56	.56	-18.85	
5	Corn Silage	Tons				-15				
6	Corn Sales	Bu.			-80			1	-37	
11	Small Grain Limit	Acres							1	
13	Wheat Acreage Limit	Acres								1
14	Capital	$	6.57	11.26	2.91	4.75	1.07		6.92	20.76
15	Cash	$	6.57	11.26	2.91	4.75	1.07		6.92	20.76
24	Annual Labor	Man hrs.	8.08	7.01	2.24	7.58			7.56	4.77
25	Period 1 Labor	Man hrs.								.30
26	Period 2 "	Man hrs.	2.85	4.61					4.75	.30
27	Period 3 "	Man hrs.	2.77	2.40					1.64	2.34
28	Period 4 "	Man hrs.							1.17	.45
29	Period 5 "	Man hrs.	.66							1.38
30	Period 6 "	Man hrs.	1.80		2.24	7.58				
34	Cropland Limit	Acres	1	1					1	
35	Row Crop Limit	Acres	1	1						
50	Silo Capacity	Tons				15				

limit, $6.57 of capital and cash, 8.08 man hours of labor (distributed by periods), one acre of cropland, and one acre of row crop limit. The standing corn activity (P_2) uses resources and produces standing corn which can be either harvested for grain (P_3) or chopped for silage (P_5). Activities (P_6) and (P_7) provide for buying and selling shelled corn. The prices are variable for both, with the assumption that the price for buying corn is ten cents per bushel greater than the sale price. The sale prices are $1.17 (high), $.97 (medium) and $.77 (low) per bushel. This is the net received by the farmer for marketed corn. Activities (P_{15}) and (P_{17}) are the oat and wheat production enterprises. The oats produced can either be sold through the corn sales activity or added to the corn equivalent equation to be used by the livestock enterprises.

Other Differences

The interest rate on private credit was 4.9 percent for the South Central area and 4.7 percent for the Thumb area. These rates were calculated from survey information from farmers on available credit for the two areas.

The cost of hiring one man equivalent hour of labor was $2.28 for the South Central area and $2.02 for the Thumb area. These prices were derived from 1960 farm wage rates projected to 1966 on the basis of the previous 10 year trend.

Grade B dairy activities were permitted only for the Small and Medium Dairy farms in the South Central area. These activities are presented in Tableau 8. The model provides for Grade B production (P_{102}) using a stanchion system, acquiring and selling dairy cows (P_{103}) and (P_{104}), and an investment activity (P_{105}). This investment is in hay storage and housing facilities only.

The Grade B dairy production activity (P_{102}) nets $271.59 and uses 35.4 cwt. of corn equivalents, 3.72 acres permanent pasture, 3 tons hay

TABLEAU 8.—GRADE B DAIRY ACTIVITIES

Equation Number	Description	Unit	Grade B Dairy P102 Cow	Buy Cow P103 Cow	Sell Cow P104 Cow	Invest in Grade B Facilities P105 Cow
	REVENUE	$	-271.59	25.68	-25.68	19.75
4	Corn Equivalents	Cwt.	35.40			
7	Permanent Pasture	Acres	3.72			
9	Hay Equivalents	Tons	3			
14	Capital	$	-135.79	367.50	-312.50	151
15	Cash	$	-135.79	367.50	-312.50	38
16	Real Estate Mortgage	$				-75.50
17	Chattel Mortgage	$		-183.75	156.25	
24	Annual Labor	Man hrs.	61.42			
25	Period 1 Labor	Man hrs.	28.44			
26	Period 2 Labor	Man hrs.	9.00			
27	Period 3 Labor	Man hrs.	6.38			
28	Period 4 Labor	Man hrs.	3.29			
29	Period 5 Labor	Man hrs.	5.23			
30	Period 6 Labor	Man hrs.	9.08			
59	Beef Sales	Cwt.	-3.06			
63	Grade B Dairy Cap.	Cow	1			-1
65	Grade B Dairy Cow	Head	1	-1	1	

equivalents, cl.~2 man hours of labor, one unit of dairy capacity, and one cow. Cull cows are sold through the beef sales activity.

Phase 2 of the Model

Phase 2 of this study is composed of Phase 2 for the Thumb and South Central areas and an extended Phase 2 for the Thumb area. The extended Phase 2 results from increasing the quantities of land for the land rental and buying equations in Phase 2 of the model. The essential difference between Phase 1 and Phase 2 is the varying of land and associated variables. Activities are added to the Phase 1 model which allow land, credit, labor (including managerial and milking labor) and machinery to be acquired under alternative arrangements. In addition, the farm is permitted to sell land, machinery, labor and other resources. By including activities in the model for such transactions, the optimal levels of their employment can be determined within the model instead of arbitrarily assuming them.

Thumb Area

Phase 2 will be presented to the extent that it is different from Phase 1. The differences stem from two sources: (1) adding new activities and resources and (2) changing or adding resource restrictions. These differences are presented by major activity groups.

Crop Activities

The same crops included in Phase 1 for the Thumb area are in Phase 2. The only difference results from adding new resource restrictions. The restrictions which affect crops are machinery and managerial labor. The added restrictions on machinery are: (1) power and tillage capacity, (2) grain harvesting, (3) corn picking, (4) silage harvesting, (5) hay baling, (6) sugar beet harvesting, and (7) sugar beet hauling. These resource restrictions are defined in the section on machinery activities.

The crop activities in Phase 2 are the same as in Phase 1 except the activities now require the use of one or more of the machinery resources and the managerial labor. The bean activity (P_1) requires 1.45 units of the power and tillage resource (equation 43), one unit of the grain harvesting capacity (equation 44), and 3.98 hours of managerial labor (equation 33) per acre. The standing corn activity (P_2) uses 1.5 units of the power and tillage capacity and 3.2 hours of the managerial labor per acre. Harvest corn for grain and for high moisture corn (P_3) and (P_4) uses one unit of corn picking capacity and 1.38 hours of managerial labor per acre. Harvesting standing corn for silage (P_5) uses one unit of the silage harvesting equipment and 4.81 hours of managerial labor per acre. Harvest meadow for hay (P_{11}) uses one unit of hay baling capacity and 3.42 hours of managerial labor per acre. The oat producing activity (P_{15}) uses one unit of power and tillage and 2.24 hours of managerial labor per acre. Oats are not required to use the grain harvesting restriction since oats are harvested at times during the crop year when grain harvesting equipment is most unlikely to be the limiting resource. The sugar beet production activity (P_{16}) uses .95 units of power and tillage, one unit of beet harvesting and hauling capacity, and 7.21 hours of managerial labor per acre produced. Wheat production (P_{17}) uses 4.08 hours managerial labor per acre. Wheat does not require any of the power and tillage restriction or any of the grain harvesting restrictions for similar reasons as for oats not using grain harvesting capacity. All other crop activities for Phase 2 are identical to those for Phase 1.

The managerial labor requirement for the crop activities was determined on the basis of the crop tasks which the manager or operator would ordinarily perform. For example, the operator would be required to pick the corn but would not have to haul it.

Credit Activities

The **credit** alternatives added are associated with acquiring land and other **resources**. The credit activities added to Phase 1 are (1) buying land on **contract,** (2) borrowing of dealer credit, and (3) getting credit on newly acquired **real** estate. These sources of credit are normally available only when **the** resources which furnish these funds are purchased. The initial **levels of** these credit resources are zero in the model. But, when the **relevant** resource-acquiring activities are activated, these credit resources are **activated.**

The land contract credit activity (P_{21}) is permitted to be activated when land is purchased on land contract; however, the credit does not have to be used unless it is profitable to do so. The land contract credit costs $.06 **for** each dollar borrowed, adds $.94 to capital, and uses $1 of the credit **limit.** The dealer credit activity (P_{22}) may be activated when silos or certain types of machinery are purchased. The model does not force the use of such credit unless it is the most profitable thing to do. The dealer credit **costs** $.12 per dollar, adds $.88 to capital, and uses up $1 of the dealer credit **limit.** The additional land mortgage credit activity (P_{24}) is permitted to be **activated when** land is acquired on real estate mortgage. This activity costs $.055 per unit ($1), adds $.945 to capital, and uses $1 of the credit limit.

Neither of these activities (P_{21}), (P_{22}) and (P_{24}) adds to the cash **resource since** they are only credit received when purchasing specific **resources and the** credit is nontransferable. The model did not allow credit **to be obtained by land** contract on owned land.

Labor Activities

Phase 1 provides for the hiring of seasonal labor to replenish family labor, but no provisions were made for selling family (including operator) labor, hiring managerial or special labor. In order to take into account

the impact of Michigan's labor situation on the organization of Michigan farms, activities were added in Phase 2 which permit (1) selling of operator and family labor, (2) hiring of managerial labor, and (3) hiring of milking labor. These activities are stated in Tableau 9.

Activities (P_{31} through P_{36}) provide for selling operator labor off the farm by periods of the year for a net return of $1.99 per hour. Because of travel time, each hour worked off the farm takes 1.125 hours from the annual labor restriction and the appropriate period labor restrictions and uses 1.125 hours of the managerial labor restriction . Each unit of the activity uses one unit of the off-farm work restriction. It is assumed in the model that income from off-farm work can be used for farm expenses if the income is earned in the first half of the year. That is why the coefficients occur in the capital and cash equations for activities (P_{31}), (P_{32}) and (P_{33}) and not in activities (P_{34}), (P_{35}) and (P_{36}). Activity (P_{37}) sells family (excluding operator) labor for $1.58 (net return) per hour, furnishes $.79 to capital and cash, uses .21 man hours of annual labor, and one hour of the family off-farm work restriction.

The restrictions for off-farm work were determined from the survey data by taking the number of people (farm operators for the operator off-farm work restriction and the family members for the family off-farm work restriction) in the sample holding off-farm jobs in 1960, multiplying by work hours in a year, dividing by the number of farms in the cell (size-type), and adjusting for age. Since 1960 was a business recession year and many people experienced layoffs, the work hours in a year were used rather than the actual hours worked to calculate the off-farm work restrictions.

Activity (P_{38}) provides the possibility of hiring managerial labor. One unit (operator hour) of this activity costs $2.70, uses $2.70 of capital and cash, furnishes one hour of annual labor (distributed by periods), and adds

TABLEAU 9.--LABOR ACTIVITIES FOR PHASE 2 - THUMB AREA

Equation No.	Description	Unit	$	Sell Operator Labor Off-Farm Pd. 1 P31	Pd. 2 P32	Pd. 3 P33	Pd. 4 P34	Pd. 5 P35	Pd. 6 P36	Sell Family Labor P37	Hire Manage. Labor P38	Hire Milking Labor P107
				hour	hour	hour	hour	hour	hour	hour	op.hr.	man hr.
	REVENUE	$		-1.99	-1.99	-1.99	-1.99	-1.99	-1.99	-1.58	2.70	2.54
14	Capital	$		-1.99	-1.99	-1.00				-.79	2.70	2.54
15	Cash	$		-1.99	-1.99	-1.00				-.79	2.70	2.54
24	Annual Labor	Man hrs.		1.125	1.125	1.125	1.125	1.125	1.125	.21	-1	-1
25	Period 1 Labor	Man hrs.		1.125							-.332	-.332
26	Period 2 "	Man hrs.			1.125						-.168	-.168
27	Period 3 "	Man hrs.				1.125					-.168	-.168
28	Period 4 "	Man hrs.					1.125				-.085	-.085
29	Period 5 "	Man hrs.						1.125			-.124	-.124
30	Period 6 "	Man hrs.							1.125		-.123	-.123
31	Op. Off-Farm Work	Hours		1	1	1	1	1	1			
32	Family Off-Farm Work	Hours								1		
33	Managerial Labor	Op. hrs.		1.125	1.125	1.125	1.125	1.125	1.125		-1	
64	Milking Labor	Man hrs.										-1

one hour to the managerial labor restriction. The 2.70 per hour is based on a 50 hour week with an annual income of $7000.

Hiring milking labor (activity P_{107}) costs $2.54 per man hour, uses $2.54 capital and cash, adds one hour to annual labor (distributed by periods), and contributes one hour to the milking labor restriction. This activity allows the dairy enterprise to hire a full-time milker and release the operator's labor for other uses. The cost per man hour of milking labor is based on the 1960 wages reported in the survey projected to 1966 by using the 1950 to 1960 trend for Michigan farm wage rates.

Land Activities

Phase 2 of the model provides for farm expansion or contraction along the extensive margin, i.e., farm size may be changed by buying or renting land.

Phase 2 permits acquisition of land under two conditions which are stated as land 1 (P_{39}) and (P_{40}) and land 2 (P_{44}) and (P_{45}) in Tableau 10. Activity (P_{39}) acquires one unit of land 1 which adds .44 acre to bean limit, .44 acre to the corn acreage limit, .05 acre permanent pasture, .44 acre to small grain limit, .06 acre to sugar beet contract, .13 acre to the wheat acreage limit, $287 to land mortgage credit, .88 acre to cropland, and .66 acre to row crop limit. This activity has a revenue or cost of $5.75 (net cost of owning one acre for one year, i.e., real estate tax payment) and uses $575 capital (full purchase price per acre), $288 cash for down payment, 3.5 man hours of labor (distributed by period), 3.5 hours of managerial labor (overhead labor in this case), and one acre of the buy land 1 limit (equation 36). Activity (P_{40}) gives the opportunity to buy land 1 (low priced land) by land contract. Activity (P_{40}) may be interpreted similarly to (P_{39}), except activity (P_{40}) provides and/or uses land contract credit. All other land activities presented in Tableau 10 may be interpreted in a similar way to activity (P_{39}).

TABLEAU 10.--LAND ACTIVITIES FOR PHASE 2 - THUMB AREA

Equation No.	Description	Unit	Buy Land 1 — Cash or: Mortgage:Contract P39	Buy Land 1 — Land P40	Sell — Land P41	Rent Land — In P42	Rent Land — Out P43	Buy Land 2 — Cash or: Mortgage:Contract P44	Buy Land 2 — Land P45	Rent Land 2 — In P56
	REVENUE	$	5.75	5.75	-5.75	var.	var.	6.90	6.90	var.
			acre	acre	acre	acre	acre	acre	acre	acre
1	Bean Acreage Limit	Acre	-.44	-.44	.44	-.50	.50	-.44	-.44	-.50
2	Corn Acreage Limit	Acre	-.44	-.44	.44	-.16	.16	-.44	-.44	-.16
7	Permanent Pasture	Acre	-.05	-.05	.05			-.05	-.05	
11	Small Grain Limit	Acre	-.44	-.44	.44	-.50	.50	-.44	-.44	-.50
12	Sugar Beet Contract	Acre	-.06	-.06	.06	-.07	.07	-.06	-.06	-.07
13	Wheat Acreage Limit	Acre	-.13	-.13	.13	-.15	.15	-.13	-.13	-.15
14	Capital	$	575	575	-169			690	690	
15	Cash	$	288	115	-169			345	138	
16	Real Estate Mortgage	$			258					
20	Land Mortgage Credit	$	-287					-345		
22	Land Contract Credit	$		-460					-552	
24	Annual Labor	Man hrs.	3.50	3.50		3.50		3.50	3.50	3.50
25	Period 1 Labor	Man hrs.	.78	.78		.78		.78	.78	.78
26	Period 2 "	Man hrs.	.50	.50		.50		.50	.50	.50
27	Period 3 "	Man hrs.	.76	.76		.76		.76	.76	.76
28	Period 4 "	Man hrs.	.39	.39		.39		.39	.39	.39
29	Period 5 "	Man hrs.	.59	.59		.59		.59	.59	.59
30	Period 6 "	Man hrs.	.47	.47		.47		.47	.47	.47
33	Managerial Labor	Op. hrs.	3.50	3.50		3.50		3.50	3.50	3.50
34	Cropland Limit	Acre	-.88	-.88	.88	-1	1	-.88	-.88	-1
35	Row Crop Limit	Acre	-.66	-.66	.66	-.75	.75	-.66	-.66	-.75
36	Buy Land 1 Limit	Acre	1	1						
37	Rent in Land 1 Limit	Acre				1				
38	Land 1 for Contract Pur.	Acre		1						
39	Buy Land 2 Limit	Acre						1	1	
40	Land 2 for Contract Pur.	Acre							1	
41	Rent in Land 2 Limit	Acre								1
42	Land Sales Limit	Acre			1					

The distinction between land 1 and land 2 is as follows: (1) The quantity of land 1 was estimated from data received from the farmers interviewed; (2) the land 2 restriction and activities were added to (a) allow the farms to make fuller use of other resources and (b) see whether it would be profitable to expand farm size beyond the original size plus land 1; and (3) land 1's price is based on what farmers thought they would have to pay for the land which they knew was available for sale at the time of interview, while land 2's price was set at 20 percent greater than the price for land 1 (this was the case for both buying and renting land).

Activity (P_{44}) acquires one unit of land 2 which adds the same quantities of crop restrictions as one unit of (P_{39}). However, (P_{44}) has a revenue or cost of $6.90, uses $690 capital (full purchase price per acre), $345 cash, same labor requirements as (P_{39}), and uses one acre of the buy land 2 limit (equation 39). Activity (P_{45}) provides the opportunity to buy land 2 (high priced land) by land contract. The price of this land (20 percent higher than land 1) was based on the assumption that for more land to be made available for sale or rent than was currently for sale or rent, the price offered had to be greater.

Activity (P_{41}) allows land to be sold for cash. Activity (P_{42}) permits renting in land 1 (this activity was in Phase 1 but no managerial labor was required there), while activity (P_{43}) permits renting out the cropland on the farm for a net revenue of $29.37 (at medium corn price). Activity (P_{46}) provides for renting land 2 at $39.16 per acre of cropland (at medium corn price).

Machinery Activities[1]

In Phase 2, to be consistent with varying land and labor, activities

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[1]The estimates for machinery capacities and custom rates were derived from the following sources: (1) 1960 farm survey data; (2) Roy Bainer, R. A.

were added which allow the machinery resources to be either expanded or sold. These activities are essentially custom hiring of machines and the machine operators. When the machine is sold by a farmer, the labor to operate it must be sold at the same time. When the farm hires custom work for a particular enterprise, labor is obtained or added to the labor restrictions to eliminate double counting. Also, cash is added back to the appropriate resources or deducted from the custom charge in order to account for these resources already counted in the production activities. The machinery activities are presented in Tableau 11.

The power and tillage activities (P_{47}) and (P_{48}), grain harvesting (P_{49}) and (P_{50}), sugar beet harvesting (P_{59}) and (P_{60}) and the sugar beet hauling (P_{61}) and (P_{62}) activities are very similar in their functioning. The buying activities and selling activities have been adjusted for resources already built into the crop production activities. For example, one unit of activity (P_{47}) costs $5 which is the custom rate adjusted by tractor expenses already accounted for in the crop budgets, uses $5 capital and cash, adds back .9 hours of labor (annual, period 2 and managerial labor) and furnishes one unit of power and tillage capacity. The power and tillage sales activity (P_{48}) contributes $5 net revenue and uses .9 hours (annual, period 2 and managerial labor) and uses up one unit of power and tillage capacity. The other three sets of activities, grain harvest, sugar beet harvesting and sugar beet hauling, operate in a similar way as the power and tillage activities.

The corn picking activities (P_{51}) and (P_{52}), corn silage harvesting

Kepner and E. L. Barger, Principles of Farm Machinery, New York: John Wiley and Sons, Inc., 1955; (3) "Cost Planning for Farm Machinery," Doane Agricultural Digest, Doane Agricultural Service, Inc., 1960; (4) Consultation with W. F. Buchele of the Agricultural Engineering Department, Michigan State University; and (5) "Rates for Custom Work in Michigan," by Charles Beer, Dept. of Agricultural Economics, Michigan State University.

TABLEAU 11.—MACHINERY ACTIVITIES FOR PHASE 2 - THUMB AREA

Equa-tion No.	Description	Unit	Power & Tillage Buy P47	Power & Tillage Sell P48	Grain Harvest Buy P49	Grain Harvest Sell P50	Corn Picking Buy P51	Corn Picking Sell P52	Corn Silage Harvesting Buy P53	Corn Silage Harvesting Sell P54
	REVENUE	$	5.00	-5.00	5.42	-5.42	7.17	-3.02	19.65	-11.90
			acre	acre	acre	acre	acre	acre	acre	acre
3	Standing Corn	Acres					1		1	
4	Corn Equivalents	Cwt.					-56			
5	Corn Silage	Tons							-18	
6	Corn Sales	Bu.					-100			
8	Rotation Meadow	Acres								
9	Hay Equivalents	Tons								
10	Hay Sales	Tons								
14	Capital	$	5.00		5.42		7.17		19.65	
15	Cash	$	5.00		5.42		7.17		19.65	
18	Dealer Credit	$								
24	Annual Labor	Man hrs.	-.90	.90	-.60	.60	1.38	1.35	3.50	3.50
26	Period 2 Labor	Man hrs.	-.90	.90						
27	Period 3 "	Man hrs.			-.17	.17				
28	Period 4 "	Man hrs.			-.43	.43			3.50	3.50
29	Period 5 "	Man hrs.					1.38	1.35	3.50	3.50
30	Period 6 "	Man hrs.					1.35	1.35		
33	Managerial Labor	Op. hrs.	-.90	.90	-.60	.60	1.35	1.35	4.45	3.50
43	Power & Tillage Cap.	Acres	-1	1						
44	Grain Harvest "	Acres			-1	1				
45	Corn Picking "	Acres						1		
46	Silage Harvest. "	Acres								
47	Hay Harvest "	Acres								
48	Sugar Beet Harvest Cap.	Acres								
49	Sugar Beet Hauling "	Acres								
50	Silo Capacity	Tons							18	

TABLEAU 11.--Continued

Equa-tion No.	Description	Unit	Hay Baling Buy P57	Hay Baling Sell P58	Sugar Beet Harvesting Buy P59	Sugar Beet Harvesting Sell P60	Sugar Beet Hauling Buy P61	Sugar Beet Hauling Sell P62	Build Silo P63
	REVENUE	$	acre 13.18	acre -8.05	acre 13.65	acre -13.65	acre 23.20	acre -23.20	tons 2.23
3	Stand Corn	Acres							
4	Corn Equivalents	Cwt.							
5	Corn Silage	Tons							
6	Corn Sales	Bu.							
8	Rotation Meadow	Acres	1						
9	Hay Equivalents	Tons	-3						
10	Hay Sales	Tons	-3						
14	Capital	$	13.18		13.65		23.20		16
15	Cash	$	13.18		13.65		23.20		4
18	Dealer Credit	$							-12
24	Annual Labor	Man hrs.	13.43	.80	-1.50	2	-6.50	6.50	
26	Period 2 Labor	Man hrs.	9.87	.60					
27	Period 3 "	Man hrs.							
28	Period 4 "	Man hrs.							
29	Period 5 "	Man hrs.	3.56	.20	-.75	1			
30	Period 6 "	Man hrs.	2.52	.80	-.75	1	-3.30	3.30	
33	Managerial Labor	Op. hrs.			-1.50	2	-3.20	3.20	
43	Power & Tillage Cap.	Acres							
44	Grain Harvest "	Acres							
45	Corn Picking "	Acres							
46	Silage Harvest "	Acres							
47	Hay Harvest "	Acres		1					
48	Sugar Beet Harvest Cap.	Acres			-1				
49	Sugar Beet Hauling "	Acres					-1	1	
50	Silo Capacity	Tons							-1

activities (P_{53}) and (P_{54}) and the hay baling activities (P_{57}) and (P_{58}) function very similarly to each other. For example, buying corn picking capacity (P_{53}) costs the custom rate for harvesting plus the cost of hauling or a total of $7.17 per acre. One unit of this activity picks one acre of standing corn and adds 80 bushels of corn to corn equivalents and corn sales equations, uses $7.17 capital and cash, 1.38 hours of labor and 1.35 hours of managerial labor (this time is spent by the operator supervising, hauling and storing the picked corn). The corn picking sales activity (P_{52}) has a net return (after operating expenses) of $3.02 and uses 1.35 hours of labor (annual, period 6 and managerial labor) and reduces the corn picking capacity by one unit per acre. The corn silage harvesting activities and the hay baling activities function the same way as the corn picking activities.

The silo building activity (P_{63}) allows expansion of the silage capacity. One unit of the activity provides one ton of capacity at an annual cost of $2.23 and uses $16 capital (full purchase price), $4 cash (down payment), and furnishes $12 dealer credit. This activity is the same for Phase 1 and Phase 2 except in Phase 1 silo construction was assumed to provide chattel credit instead of dealer credit.

The initial supplies of these machinery resources were based on the farm survey information on machinery inventories. The procedure used in developing the machinery restrictions for the representative farms is as follows: (1) Machines were inventoried and quantified as to size and condition; (2) the individual machine capacities were estimated by using information obtained from the Agricultural Engineer's Handbook; and (3) then the specific machine capacity was adjusted on the basis of the number of days available during the crop season to do its specific task under weather conditions assumed to equal the average of the 16 worst years out of 20.[1]

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[1] J. H. Sitterley and Richard Bere, "The Effect of Weather on the Days Available to Do Selected Crop Operations," Mimeograph Bulletin A.E. 313, Department of Agricultural Economics, Ohio State University, August, 1960.

Livestock Enterprises

The livestock activities in Phase 2 are the same activities included in Phase 1. Their only difference is that the Phase 2 activities use the managerial labor and/or the special milking labor resources.

For the beef production activities and the hog production activities, the assumption was made that the manager or operator type labor must contribute 60 percent of the total labor required by the enterprises. The remaining portion of the labor required may be furnished by the operator or family or hired labor or any combination of these. Therefore, the coefficients for the hog and beef production activities in the managerial labor equation are .6 of the coefficients for the annual labor equation.

The dairy production activities (P_{96} or stanchion dairy and P_{97} or parlor dairy) use both the managerial labor and the special milking labor. Activity (P_{96}) uses 64.04 hours of managerial labor and 64.04 hours of the special milking labor per unit of the activity. Activity (P_{97}) uses 46.8 hours of managerial and special milking labor per unit of the activity. The activities for hiring managerial and milking labor are stated in Tableau 9.

Extended Phase 2 Model

The extended Phase 2 model changes restrictions on buying and renting land. The restriction for buying land 2 was increased from 40 acres to 400 acres. The restriction on renting land 2 was increased from 40 acres to 120 acres. These increases were introduced to see what other resources might become limiting and to see how various farm situations would be adjusted or changed by increasing the levels of these restrictions.

South Central Area

Phase 2 of the model for the South Central area differs from Phase 1 of the model in very much the same way as the Thumb Phase 2 varies from Thumb

Phase 1. Only the differences in the South Central Phase 2 are presented here.
Reference must be made to the appropriate Tableau under the section on Phase 1
for the South Central area in order to view the major parts to many of the
activities.

Crop Activities

The crop activities in Phase 2 for the South Central area are identi-
cal to those for Phase 1; however, the activities now use the managerial labor
resource and the machinery capacity restrictions where relevant.

The soybean activity (P_2) uses 3.2 hours of managerial labor, 1.7
units of power and tillage, and one unit of grain harvest capacity per acre
produced. The standing corn (P_2) uses 3.20 hours of managerial labor and 1.75
units of power and tillage per acre. Harvest corn for grain (P_3) uses 1.2
hours of managerial labor and one unit of corn picking capacity per acre.
Harvest corn silage (P_5) uses 4.81 hours of managerial labor and one unit of
silage harvest capacity per acre. Oat production (P_{15}) uses one unit of power
and tillage and 2.24 hours of managerial labor per acre. Wheat production
(P_{17}) uses 4.08 hours of managerial labor per acre. All other coefficients
and activities remain unchanged from Phase 1.

Credit Activities

The credit activities included in Phase 2 for the South Central area
are the same as the ones in Phase 1 plus the credit activities added to the
Thumb model to compose the Phase 2 Thumb model. The initial supplies of these
resources are different.

Labor Activities

The activities added to the South Central Phase 1 are the same as
the ones added to the Thumb Phase 1 to make Phase 2. The only difference
is in the net return per hour worked. Operators were assumed to receive

$1.99 per hour in the Thumb and $2.25 per hour in the South Central area.
The family workers received a net of $1.58 per hour in the Thumb and $1.72
in the South Central area. These net returns are based on the wages received
by people in the survey during 1960 projected to 1966 by using the national
index for industrial wage rates (1947-1949 equals 100) corrected for the
Michigan differential and adjusted by age and for traveling expenses. The
differences in the wage rates from one area to the other is based on the dif-
ferences in the wage rates received by workers in each area in 1960.

The hiring of managerial labor (P_{38}) was assumed to be the same as
for the Phase 2 model for the Thumb. The hiring of milking labor (P_{107}) for
the dairy enterprise costs 5 cents more per hour. This price difference was
based on the 1960 price differential for hiring milkers for the two areas.

Land Activities

The land activities for the Phase 2 model are the same activities as
for the Thumb Phase 2 model, but the coefficients are different. The main
reason for the differences in the coefficients is the difference in the
productivities of the soils. As a result, the crop yields are lower and the
cropping program is more extensive in the South Central area than in the
Thumb. The activity for land buying, selling and renting for the South
Central area are presented in Tableau 12. These activities are interpreted
the same way as the land activities in the Thumb Phase 2 model.

Machinery Activities

The machinery activities, unique to the South Central Phase 2 model,
are stated in Tableau 13. The power and tillage activities (P_{47}) and (P_{48}),
the hay baling activity and the silo construction activity, are the same as
in the Thumb Phase 2 model.

The grain harvesting (P_{49}) and (P_{50}), corn picking (P_{51}) and (P_{52}),
and the corn silage harvesting (P_{53}) and (P_{54}) activities differ from the

TABLEAU 12.--LAND ACTIVITIES FOR PHASE 2 - SOUTH CENTRAL AREA

Equation No.	Description	Unit	Buy Land 1: Cash or Mortgage P39	Buy Land 1: Contract P40	Sell Land P41	Rent Land: In P42	Rent Land: Out P43	Buy Land 2: Cash or Mortgage P44	Buy Land 2: Contract P45	Rent Land 2: In P46
			acre	acre	acre	acre	acre	acre	acre	acre
	REVENUE	$	2.83	2.83	-2.83	var.	var.	3.40	3.40	var.
1	Bean Acreage Limit	Acres	-.27	-.27	.27	-.34	.34	-.27	-.27	-.34
2	Corn Acreage Limit	Acres	-.28	-.28	.28	-.35	.35	-.28	-.28	-.35
7	Permanent Pasture	Acres	-.13	-.13	.13			-.13	-.13	
11	Small Grain Limit	Acres	-.40	-.40	.40	-.50	.50	-.40	-.40	-.50
13	Wheat Acreage Limit	Acres	-.10	-.10	.10	-.12	.12	-.10	-.10	-.12
14	Capital	$	283	283	-190			340	340	
15	Cash	$	141	57	-190			170	68	
16	Real Estate Mortgage	$			142					
20	Land Mortgage Credit	$	-142					-170		
22	Land Contract Credit	$		-226					-272	
24	Annual Labor	Man hrs.	4.00	4.00		4.00		4.00	4.00	4.00
25	Period 1 Labor	Man hrs.	.92	.92		.92		.92	.92	.92
26	Period 2 "	Man hrs.	.56	.56		.56		.56	.56	.56
27	Period 3 "	Man hrs.	.90	.90		.90		.90	.90	.90
28	Period 4 "	Man hrs.	.42	.42		.42		.42	.42	.42
29	Period 5 "	Man hrs.	.68	.68		.68		.68	.68	.68
30	Period 6 "	Man hrs.	.52	.52		.52		.52	.52	.52
33	Managerial Labor	op. hrs.	4	4		4		4	4	4
34	Cropland Limit	Acres	-.80	-.80	.80	-1		-.80	-.80	-1
35	Row Crop Limit	Acres	-.53	-.53	.53	-.67	.67	-.53	-.53	-.67
36	Buy Land 1 Limit	Acres	1							
37	Rent in Land 1 Limit	Acres				1				
38	Land 1 Contract Pur.	Acres		1						
39	Buy Land 2 Limit	Acres						1		
40	Land 2 Contract Pur.	Acres							1	
41	Rent in Land 2 Limit	Acres								1
42	Land Sales Limit	Acres			1		1			

TABLEAU 13.--MACHINERY ACTIVITIES FOR PHASE 2 - SOUTH CENTRAL AREA

Equation No.	Description	Unit	Grain Harvest		Corn Picking		Corn Silage Harvesting	
			Buy P49	Sell P50	Buy P51	Sell P52	Buy P53	Sell P54
			acre	acre	acre	acre	acre	acre
	REVENUE	$	4.90	-4.90	6.95	-4.04	16.65	-11.90
3	Standing Corn	Acres			1		1	
4	Corn Equivalents	Cwt.			-44.8			
5	Corn Silage	Tons					-15	
6	Corn Sales	Bu.			-80			
14	Capital	$	4.90		6.95		16.65	
15	Cash	$	4.90		6.95		16.65	
24	Annual Labor	Man hrs.	-.63	.63	1.20	1.04	3.50	3.50
29	Period 5 Labor	Man hrs.	-.35	.35				
30	Period 6 "	Man hrs.	-.28	.28				
33	Managerial Labor	Op. hrs.	-.63	.63	1.20	1.04	3.50	3.50
44	Grain Harvest. Cap.	Acres	-1	1				
45	Corn Picking "	Acres			1	1		
46	Silage Harvest "	Acres						1
50	Silo Capacity	Tons					15	

same activities in the Thumb Phase 2 because of the differences in yields, size of machines used, and weather conditions during harvest season. However, the functioning of these activities is identical to the same activities in the Phase 2 model for the Thumb.

The differences in harvesting machines for the two areas are as follows: (1) grain harvesting machine--10 ft. self-propelled combine for Thumb farms and a 7 ft. power take-off combine for the South Central farms and (2) corn picker--1-row corn picker for Thumb area and a 2-row mounted corn picker for the South Central area. The corn silage activities differ in that Thumb corn silage yield is assumed to be 18 tons per acre, while the South Central yield is set at 15 tons per acre.

Livestock Activities

The livestock activities for Phase 2 are the same activities in Phase 1, but now they require managerial labor and milking labor where appropriate. The beef production activities and the hog production activities are identical to those for the Thumb Phase 2 model. The Grade A stanchion and parlor dairy activities are the same for both areas.

CHAPTER V

OPTIMAL SOLUTIONS FOR THE REPRESENTATIVE FARMS

This chapter presents the resulting optimal organizations of repre-
sentative farms for selected price combinations. First, adjustments and
organizations will be presented for Phase 1 (land restricted to the 1960
levels) by geographic area. Second, the resulting optimal organizations
under Phase 2 (land variable for renting and purchasing) will be given pri-
marily as they differ from Phase 1. Finally, a partial assessment of cer-
tain changes in the model (Phase 1 and Phase 2) and of the results will be
submitted.

The optimal solutions or organizations for the representative farms
presented in this chapter are based on projected product and input prices
for the period 1963 to 1970. These prices may be viewed as the expected
prices over this period. The prices assumed for corn, hogs and beef cattle
are presented in Table 6 (the other prices can be found in Table 3 of Appen-
dix A). The resource supplies of the farms programmed are based on survey
data for the year 1960 as presented in Chapter 3, Tables 4 and 5.

TABLE 6.--PRICE LEVELS* ASSUMED FOR THE STUDY AREAS

Product	Unit	Thumb Area			South Central Area		
		High (H) Price	Medium (M) Price	Low (L) Price	High (H) Price	Medium (M) Price	Low (L) Price
Corn	Bu.	$ 1.19	$ .99	$ .79	$ 1.17	$ .97	$ .77
Hogs	Cwt.	16.57	13.73	10.89	16.82	13.98	11.14
Beef Cattle	Cwt.	24.31	20.20	16.08	24.56	20.45	16.33

*Adjustments have been made in the prices for transportation and
marketing charges.

Optimal Organizations and Adjustments Using Phase 1 of the Model

As was described in Chapter IV, Phase 1 of this analysis treats land, machinery and managerial labor constant at the 1960 levels for the representative farms. No provisions are made for selling different kinds of family labor off the farm or for selling durable resources. Therefore, the results from Phase 1 will not handle the questions concerning: (1) farm expansion and contraction along the extensive margin; (2) farm consolidation; (3) off-farm employment; and (4) the economic levels for employment of durable resources. However, the resulting solutions, under Phase 1, do give some indications of the pressures to expand or contract the use of specific resources. These indicated pressures are revealed by the marginal value productivities (MVP's) of the type of resources in question.[1] But, these pressures do not tell _how_ _far_ adjustments should be made or for _what range_ these MVP's hold.

Thumb Area[2]

The resulting optimal solutions for the representative farm situations for the Thumb area differ considerably from the 1960 organization. The optimal solutions will be presented in this chapter by studying first the effects of size and type of farm, then the effects of price variations on farm organization.

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[1]The linear programming MVP is not the same as the MVP from a continuous function. In programming, the MVP of a resource is evaluated at the margin with no other resource restricting. Thus, resources which are not restricting are treated as free and can be combined with one more unit of the restricting resource to yield the MVP of that resource. This type MVP only holds for an additional unit of the resource and its behavior may be very "erratic" for further additional units. Its value may decrease or fall all the way to zero depending upon which other factors become restricting as output changes. The "erratic" behavior of the MVP's results from the characteristic of corner solutions of linear programs, i.e., the solutions hold for a specific range until other resources become limiting, then another organization becomes optimal and MVP's of resources change.

[2]The use of the term Thumb area in this thesis refers to the Thumb and Saginaw Valley areas (see Figure 1).

Type and Size Effects

As was stated in Chapter III, the quantity of resources and type of farm were believed to affect farm adjustment possibilities. Thus, farms were stratified or classified into size-type categories for analysis. These initial characteristics were expected to have significant effects upon the programmed optimal organizations.

In 1960, the farms in the Thumb area were, by and large, cash crop farms. Dairying was the second most important enterprise. The existing organizations of the representative farms are compared with the optimal organizations in Table 7. The 1966 medium projected prices for corn, hogs and beef cattle are used for these comparisons. All other product and input prices for the optimal solutions are the 1966 projected prices.

Table 7 presents the estimated gross incomes and proportions of income by enterprise for 1960 and for the optimal organization. Also, the enterprise levels are compared. The prices for 1960 are different from the 1966 projected prices. The beef cattle price in the optimal solutions is approximately $4 per cwt. lower than the 1960 price. The projected hog price is $3 per cwt. lower than the 1960 price. All other projected product prices are approximately the same as for 1960.

The proportions of gross income coming from the various enterprises are quite different for the 1960 and the optimal organization. In 1960, cash crop and feed grain sales contributed approximately 80 to 90 percent of the gross income to the Small, Medium and Large Cash Crop representative farms in the Thumb area. In the optimal organization, none of these representative farms had sales of feed grains and only 22 to 28 percent of their gross income came from cash crop sales. There are few differences in the proportions of gross income contributed from the dairy enterprises between the 1960 and optimal organization. The proportion of gross income coming from hog sales

TABLE 7.--GROSS INCOME AND PERCENT OF SALES INCOME BY ENTERPRISE AND ENTERPRISE LEVELS FOR FARMS IN THE THUMB AREA

Representative Farm Situation	Gross Income 1960	Gross Income Optimal	Feed Grain 1960	Feed Grain Optimal	Cash Crops 1960	Cash Crops Optimal	Beef Cattle 1960	Beef Cattle Optimal	Dairy 1960	Dairy Optimal	Hogs 1960	Hogs Optimal	Other 1960
Percent of Income by Enterprise													
Small Cash Crop	$7,545	23,127	9	0	80	22	0	67	4	2	2	9	5
Medium Cash Crop	12,149	33,961	8	0	82	28	4	68	2	0	3	4	1
Large Cash Crop	21,897	57,410	9	0	69	22	2	67	13	4	3	7	4
Small-Medium Dairy	15,501	37,410	1	0	11	12	0	53	84	33	1	2	3
Large Dairy	34,437	95,411	2	0	22	15	0	60	73	24	0	1	3
Enterprise Levels[a]													
Small Cash Crop			15	34	64	44	0	187	1	1	8		
Medium Cash Crop			28	54	103	81	2	277	1	1	5		
Large Cash Crop			57	153	156	106	4	463	6	4	16		
Small-Medium Dairy			32	64	24	42	2	236	21	22	4		
Large Dairy			102	191	95	126	7	691	41	38	3		

a/ Crops are stated in terms of acres and livestock in terms of numbers of beef cattle, dairy cows and sows.

increases over two times the 1960 percentages of income coming from such sales. The most significant adjustment for the Cash Crop farms is the large increase in beef cattle. In 1960 the beef cattle enterprise contributed from 0 to 4 percent of gross income but in the optimal solution beef cattle sales contributed 69 to 80 percent. All of the Cash Crop representative farms in the Thumb area change to Livestock farms in the optimal solutions based on the criteria used in this study for defining farm type.

The Dairy representative farms in the Thumb area also turn out in the optimal organization to be Livestock farms, but they have smaller proportions of their gross income coming from beef cattle sales than the reorganized Cash Crop farms. The proportion of income from cash crop and hog sales are about the same in 1960 and the optimal organization. The major change in the Dairy farms is the proportion of income from the dairy and beef cattle enterprises. In 1960 dairy made up 84 and 73 percent of the gross incomes for the Small-Medium and Large Dairy farms, and beef none, while in the optimal solution beef made up 53 and 60 percent and dairy added only 33 and 24 percent of gross income for the Small-Medium and Large Dairy farms, respectively.

Farm size has a significant effect upon the extent of adjustments from the 1960 to the optimal organization. As is indicated in Table 7 (lower part of the table), the levels of the enterprises in the optimal solutions vary directly with the size of the farm. There is one exception. The level of the hog activity for (1) the Medium Cash Crop farm is less than for the Small Cash Crop farm and for (2) the Large Dairy farm is less than for the Small-Medium Dairy farm. The levels of the beef cattle enterprise in the optimal solution vary from 187 head for the Small Cash Crop farm to 691 for the Large Dairy farm.

Adjustments in the crop enterprises are closely related to the shift from cash crop and dairying to beef cattle production. The shift away from

high forage consuming livestock to high concentrate consuming livestock, i.e., from dairy to beef and hogs, is consistent with the shift from hay crops to growing more feed grains, primarily corn since oats remain about constant at the 1960 level. The wheat and the sugar beet enterprises in the optimal organization are operated up to the acreage restrictions. The dry bean acre- ages on the Cash Crop representative farms in the optimal organization are approximately 40 percent less than they were in 1960. This land changes to corn production to supply feed to the livestock enterprises. However, the representative Dairy farms in the optimal solutions have increases in dry beans from 7 to 22 acres and 53 to 70 acres for the Small-Medium and Large Dairy farms, respectively. No corn is sold in the optimal organizations. The levels of the feed grain and cash crop enterprises for the 1960 and opti- mal organizations are presented in the lower half of Table 7.

The levels of the dairy enterprise in the optimal solutions are approximately the same as those of 1960. The dairy enterprise increases from 21 to 22 cows on the Small-Medium Dairy and decreases from 41 to 38 cows on the Large Dairy farms.

The levels of the beef cattle and hog enterprises in the optimal organizations increase many times over the 1960 levels. The beef cattle enterprise varies from 187 head of yearlings for the Small Cash Crop farm to 691 head for the Large Dairy farms. In 1960 the representative farms had from 0 to 7 head of beef cattle per farm. The increase in sows farrowed varies from 2 to 16 times the existing level. The major increase in the hog enterprise occurs on the Cash Crop farms with the largest increase on the Large Cash Crop representative farm. The increase there is from 1 to 16 sows.

The levels of the livestock activities for the existing and the opti- mal organization for the Thumb area are presented in the lower half of Table 7. The additional resources necessary to increase the activities to the

levels as indicated by the optimal solutions are presented by representative farms throughout this chapter.

Effects of Prices on Organization

Corn, hog and beef cattle prices were varied in this study. These prices were set at three levels (see Table 6 for specific prices) which are referred to as high, medium and low through this chapter. It is expected that representative farm organizations are affected by price changes, i.e., there are production responses to price changes. Some price changes may have more significant effects upon farm organization and production than others. This is the case with the results of this study. Hence, only the most significant effects of price changes will be presented in the text of this thesis. Since there are two phases, 14 representative farms, and 27 optimal solutions (one for each of 27 price combinations) for each representative farm in this study, only specific selected price combinations and representative farm situations are presented.

The reporting of the optimal solutions in this study is as follows: (1) Only solutions at the <u>medium</u> price for corn are presented; (2) solutions to all three price levels for hogs and beef cattle are given; (3) for Phase 1, only the <u>medium</u> size representative farm situations will be presented in the text and the other representative farm results will be placed in Appendix B; (4) for Phase 2, only the results for the <u>medium</u> representative farms are presented in table form in this thesis; (5) it is assumed that the results of the linear programming, in total, will be presented elsewhere and at a later date; (6) all results for Phase 1 and Phase 2 have been summarized and are on file in the Department of Agricultural Economics, Michigan State University.

Since changes in corn price had few significant effects upon farm organization in the optimal solutions, only the solutions with medium corn price are presented. Lowering the corn price resulted in less corn production

and more bean acreages. With the low corn price, slight increases in corn purchases and levels of corn using activities occurred. When corn price was high, with high beef and hog prices, the main effect was an increase in beef cattle production and a reduction of swine production to the point where the hog enterprise was only slightly dominant over the beef cattle enterprise. In all other respects, the optimal solutions for low and high corn prices were similar to those for the medium corn price.

Cash Crop Farms

The Small Cash Crop representative farm is typical of the 80 to 120 acre cash crop farms in the Thumb area. This farm is characterized by a labor force composed of the operator and a few family workers, usually the wife and/or small children. In 1960 the small cash crop farms grew dry beans, sugar beets, corn, oats and hay. There were very few dairy and livestock facilities even though all farms had adequate buildings and facilities to handle some livestock, 3 or 4 sows, and 20 to 30 head of steers.

The optimal organizations for the Small Cash Crop farm for the medium corn price of $.99 per bushel and various hog and beef cattle prices are presented in Table 1 of Appendix B. Moving from right to left in the table, the net incomes[1] and levels of specific enterprises are stated for various beef prices. The solutions under alternative hog prices are revealed as one reads down the table.

When both hog and beef cattle prices are low and with corn price medium, the Small Cash Crop farm becomes a Dairy farm with 26 grade A dairy

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[1]The net incomes are the incomes left after subtracting operating expenses and annual costs of owning any new buildings and facilities. A deduction has been made in the initial level of the annual cash account to account for real estate taxes, but no deduction has been made for annual depreciation expenses on buildings and facilities. The net income is the return to owned labor, capital, land, buildings and facilities.

cows, only 18 head of beef steers, and 2 sows. The farm becomes a 200 head
beef cattle farm when hog prices are low and beef prices are medium and high.
When the hog price is medium and beef is high, a 200 head beef farm also
results. The farm becomes a hog farm when hog prices are medium or high with
beef cattle prices at low or medium, respectively. At all other price combina-
tions the resulting organization is a beef-hog or a hog-beef farm. For con-
venience, henceforth, the letters H, M and L will be used to denote high,
medium and low prices, and the order of these will be corn, hog and beef prices
when they occur in a threesome.

In order to obtain these optimal organizations, additional resources
must be acquired. The amounts of specific resources acquired by the Small
Cash Crop farm and marginal value productivities (MVP's) of specific resources
are presented in Table 2 of Appendix B.

In all cases in Table 2 of Appendix B except MML, MHL and MHM wheat
and sugar beets were grown up to the acreage restrictions. Substantial quanti-
ties of purchased corn and borrowed credit were necessary for the optimal
solutions as indicated by Tables 1 and 2 in Appendix B.

The Medium Cash Crop optimal organizations are very similar to that of
the Small Cash Crop farm. These optimal solutions are presented in Table 8.
The essential difference between the solutions for the Small and Medium Cash
Crop farm is the activity levels which are greater for the Medium Cash Crop
farm. There is another difference, the Medium Cash Crop farm is a dairy-beef
farm at low livestock prices instead of a Dairy farm.

The additional resource requirements and MVP's for specific resources
are presented in Table 9 for the Medium Cash Crop farm. Since purchases of
seasonal labor were allowed, labor will have an MVP in the linear programming
results when capital is restricting or some other resource limits the use of
labor. Labor costs $2.02 per man hour in the Thumb model. Therefore, for it

TABLE 8.—OPTIMAL ORGANIZATIONS FOR MEDIUM CASH CROP FARM IN THE THUMB
AREA - PHASE 1

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	12,457	16,361	21,164
Dry beans	Acre	53	44	44
Corn	Acre	45	53	53
Alfalfa	Acre	13	13	13
Sugar beets	Acre	13	13	13
Wheat	Acre	24	24	24
Real estate credit	$	18,744	18,878	18,878
Chattel and private credit	$	2,100	17,480	17,480
Yearlings fed, Pd. 1	Head	37	141	141
" " Pd. 2	Head	37	142	142
Dairy	Cow	13		
Sows farrowed, Qu. 1	Sow	1		
" " Qu. 2	Sow			
" " Qu. 3	Sow			
" " Qu. 4	Sow	2		
(2) Hog Price @ $13.73/Cwt.				
Net income	$	14,353	16,500	21,210
Dry beans	Acre	44	44	44
Corn	Acre	53	53	53
Alfalfa	Acre	13	13	13
Sugar beets	Acre	13	13	13
Wheat	Acre	24	24	24
Real estate credit	$	26,159	18,822	18,847
Chattel and private credit	$	13,628	17,480	17,480
Yearlings fed, Pd. 1	Head		138	140
" " Pd. 2	Head		138	140
Dairy	Cow	1		
Sows farrowed, Qu. 1	Sow	33	3	3
" " Qu. 2	Sow	33		
" " Qu. 3	Sow	33	2	
" " Qu. 4	Sow	33		
(3) Hog Price @ $16.57/Cwt.				
Net income	$	21,562	21,565	22,229
Dry beans	Acre	44	44	44
Corn	Acre	53	53	53
Alfalfa	Acre	17	17	7
Sugar beets	Acre	13	13	13
Wheat	Acre	20	20	25
Real estate credit	$	23,097	23,023	26,608
Chattel and private credit	$	15,087	15,309	17,480
Yearlings fed, Pd. 1	Head		5	56
" " Pd. 2	Head			56
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	35	34	24
" " Qu. 2	Sow	35	34	24
" " Qu. 3	Sow	35	34	24
" " Qu. 4	Sow	35	34	24

TABLE 9.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM CASH CROP FARM IN THUMB AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	9,177	5,705	5,537	5,537	5,834	10,306	10,279	9,616	
Hay purchased	Tons	20	20	21	21	21	1		4	62
Silo constructed	"									45
Beef housing	Animal	27	82	83	83	81				15
Low mechanized feeding	"	27	82	83	83	81				15
Dairy cows	Head									12
Hog farrowing	Sow	21					31	32	30	
Hog feeding	Head	355					527	532	508	
Seasonal labor	Man hrs.	339	213	204	204	213	293	293	234	
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn	"	20.79	14.50	14.50	3.08	4.70	20.74	21.91	1.18	
Sugar beet acreage limit	"	53.22	59.06	59.06	63.56	59.46	54.30	56.15	56.70	69.26
Wheat	"	32.07	31.73	31.73	38.09	41.13			32.08	37.33
Capital	$	.31	.26	.26	.15	.14	.35	.34	.08	.06
Labor:	$/hr.									
Dec., Jan., Feb., Mar.										
Apr., May		2.64	2.55	2.55	2.31	2.31	2.72	2.71	2.18	.47
June - July		2.64	2.55	2.55	2.31	2.31	1.83	2.71	2.18	.93
August										
Sept. - Oct. 15		.97				.99			2.18	1.67
Oct. 15 - Nov. 30		2.64	2.55	2.55	2.31	2.31	2.72	2.71	2.18	
Cropland	$/acre	30.01	32.28	32.28	28.72	24.87	63.76	62.20	34.29	33.40
Land rented	"	35.27	38.00	38.00	38.63	36.09	43.70	40.36	34.91	47.64

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

to be profitable to purchase more labor, the MVP of that labor must be greater than $2.02 plus 2.02 times the MVP for capital (the opportunity cost of the money to be spent for hired labor). In all cases, the MVP's of cropland and rental land were large enough that it would have been profitable to expand farm size had it been permitted. Credit was most often the limiting resource. August labor was seldom exhausted. The major purchases required were corn, beef cattle facilities, and hog facilities.

The optimal organizations for the Large Cash Crop farm were very similar to those for the Medium Cash Crop farm. The levels of the activities are higher which is consistent with the larger resource base for the Large farms. The dairy enterprise is a little more competitive with beef and hogs than on the Medium Cash Crop farm. The solutions, resource acquisition, and MVP's for the Large Cash Crop farm are presented in Tables 3 and 4 in Appendix B.

Dairy Farms

The Small-Medium Dairy farm has a 21 cow stanchion dairy and the Large Dairy farm has a 41 cow stanchion dairy. The Dairy farms in the Thumb tend to have more family labor available for farm work than do the Cash Crop farms.

The optimal organizations and net incomes for the Small-Medium Dairy farm are presented in Table 10. At MLL prices, dairy remains the major enterprise. At MLM, MLH, MMM and MMH, a combination of beef and dairy enterprises was optimal. Combinations of hog and dairy enterprises result at MML, MHL and MHM prices. However, a general type farm becomes optimal at MHH prices.

The amounts of specific resources acquired and MVP's for specific resources for the Small-Medium Dairy are shown in Table 11. Again, large quantities of corn purchases and investments in hog and beef facilities are indicated by the optimal solutions. The MVP's for cropland and land rental indicate possible expansion in farm size. The rental rate for land in the

TABLE 10.--OPTIMAL ORGANIZATIONS FOR SMALL-MEDIUM DAIRY FARM IN THE THUMB AREA - PHASE 1

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	14,300	17,360	22,043
Dry beans	Acre	53	22	22
Corn	"	22	53	53
Alfalfa	"			
Sugar beets	"	4	4	4
Wheat	"	16	16	16
Real estate credit	$		14,334	14,305
Chattel and private credit	$		16,072	16,072
Yearlings fed, Pd. 1	Head	8	120	138
" " Pd. 2	"	8	120	138
Dairy	Cow	25	22	13
Sows farrowed, Qu. 1	Sow	2		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"			
(2) Hog Price @ $13.73/Cwt.				
Net income	$	15,155	17,448	22,076
Dry beans	Acre	22	22	22
Corn	"	53	53	53
Alfalfa	"	5		
Sugar beets	"	4	4	4
Wheat	"	16	16	16
Real estate credit	$	20,887	14,295	14,283
Chattel and private credit	$	5,777	16,072	16,072
Yearlings fed, Pd. 1	Head		118	138
" " Pd. 2	"		118	138
Dairy	Cow	25	22	13
Sows farrowed, Qu. 1	Sow	21	2	2
" " Qu. 2	"	21		
" " Qu. 3	"	21	2	
" " Qu. 4	"	21		
(3) Hog Price @ $16.57/Cwt.				
Net income	$	21,686	21,916	23,060
Dry beans	Acre	22	18	22
Corn	"	53	53	53
Alfalfa	"	11	15	6
Sugar beets	"	4	4	4
Wheat	"	16	16	16
Real estate credit	$	23,843	19,865	24,893
Chattel and private credit	$	13,356	16,072	16,072
Yearlings fed, Pd. 1	Head		2	41
" " Pd. 2	"			41
Dairy	Cow	13	14	10
Sows farrowed, Qu. 1	Sow	34	34	28
" " Qu. 2	"	34	34	28
" " Qu. 3	"	34	34	28
" " Qu. 4	"	34	34	28

TABLE 11.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL-MEDIUM DAIRY FARM IN THUMB AREA - PHASE 1

Item	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	11,134	6,231	6,101	5,583	5,798	11,564	10,952	6,409	528
Hay purchased	Tons	51	100	103	149	148	62	52	122	120
Silo constructed	"				16	16				32
Beef housing	Animal		67	68	69	67				32
Low mechanized feeding	"	21	85	85	73	72				
Dairy cows	Head								3	3
Hog farrowing	Sow	25					31	31	18	
Hog feeding	Head	438				528	528	425	329	
Seasonal labor	Man hrs.	335	224	229	487	498	395	330	520	68
Marginal value productivities:										
Bean acreage limit	$/acre									1.18
Corn	$/acre	21.27	13.30	13.30	6.84	6.84	23.65	22.01	.77	
Sugar beet	"	49.16	57.54	57.54	54.08	54.08	44.00	41.06	57.19	68.21
Wheat	"	32.05	35.39	35.39	40.23	40.23	17.36	16.09	43.80	46.07
Capital	$	.29	.27	.27	.14	.14	.32	.33	.08	.05
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"									
Apr. - May	"	2.61	2.56	2.56	2.30	2.30	2.67	2.69	2.06	2.11
June - July	"	2.61	1.79	1.79	2.30	2.30	1.84	.51	2.06	
August	"									
Sept. - Oct. 15	"	2.08	2.56	2.56	2.30	2.30	2.67	2.69	2.06	2.11
Oct. 15 - Nov. 30	"	2.61			2.30	2.30	2.67	2.69	2.06	2.11
Cropland	$/acre	46.08	55.77	55.77	47.81	47.81	71.32	75.17	44.67	46.56
Land rented	"	44.31	51.51	51.51	41.33	41.33	50.65	55.29	39.34	50.25

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

Thumb model was estimated to be approximately $33 per acre. The MVP's for sugar beet contract indicated the farm could pay from $41 to $68 for another acre of sugar beet contract at the margin.

The optimal organizations for the Large Dairy farm were very similar to those for the Small-Medium Dairy except the levels of the activities were higher. The resulting optimal organizations, resource acquisitions, and MVP's for the Large Dairy farm are presented in Tables 5 and 6 of Appendix B. The most significant difference between the organizations for the Medium and Large Dairy farms is elimination of the dairy enterprise at MHL, MHM and MHH prices for the Large Dairy farm.

The main effect of lowering corn price is more corn purchases and some substitution of dry beans for corn acreage at low livestock prices.

South Central Area

There are significant differences in the organizations of the representative farms between the existing and the programmed optimal organizations for the South Central area. The adjustments in organizations depend upon size of farm, type of farm, and prices.

Type and Size Effects

In 1960 farms in the South Central area were divided among livestock, cash grain, dairy and general type farms. Using the criteria employed in this study the general type farms were reclassified into one of the other three types depending upon which enterprise contributed the greatest percent to gross income. The resulting classification by type gave 30 percent livestock farms, 28 percent cash grain, and 42 percent dairy farms. These farms were then classified by size. The size-type classification delineates the representative farm situations programmed.

The effects of size and type upon farm adjustments from the existing (1960) to the optimal organization are revealed in Table 12. The 1966 medium projected prices for corn, hogs and beef cattle are used for the comparisons. All other prices used to obtain the optimal solutions are the 1966 projected prices.

Table 12 shows the estimated gross incomes and proportions of income by enterprise for 1960 and for the optimal organization. Also, the optimal and 1960 enterprise levels are compared. It should be recalled at this time that the hog and beef cattle prices are about $3 and $4 per cwt. less, respectively, in the optimal solution than those used for estimating the 1960 gross income. See Table 6 in this chapter and Table A-3 in the Appendix A for the specific prices used.

In most representative farm situations the proportions of income derived from certain enterprises change considerably from the existing to the optimal organization. The most significant change for the Livestock farms is the two to two and one-half times increase in proportion of gross income coming from beef cattle sales. No feed grains are sold. Livestock farms in 1960 had from 59 to 72 percent of their income from hog and beef cattle sales while in optimal organization the livestock sales contribute 82 to 89 percent of gross income.

The most significant changes in income sources for the Cash Grain farms are the decreases in feed grain and cash crop sales and the large percentage increases in income from livestock sales, especially beef sales. The increase in proportion of income from beef cattle sales is from an average of 4 percent to over 70 percent of gross returns. No feed grains are sold; they are used by the livestock enterprises.

The Dairy farms change from dairy to dairy-livestock farms. Dairy sales contribution in 1960 was approximately 75 percent of gross income,

TABLE 12.--GROSS INCOME AND PERCENT OF INCOME BY ENTERPRISE AND ENTERPRISE LEVELS FOR FARMS IN THE SOUTH CENTRAL AREA

Representative Farm Situation	Gross Income 1960	Gross Income Optimal	Feed Grains 1960	Feed Grains Optimal	Cash Crop 1960	Cash Crop Optimal	Beef Cattle 1960	Beef Cattle Optimal	Dairy 1960	Dairy Optimal	Hogs 1960	Hogs Optimal	Others 1960	Others Optimal
Proportion of Income by Enterprise														
Small Livestock	$ 8,470	24,776	8	0	9	4	21	22	6	14	50	61		5
Medium Livestock	9,576	29,958	4	0	11	10	58	25	7	4	38	28		15
Large Livestock	23,349	53,523	8	0	15	11	79	29	6	0	30	10		12
Small Cash Grain	3,891	13,995	18	0	58	8	74	6	7	4	6	14		5
Medium Cash Grain	6,988	25,462	29	0	47	15	65	2	9	4	5	16		8
Large Cash Grain	16,041	40,973	42	0	32	18	75	4	5	1	4	6		13
Small Dairy	8,271	20,542	4	0	11	4	55	0	73	19	9	22		3
Medium Dairy	10,397	26,206	4	0	10	8	61	0	72	21	6	10		8
Large Dairy	22,455	54,396	5	0	9	12	57	0	77	28	6	3		3
Enterprise Levels [a]														
Small Livestock			34	28	10	16	16	63	0	6	12	60		
Medium Livestock			58	47	18	49	25	208	2	2	13	32		
Large Livestock			141	153	36	96	56	499	3	0	16	20		
Small Cash Grain			19	23	34	16	2	122	1	1	1	8		
Medium Cash Grain			45	43	51	63	0	195	2	2	2	16		
Large Cash Grain			131	153	70	122	10	364	2	1	2	10		
Small Dairy			25	36	14	12	0	128	12	14	3	17		
Medium Dairy			51	62	18	31	1	183	15	18	3	10		
Large Dairy			103	94	28	112	4	369	29	27	4	7		

[a] Crops are stated in terms of acres and livestock in terms of numbers of beef cattle, dairy cows and sows.

but in the optimal organization dairy sales contribute only 23 percent. There is a slight increase in the proportion of income received from hog sales from 7 to approximately 12 percent. The greatest change is from 0 percent of sales made up of beef cattle in 1960 to near 55 percent in the optimal organization. Again, no corn is sold.

In the optimal organization, based on the type of farm criteria for this study, all farms become livestock farms at medium projected prices. The changes in the levels of the enterprises are presented in the lower half of Table 12.

The acreage of farms and quantities of resources already on hand affect farm adjustments, particularly the level of the activities. The level of all activities varies directly with farm size except the hog enterprises. The level of these activities is more dependent upon the quantities of hog farrowing and feeding facilities already on the farm (see Table 5 in Chapter III for quantities of these resources).

The feed grain activities are approximately the same for the existing and the optimal organizations. Cash crops, mainly soybeans, increase in acreage. This land for the soybeans has been shifted from the hay crops. The wheat acreage is grown up to the acreage restriction. All other crops are approximately the same as the 1960 levels. No feed grains are sold. The changes in crop enterprise levels are presented in the lower half of Table 12.

The optimal level of the dairy activity is about the same as in 1960. The main difference in the dairy activity levels occurs on the Small and Medium Dairy farms where increases of 2 and 3 cows occurred. Changes in livestock enterprises are shown in the lower part of Table 12.

Beef cattle and hog enterprises experience many-fold increases for all representative farm situations. In the optimal organization, the level

of the beef cattle enterprise ranges from 63 head on the Small Livestock farm to 499 on the Large Livestock farm. The hog enterprise increases from 12 sows (one to four farrowings) in 1960 to as high as 60 sows (single farrowings) on the Small Livestock farm in the optimal organization.

The additional resources required to change the activities to the levels indicated by the optimal reorganizations are presented by representative farms in the following section to this chapter.

Effects of Prices on Organization

The prices of corn, hogs and beef cattle were varied in the South Central model, also. Each price took three levels (high, medium and low) which lead to 27 different price combinations and 27 optimal solutions. Not all solutions were unique. On the average, there were usually from 6 to 12 significantly different solutions for each representative farm situation. The corn price had the least effect on organization of the three prices varied; therefore, only the solutions with corn at the medium price of $.97 per bushel are presented in the text of this thesis. Many of the solutions presented below may be identical, while the revenues may be difference since prices vary.

A lower corn price resulted in greater corn purchases and a slight increase in the hog enterprise relative to the beef cattle enterprise. The effects of increasing the price of corn from medium to high were decreased corn purchases and a slight increase in beef production accompanied by a small reduction in the swine enterprise.

Livestock Farms

The Livestock farms delineated in this study have facilities for both hogs and beef cattle and grow cash grain crops, primarily wheat and soybeans. The Small Livestock farm is less than 100 acres in size, while the Medium and Large Livestock farms are 100 to 200 acres and over 200 acres, respectively.

The programmed optimal organizations for the Medium Livestock farm are presented in Table 13. The solutions for the medium corn price and various beef and hog prices are given in this table. Reading across the table, one can observe the effects of changing beef prices on organization. By reading down the table, the effects of varying hog prices are exhibited.

At low livestock prices, the Medium Livestock representative farm becomes a general type farm producing cash crops, feeding 46 beef steers, farrowing 13 sows, and milking 16 grade A dairy cows. When prices are MLM, MLH and MMH the principal enterprise is beef cattle with droves ranging from 244 to 262 heads. The hog enterprise becomes the dominant enterprise at MML, MHL and MHM prices. At MMM and MHH prices a combination of beef cattle and hog enterprises is optimal. Wheat is always grown up to the acreage restriction.

The net incomes for the different organizations and the credit required are given in Table 13, also. Some of the other resources acquired to obtain the optimal organizations are stated in Table 14. Large corn purchases are required for medium or high livestock prices. Additional investments are required in 38 to 55 units of beef facilities and in swine facilities. Some seasonal labor is required.

The marginal value productivities (MVP's) for selected resources are presented in the lower half of Table 14. As is exhibited by the MVP's of cropland and land rented, it would be more profitable for the farm to become more intensive. The rental rate for land in the South Central area was estimated to be $20 per acre. In Phase 1, farm size was not permitted to vary; therefore, cropland and presently rented land had to be forced into the solution. This should explain the low MVP's for land.

The optimal organization of the Small Livestock farm includes the same activities as the Medium Livestock farm with only the levels different.

TABLE 13.--OPTIMAL ORGANIZATIONS FOR MEDIUM LIVESTOCK FARM IN THE SOUTH
CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel		Unit	Beef Prices per Cwt.		
			$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.					
Net income		$	7,386	10,417	14,860
Soybeans		Acre	31	31	31
Corn		"	47	47	47
Alfalfa		"	22	21	21
Wheat		"	18	18	18
Real estate credit		$	9,411	13,073	12,526
Chattel credit		$		9,355	9,355
Private credit		$	2,400	2,400	2,400
Yearlings fed,	Pd. 1	Head	46	126	131
" "	Pd. 2	"		126	131
Dairy		Cow	16	2	
Sows farrowed,	Qu. 1	Sow	10		
" "	Qu. 2	"			
" "	Qu. 3	"			
" "	Qu. 4	"	3		
(2) Hog Price @ $13.98/Cwt.					
Net income		$	9,632	11,068	15,097
Soybeans		Acre	31	31	31
Corn		"	47	47	47
Alfalfa		"	22	21	21
Wheat		"	18	18	18
Real estate credit		$	16,514	12,683	12,374
Chattel credit		$	9,355	9,355	9,355
Private credit		$	2,400	2,400	2,400
Yearlings fed,	Pd. 1	Head		104	122
" "	Pd. 2	"		104	122
Dairy		Cow	6	2	
Sows farrowed,	Qu. 1	Sow	31	13	11
" "	Qu. 2	"	31	3	
" "	Qu. 3	"	31	13	
" "	Qu. 4	"	31	3	2
(3) Hog Price @ $16.82/Cwt.					
Net income		$	17,010	17,010	17,362
Soybeans		Acre	31	31	31
Corn		"	47	47	47
Alfalfa		"	13	13	17
Wheat		"	18	18	18
Real estate credit		$	20,562	20,562	15,892
Chattel credit		$	9,355	9,355	9,355
Private credit		$	2,400	2,400	2,400
Yearlings fed,	Pd. 1	Head			46
" "	Pd. 2	"			46
Dairy		Cow			
Sows farrowed,	Qu. 1	Sow	36	36	25
" "	Qu. 2	"	36	36	25
" "	Qu. 3	"	36	36	25
" "	Qu. 4	"	36	36	25

TABLE 14.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM LIVESTOCK FARM IN SOUTH CENTRAL AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	10,846	7,139	6,323	6,146	8,053	11,877	11,877	10,605	1,041
Hay purchased	Tons									
Silo constructed	"									21
Beef housing	**A. units** Head	50	50	55	52	38				
Low mechanized feeding	"	50	50	55	52	38				
Dairy cows	Head								4	14
Hog farrowing	Sow	12					23	23	18	
Hog feeding	Head	294				21	463	463	382	
Seasonal labor	Man hrs.	474	416	386	416	452	464	464	517	310
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn	"	44.26	41.59	41.59	32.64	32.64	44.26	44.26	29.52	24.97
Wheat	"	28.50	29.72	29.72	28.92	28.92	28.50	28.50	23.40	34.90
Capital	$	.32	.28	.28	.16	.16	.32	.32	.12	.06
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"	3.01	2.93	2.93	2.65	2.65	3.01	3.01	2.55	2.41
Apr. - May	"	3.01	2.93	2.93	2.65	2.65	3.01	3.01	2.55	2.41
June - July	"									
August	"									
Sept. - Oct. 15	"								.23	
Oct. 15 - Nov. 30	"	3.01	2.93	2.93	2.65	2.65	3.01	3.01	2.55	2.41
Cropland	$/acre	5.30	5.04	5.04	9.10	9.10	5.30	5.30	15.49	17.07
Land rented	"	1.09	.95	.95	1.51	1.51	1.09	1.09	2.51	4.27

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

The optimal organization, additional resource requirements, and MVP's for the Small Livestock farm are presented in Tables 7 and 8 in Appendix B. The level of the beef cattle enterprise at MLH prices is 180 steers, whereas for the same price combination on the Medium farm there are 262 head of steers. At MMM and MMH prices for the Small farm farrows 58 and 15 sows, respectively, while the Medium farm farrows only 32 and 13 sows. The dairy enterprise is at a slightly higher level on the Small Livestock farm for MLM and MMM prices than on the Medium Livestock farm. In all other respects, the levels of the crop and livestock activities for the Medium Livestock farm are greater than the same activities on the Small Livestock farm.

The MVP's for cropland and rented land is much higher on the Small Livestock farm than on the Medium Livestock farm. In all cases, the MVP's for cropland are greater than the rental rate of $20 per acre. It ranged from $26.61 to $35.86 per acre.

The optimal organizations for the Large Livestock farm were very similar to those for the Medium Livestock farm. The levels of the activities were higher; for example, the beef cattle activity for MMH prices had 516 steers compared to 244 for the Medium Livestock farm. More resources were acquired on the Large Livestock farm. The optimal organizations, resource acquisition, and MVP's for the Large Livestock farm are stated in Tables 9 and 10 in Appendix B. With respect to the MVP's, rented land had a negative MVP because the farm size was forced to remain constant, that is, rented land was forced into the optimal solutions. The MVP for cropland in the case of MLM prices should be negative instead of zero, but there was an error in one of the controls for the programming routine which allowed the farm to idle some of its own land until the MVP was zero.

Cash Grain Farms

The Small, Medium and Large Cash Grain farms typify the less than 100 acres, 100 to 200 acre, and over 200 acre cash grain farms in the South Central area. In 1960, these farms had very few livestock or livestock facilities. Usually some member of the family had an off-farm job. In the programmed solutions all of these farms turn out to be Livestock farms except at low livestock prices. However, acreages of feed grains and cash grains were approximately the same for both the 1960 and optimal organization. Some expansion in soybeans occurred at the expense of hay crops.

The optimal organizations for the Medium Cash Grain representative farms are presented in Table 15. This table exhibits the effects on farm organization of varying hog and beef cattle prices. At MLL prices the Medium Cash Grain farm is a Dairy farm with 24 grade A dairy cows. When prices are MLM, MLH and MMH, the major enterprise is beef cattle. Hogs become the major enterprise at MML, MHL, MHM and MHH prices. MMM prices result in both hog and beef production. The size of the beef enterprise ranges from 17 head at MLL prices to 224 head at MLH prices. Sow farrowings vary from 5 at MLL prices to 124 at MHL prices. Wheat is always grown to the wheat acreage restriction.

The additional resources required to reach the optimal organizations and the MVP's for selected resources are presented in Table 16. Again, large quantities of corn purchases are required and investments in beef and hog facilities are necessary to obtain the optimal. The MVP's for cropland are low. It is characteristic throughout the results for the South Central area for the MVP to be lower on cropland as the farm size increases.

The optimal organizations, resource acquisitions, and MVP's for the Small and Large Cash Grain representative farms are presented in Tables 11, 12, 13 and 14 in Appendix B. The organizations are very similar to those

TABLE 15.--OPTIMAL ORGANIZATIONS FOR MEDIUM CASH GRAIN FARM IN THE SOUTH CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.36
(1) Hog Price @ $11.14/Cwt.				
Net income	$	7,654	10,401	14,199
Soybeans	Acre	18	41	41
Corn	"	43	43	43
Alfalfa	"	43	19	17
Wheat	"	22	22	22
Real estate credit	$	19,050	16,750	16,755
Chattel credit	$		7,624	7,624
Private credit	$	2,700	2,700	2,700
Yearlings fed, Pd. 1	Head	17	108	112
" " Pd. 2	"		108	112
Dairy	Cow	24	2	1
Sows farrowed, Qu. 1	Sow	1		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	4		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	9,511	10,645	14,288
Soybeans	Acre	39	41	41
Corn	"	43	43	43
Alfalfa	"	22	19	17
Wheat	"	22	22	22
Real estate credit	$	21,114	16,407	16,298
Chattel credit	$	7,624	7,624	7,624
Private credit	$	2,700	2,700	2,700
Yearlings fed, Pd. 1	Head		97	109
" " Pd. 2	"		97	109
Dairy	Cow	9	2	1
Sows farrowed, Qu. 1	Sow	24	4	1
" " Qu. 2	"	24	4	
" " Qu. 3	"	24	4	
" " Qu. 4	"	24	4	4
(3) Hog Price @ $16.82/Cwt.				
Net income	$	15,800	15,814	15,902
Soybeans	Acre	41	41	41
Corn	"	43	43	43
Alfalfa	"	12	12	11
Wheat	"	22	22	22
Real estate credit	$	26,123	26,123	25,216
Chattel credit	$	7,624	7,624	7,624
Private credit	$	2,700	2,700	2,700
Yearlings fed, Pd. 1	Head			9
" " Pd. 2	"			9
Dairy	Cow	1	1	1
Sows farrowed, Qu. 1	Sow	31	31	28
" " Qu. 2	"	31	31	28
" " Qu. 3	"	31	31	28
" " Qu. 4	"	31	31	28

TABLE 16.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM CASH GRAIN FARM IN SOUTH CENTRAL AREA - PHASE 1

| | Unit | Price Combinations [a] |
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	9,751	5,489	5,172	5,090	6,009	9,975	9,975	8,210	
Hay purchased	Tons									
Silo constructed	"									81
Beef Housing	A. units		65	67	64	57				5
Low mechanized feeding	Head		65	67	64	57				5
Dairy cows	"								7	22
Hog farrowing	Sow	25					27	27	20	
Hog feeding	Head	430				28	453	453	347	
Seasonal labor	Man hr.	147	93	93	121	125	150	150	214	145
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn	"	44.28	44.08	44.08	35.32	34.91	44.28	44.28	29.46	25.47
Wheat	" , "	28.57	29.33	29.33	28.97	29.01	28.57	28.57	23.56	34.66
Capital	$	.32	.30	.30	.18	.18	.32	.32	.12	.06
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"									
Apr. - May	"	3.01	2.96	2.96	2.50	2.68	3.01	3.01	2.55	2.03
June - July	"	2.84	2.96	2.96	2.69	2.68	2.84	2.84	2.55	2.41
August	"									
Sept. - Oct. 15	"									
Oct. 15 - Nov. 30	"	3.01					3.01	3.01	2.55	.25
Cropland	$/acre	5.60	5.01	5.01	8.67	8.60	5.60	5.60	15.61	22.31
Land rented	"	1.65	6.55	6.55	7.08	6.49	1.65	1.65	2.77	10.99

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

for the Medium Cash Grain farm; however, the levels of the activities vary directly with the size of farm and the initial resource base. For example, at MMM prices the Small farm has 122 head of yearlings and 8 sows farrowing, while the Large Cash Grain farm has 364 steers and 11 sows farrowing. All solutions have wheat at the level of the acreage restriction. The MVP's for rented land is above the rental rate for the Small farm and negative for the Large farm. Family labor (operator and family members) supply is seldom exhausted on the Small farm, but the Large farm buys additional labor under every solution.

Dairy Farms

The price effect from varying livestock prices does not drive dairy out in the South Central area as it did on the Large Dairy farm at MHH prices in the Thumb. However, the level of the dairy enterprise decreases as live-stock prices increase from low to high. The dairy enterprise for the Small and Medium Dairy farms is an exception since it is made up of the grade A and grade B facilities on these farms; therefore, the resulting enterprise is a combination of A and B dairying. Since the resources are statistical averages of those making up the size-type strata, this situation needs to be explained. If the solution results in both grade A and grade B, then the following reasoning may apply. There is no mixture of grade A and grade B production on an individual farm, but those farms that have grade A facil-ities would produce grade A and those that have grade B facilities would produce grade B. The Small Dairy farm had 7 units of grade A capacity and 5 units of grade B. The Medium Dairy farm had 10 units of grade A capacity and 8 units of grade B facilities. These farms, in optimal organization, produce up to the grade A capacity limit, and the remainder of the produc-tion is grade B. Any expansion that occurred was in grade B production because of the relatively inexpensive cost of grade B facilities.

The optimal solutions for the Medium Dairy farm are presented in Table 17. The effects of varying hog and beef prices are shown in this table by reading down and across the table. At low livestock prices the dairy enterprise is most important. When prices are MLM, MLH and MMH, the farm becomes a beef-dairy farm. A hog-dairy farm results when prices are MML, MHL, MHM and MHH. MMM prices give a beef-dairy-hog farm. The dairy herd ranges from 13 cows at MLH and MHM prices to 35 cows at MLL prices.

The additional resource requirements and MVP's for the Medium Dairy farm are given in Table 18. The MVP's for land indicates that it would not be profitable to expand farm size under the assumed price and output conditions. However, in almost every solution the MVP's for corn land and wheat land are above the rental rate. This indicates the farm would very likely find it profitable to expand these acreages if this type of land could be obtained.

The optimal organizations for the Small and Large Dairy farms are very similar to the solutions for the Medium Dairy farm. The levels of the activities are the only essential differences. The effects of varying hog and beef cattle prices, optimal organizations, resource acquisitions, and MVP's for the Small and Large Dairy farms are presented in Tables 15, 16, 17 and 18 in Appendix B.

Optimal Organizations and Adjustments for Phase 2

Phase 2 of the analysis permits land, machinery and managerial labor to vary. The initial levels of these resources were the same as for Phase 1. As part of the survey, data were collected from the farmers concerning potential land rentals and land purchases. Farmers interviewed were questioned as to the quantity, quality, location and term of acquisition of land tracts available for purchase and/or for rent. Efforts were made to delete all double counting. This information was summarized and

TABLE 17.--OPTIMAL ORGANIZATIONS FOR MEDIUM DAIRY FARM IN THE SOUTH CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	9,924	12,658	16,284
Soybeans	Acre		13	6
Corn	"	43	43	37
Alfalfa	"	64	33	32
Wheat	"	19	19	17
Real estate credit	$	2,583	12,191	12,217
Chattel credit	$		8,959	8,959
Private credit	$	2,100	2,100	2,100
Yearlings fed, Pd. 1	Head	8	99	101
" " Pd. 2	"	8	99	101
Dairy	Cow	35	18	17
Sows farrowed, Qu. 1	Sow	2		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	1		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	11,513	12,793	16,340
Soybeans	Acre	13	12	7
Corn	"	43	43	38
Alfalfa	"	32	33	32
Wheat	"	19	19	17
Real estate credit	$	15,056	12,058	12,183
Chattel credit	$	8,959	8,959	8,959
Private credit	$	2,100	2,100	2,100
Yearlings fed, Pd. 1	Head		92	99
" " Pd. 2	"		92	99
Dairy	Cow	18	18	17
Sows farrowed, Qu. 1	Sow	26	4	3
" " Qu. 2	"	26	1	
" " Qu. 3	"	26	4	
" " Qu. 4	"	26	1	
(3) Hog Price @ $16.82/Cwt.				
Net income	$	17,228	17,412	17,687
Soybeans	Acre	41	37	12
Corn	"	42	42	38
Alfalfa	"	22	22	26
Wheat	"	19	18	17
Real estate credit	$	20,816	20,977	20,380
Chattel credit	$	8,959	8,959	8,959
Private credit	$	2,100	2,100	2,100
Yearlings fed, Pd. 1	Head			8
" " Pd. 2	"			
Dairy	Cow	13	13	17
Sows farrowed, Qu. 1	Sow	28	28	26
" " Qu. 2	"	28	28	26
" " Qu. 3	"	28	28	26
" " Qu. 4	"	28	28	26

TABLE 18.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM DAIRY FARM IN SOUTH CENTRAL AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	9,811	5,734	5,601	5,014	5,559	10,058	10,057	9,069	
Hay purchased	Tons									43
Silo constructed	"									
Beef housing	A. units		59	60	60	55				
Low mechanized feeding	Head		59	60	60	55				
Dairy cows	"	2	2	2	3	2			3	20
Hog farrowing	Sow	22					24	24	22	
Hog feeding	Head	397					419	419	392	
Seasonal labor	Man hr.	418	359	408	545	555	459	468	563	191
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn	"	44.78	42.03	42.03	33.12	33.12	45.28	45.48	30.18	14.03
Wheat	"	25.80	27.12	27.12	32.09	32.09	25.56	25.93	33.83	34.65
Capital	$	.31	.27	.27	.15	.15	.31	.32	.11	.06
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"									
Apr. - May	"	2.98	2.89	2.89	2.61	2.61	2.99	3.01	2.52	2.41
June - July	"	2.98	2.89	2.89	2.61	2.61	2.99	3.01	2.52	2.41
August	"									
Sept. - Oct. 15	"	2.38	2.60	2.60	2.61	2.61	2.34	1.86	2.52	2.41
Oct. 15 - Nov. 30	"	2.98	2.89	2.89	2.61	2.61	2.99	3.01	2.52	
Cropland	$/acre	9.66	10.44	10.44	13.27	13.27	9.52	7.97	14.25	23.01
Land rented	"				.85	.85			1.24	6.38

a/ The upper case letter H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

analyzed to determine the quantities and prices of land for sale and rent for the representative farm situations. Land values were projected to 1966 on the basis of current trends in land prices for each area.

In the Thumb area the estimated quantity of land for sale was 40 acres and the quantity for rent was 40 acres. The purchase price was estimated at $575 per acre, while the rental rate was estimated at $32.63 (at medium corn prices) per cropland acre. In addition, it was assumed that the farms could buy another 40 and rent another 40 acres at a 20 percent increase in price. This was called land 2 in the model as described in Chapter IV. Land 2 prices were estimated at $690 and $39.16 (at medium corn prices) for purchase and rental, respectively.

In the South Central area there were 80 acres for sale and 40 acres for rent. The costs to gain control of an acre of land were $283 and $20, respectively, for buying and renting. The farms were permitted the opportunity to acquire 40 more acres by purchasing and 40 more by renting at costs of 20 percent higher than the first tracts.

The Phase 2 model had alternatives for renting out and selling land. If the representative farm sold land, it was required to pay off the real estate debts. Thus, the resulting net sale price was less than the price for acquiring land.

By allowing land and other major durable resources to vary in the Phase 2 model, one can observe not only the effects of varying corn, hog and beef cattle prices but also the effects of changing the land area of farms. The optimal organizations for Phase 2 are presented below by geographic area.

Thumb Area

Only the most important differences in the results for Phase 2 from those for Phase 1 will be pointed out in this section. Since organization

changes very little as corn price changes, only the solutions at the medium

corn price are presented. As the optimal organizations for different sizes

of representative farms, within type, are quite similar, only Medium size

farm solutions are presented in table form for each type of farm.

Cash Crop Farms

The same prices for corn, hogs and beef cattle were used in Phase 2

as were used in Phase 1. The responses in production are somewhat greater

to price changes in Phase 2 than in Phase 1 since other resources are permit-

ted to vary in the model. The optimal organizations for the Medium Cash Crop

farm are presented in Table 19.

As prices vary for hogs and beef cattle in Phase 2, the changes in

organization are very similar to those in Phase 1. The main differences in

the optimal organizations for the Cash Crop farms in the Thumb area for

Phase 1 and Phase 2 are: (1) Farms acquire all the land available for rent

at all price combinations which permit the farms to expand their crop activ-

ity levels; (2) an increase in crop production occurs instead of adding dairy

in the competition for resources; (3) with MML prices, dry beans are expanded

at the expense of corn on the Large Cash Crop farm and the level of the

swine enterprise is reduced substantially from the Phase 1 level; (4) the

levels of the net incomes are increased in all cases without exception, and

levels of the beef cattle and hog enterprises are increased above the Phase

1 levels for most price combinations.

Table 20 reveals the resource acquisitions, resource sales, and

MVP's for selected resources in optimal organizations for the Medium Cash

Crop farm. As in the case of Phase 1, large quantities of purchased corn

are necessary and large investments in hog and beef facilities are made.

Also in Phase 2 more seasonal labor is required than in Phase 1; sales of

TABLE 19.--OPTIMAL ORGANIZATIONS FOR MEDIUM CASH CROP FARM IN THUMB AREA - PHASE 2

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $ $10.89/Cwt.				
Net income	$	18,142	21,555	27,014
Dry beans	Acre	131	39	39
Corn	"	45	113	113
Alfalfa	"	14		
Oats	"	11	21	21
Sugar beets	"	21	19	19
Wheat	"	41	36	36
Land contract credit used	$	9,200		
All other credit used	$	27,016	36,662	37,692
Yearlings fed, Pd. 1	Head	53	189	162
" " Pd. 2	"		159	162
Dairy	Cow	5		
Sows farrowed, Qu. 1	Sow	1		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	2		
(2) Hog Price @ $13.73/Cwt.				
Net income	$	19,565	21,652	27,038
Dry beans	Acre	96	39	39
Corn	"	75	113	113
Alfalfa	"	8		
Oats	"	15	21	21
Sugar beets	"	20	19	19
Wheat	"	40	36	36
Land contract credit used	$	5,593		
All other credit used	$	27,090	36,607	37,647
Yearlings fed, Pd. 1	Head		156	160
" " Pd. 2	"		156	160
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	18	3	3
" " Qu. 2	"	18		
" " Qu. 3	"	18	2	
" " Qu. 4	"	18		
(3) Hog Price @ $16.57/Cwt.				
Net income	$	27,235	27,235	27,624
Dry beans	Acre	39	39	39
Corn	"	113	113	113
Alfalfa	"	19	19	8
Oats	"	2	2	13
Sugar beets	"	17	17	19
Wheat	"	36	36	36
Land contract credit used	$			
All other credit used	$	40,769	40,769	47,121
Yearlings fed, Pd. 1	Head			47
" " Pd. 2	"			47
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	40	40	30
" " Qu. 2	"	40	40	30
" " Qu. 3	"	40	40	30
" " Qu. 4	"	40	40	30

TABLE 20.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM CASH CROP FARM IN THUMB AREA - PHASE 2

Item	Unit	Price Combinations [a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired or sold: [b]										
Seasonal labor	Man hrs.	1,042	964	959	946	956	988	988	861	787
Operator labor	Hour	-314	-348	-354	-363	-351	-310	-310	-563	-563
Family labor	"	-683	-683	-683	-683	-683	-683	-683	-683	-683
Managerial labor	Op. hr.	257	38	45	35	43	275	275		
Land	Acre									
Rented land [c]	"	93	98	98	98	98	98	98	31	40
Buy high priced land	"								98	98
Rent high cost land	"	40	40	40	40	40	40	40	40	40
Grain harvest equip.	Acre cap.	-69	-69	-69	-69	-69	-69	-69	-13	23
Corn picking	"	85	85	85	85	85	85	85	47	16
Beef housing	An. unit	22	95	96	94	92	85	85		26
Low mech. feeding	Head	22	95	96	94	92				26
Dairy cows	"	-1	-1	-1	-1	-1	-1	-1	-1	-1
Hog farrowing	Sow	27					37	37	15	
Hog feeding	Head	463				612	612	612	267	
Marginal value productivities:										
Capital	$	.23	.21	.21	.12	.10	.26	.26	.07	.08
August labor	$/hr.	.21							.71	
Sept.–Oct. 15 labor	"	1.96	1.93	1.93	1.78	1.75	2.01	2.01	.71	2.17
Cropland	$/acre	21.96	21.52	21.52	15.27	18.04	23.00	23.00	13.52	11.19
Rented land	"	20.27	20.03	20.03	14.38	18.11	20.84	20.84	18.46	22.61
Managerial labor	$/hr.	1.65	1.63	1.63	1.50	1.48	1.70	1.70	.32	

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

[b] A minus sign in front of the entry indicates sale and no sign indicates purchase.

[c] A minus sign in front of the entry indicates renting land out while no sign indicates renting in.

operator and family labor occur, additional managerial labor is acquired; sales of grain harvesting and purchase of corn picking equipment are necessary to obtain the optimal organizations. In the lower part of Table 20, the MVP's of certain resources are presented for the Medium Cash Crop farm. In comparing the MVP's with those for the same resources in Phase 1, one finds them considerably smaller in most cases. This is to be expected when variation in restricting resources is allowed.

The optimal organizations for the Small and Large Cash Crop farms vary from the optimal organizations for the Medium Cash Crop farm as they did in Phase 1. The most significant difference was the use of land contract credit under the MLM, MML and MMM price situations, but the Large Cash Crop farm never uses this source of credit. The optimal organization, resource transactions, and MVP's for the Small and Large Cash Crop farms are not presented in this thesis but are summarized and on file in the Department of Agricultural Economics. However, the optimal levels of specific resources for all representative farm situations at medium prices are compared in the last major section of this chapter (pages 128-140).

Extended Phase 2 Model

The extended model for Phase 2 results from increasing the resource restrictions for land 2 rental and land 2 buying. The Large Cash Crop representative farm was used as an example to study the effect of further farm land area expansion on farm organization. The optimal organization for the Large Cash Crop farm at medium prices using the extended model is presented in Table 19 in Appendix B. This table compares the original (1960), Phase 1 optimal, Phase 2 optimal, and the extended Phase 2 optimal organizations of the Large Cash Crop farm for the Thumb area.

The optimal organization at MMM prices differs very little from the organization using the Phase 2 model at the same prices. The farm rents

all the available land 2 and increases crop acreages. Dry beans acreages increase from 60 to 75 acres. Corn increases from 169 to 210 acres. Oats increase from 32 to 40 acres, sugar beets increase from 25 to 31 acres, and wheat increases from 52 to 64 acres. Thus, crops stay in about the same relationship to each other though total acreage increases. There are increases of 62 steers fed and 7 sows farrowed annually. The total credit used is expanded from $54,399 to $64,190. Some additional seasonal labor and managerial labor are hired.

With the extended model, more beef cattle and fewer hogs are produced at high livestock prices and the medium corn price. When land is allowed to vary and livestock prices are low, corn is sold and beef steers are reduced from 57 to 15 head.

The effects of varying the price of corn when land is varied, as in the extended model, are as follows: (1) When increasing corn price from medium to high, less corn is purchased and corn is sold at low livestock prices; (2) when corn price is low, more corn is bought and less grown, while dry beans take over the land that was used for corn production at medium and high corn prices.

The main effects of allowing further expansion of farm size in the extended Phase 2 can be summarized as follows: (1) Increases in crop acreages occurred; (2) slight increases in livestock activities were indicated; and (3) more labor and machinery were acquired.

Dairy Farms

When land and other resources are allowed to vary in the model, the effects of varying corn, hog and beef cattle prices are much more pronounced than in Phase 1. In Phase 1 dairying was hard to drive out of the organization, but in Phase 2 dairying is in the optimal organizations only with the MLL and MML price combinations. In reality this is what has

been happening in the Thumb area. Some of the main reasons why this happens
are that the grade A dairy enterprise takes large quantities of labor,
particularly managerial type labor and the return for labor from cash crop
production is relatively high. The optimal organizations for the Small-Medium
Dairy farm are presented in Table 21.

The main differences between the organizations in Phase 1 and Phase
2 for the Dairy farms are the increases in crop acreages and the substitu-
tion of cash crops for hog production in the case of MML prices. The net
revenues are greater and the levels of the livestock enterprises, in general,
are above those in Phase 1. The resource transactions necessary to achieve
the optimal organizations for the Small-Medium Dairy farm are presented in
Table 22. This table also includes MVP's for selected resources. The MVP's
for the resources are, in general, much less than their MVP's in Phase 1
except for labor, and it is higher. The most striking difference is probably
the reduction in the amount of seasonal labor hired. Compared to the Cash
Crop farm solutions, the Dairy farms require more managerial and seasonal
labor purchases.

The optimal organizations, resource transactions, and MVP's for the
Large Dairy farm were very similar to the Small-Medium Dairy farm except the
levels of the activities were usually higher for the Large farm. The most
interesting difference for the Large Dairy farm was the number of steers fed
out in period 1 relative to the number fed out in period 2 for the MLM and
MMM price combinations. For example, at MMM prices 491 steers in period 1
are fed out while only 331 are fed out in period 2. This can be explained
in part by the fact that the period 1 beef activity's major use of labor
comes in the winter months when the crop activities are not competing for
labor.

South Central Area

From Phase 1, several indications were revealed about potential

TABLE 21.—OPTIMAL ORGANIZATIONS FOR SMALL-MEDIUM DAIRY FARM IN THUMB AREA - PHASE 2

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	18,734	21,047	26,931
Dry beans	Acre	102	37	37
Corn	"	40	93	93
Alfalfa	"	6		
Sugar beets	"	11	10	10
Wheat	"	30	28	28
Land contract credit used	$			
All other credit used	$	10,943	30,442	31,600
Yearlings fed, Pd. 1	Head	20	171	174
" " Pd. 2	"		171	174
Dairy	Cow	19		
Sows farrowed, Qu. 1	Sow			
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	2		
(2) Hog Price @ $13.73/Cwt.				
Net income	$	19,213	21,115	26,951
Dry beans	Acre	110	37	37
Corn	"	43	93	93
Alfalfa	"	6		
Sugar beets	"	12	10	10
Wheat	"	32	28	28
Land contract credit used	$			
All other credit used	$	26,299	30,401	31,571
Yearlings fed, Pd. 1	Head		169	173
" " Pd. 2	"		169	173
Dairy	Cow	21		
Sows farrowed, Qu. 1	Sow	7	2	2
" " Qu. 2	"	7		
" " Qu. 3	"	7	2	
" " Qu. 4	"	7		
(3) Hog Price @ $16.57/Cwt.				
Net income	$	26,739	26,739	27,578
Dry beans	Acre	37	37	37
Corn	"	93	93	93
Alfalfa	"	19	19	12
Sugar beets	"	10	10	10
Wheat	"	28	28	28
Land contract credit used	$			
All other credit used	$	36,481	36,481	40,807
Yearlings fed, Pd. 1	Head			63
" " Pd. 2	"			63
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	41	41	29
" " Qu. 2	"	41	41	29
" " Qu. 3	"	41	41	29
" " Qu. 4	"	41	41	29

TABLE 22.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL-MEDIUM DAIRY FARM IN THUMB AREA - PHASE 2

	Unit	Price Combinations [a]								
		MHH	MMH	MLH	MIM	MMM	MHM	MHL	MML	MLL
Items acquired or sold: [b]										
Seasonal labor	Man hrs.	914	770	768	761	764	846	846	867	711
Operator labor	Hour	-434	-446	-446	-446	-446	-408	-408	-446	-446
Family labor	"	-340	-340	-340	-340	-340	-340	-340	-340	-340
Managerial labor	Op. hr.	206	49	43	20	33	160	160	685	306
Land	Acre								38	20
Rented land [c]	"	70	70	70	70	70	70	70	70	70
Buy high priced land	"									
Rent high cost land	"	40	40	40	40	40	40	40	40	40
Grain harvest equipment	Acre cap.	-39	-39	-39	-39	-39	-39	-39		
Corn picking	"	36	36	36	36	36	36	36		26
Beef housing	An. unit		71	72	70	69				
Low mech. feeding	Head	36	108	108	106	105				5
Dairy cows	"	-22	-22	-22	-22	-22	-22	-22	-1	-3
Hog farrowing	Sow	26					38	38	4	
Hog feeding	Head	455				648	648	648	91	
Marginal value productivities:										
Capital	$	.21	.21	.21	.10	.10	.24	.24	.06	.06
August labor	$/hr.	1.56					1.72	1.72	2.02	1.25
Sept.-Oct. 15 labor	"	1.71	2.45	2.45	2.22	2.22	1.72	1.72	2.02	2.14
Cropland	$/acre	20.17	21.76	21.76	18.25	18.25	51.54	51.54	13.99	13.65
Rented land	"	20.25	19.82	19.82	17.77	17.77	23.71	23.71	14.13	13.32
Managerial labor	$/hr.	1.41	1.84	1.84	1.67	1.67	1.41	1.41	1.39	1.54

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

[b] A minus sign in front of the entry indicates sale and no sign indicates purchase.

[c] A minus sign in front of the entry indicates renting land out while no sign indicates renting in.

expansion. The very low MVP's on cropland and rented land indicated that expansion along the extensive margin (increasing land area) would not be profitable in the South Central area with bare land priced at $283 an acre. Also, the relative high MVP's on capital indicated that if further sources of capital were made available at prevailing interest rates, it would be profitable for the farms to borrow such capital.

The prices farmers reported they would have to pay for land were probably high with respect to what would actually have to be paid. In most cases the MVP's for wheat acreage and additional corn land were above the cost of renting an acre of land. This indicates that it would be profitable to expand if only the corn or wheat acreages could be acquired without acquiring the other land on the farm or if less were to be paid for land. Also, this indicates that renters could pay more than the current rental rate for such land or landlords could charge higher rental rates for wheat and corn acreages.

In Phase 2 where land, machinery, family labor (operator and family members), and managerial labor were all variable, the optimal organizations of the representative farms for the South Central area were much different than for Phase 1. Only the optimal organizations for medium corn prices and medium types of farms are presented in this thesis. The other solutions are summarized and are on file in the Department of Agricultural Economics.

Livestock Farms

The outstanding difference between the results for the Livestock farms for Phase 1 and Phase 2 is the reduction in farm size in Phase 2. Land rented in 1960 is usually not rented, and at many price combinations land is sold. The sale of this land provides capital for expanding the livestock enterprises. However, when the corn price is $1.17 per bushel, the farms seldom sell land, especially the Large farms. Even at high corn prices, the optimal solution indicates less land rental than in 1960.

The optimal organizations for the Medium Livestock farm in Phase 2
are presented in Table 23. The main differences between these solutions
and those for Phase 1 are: (1) the reduction in crop acreages and (2) the
increase in livestock activity levels. For example, at MLM prices the beef
cattle enterprise increased from 252 to 298 head. At the same price combina-
tion, soybeans go from 31 acres to zero and corn goes from 47 acres down to
24. The net incomes are higher in Phase 2 than Phase 1 at any given price
combination.

The most significant changes from Phase 1 to Phase 2 are exhibited in
Table 24. This table presents the changes in resources required to obtain
the optimal organizations. The most important indications in this table are
the sales of operator and family labor, the sale of land (as much as all of
the owned cropland), very little renting of land, the machinery sales, and
the MVP's.

The optimal organizations for the Small and Large Livestock farms dif-
fered much the same way from Phase 1 as did the Medium Livestock farm. There
was one real difference for the Large Livestock farm. At high corn prices,
land was never sold.

Cash Grain Farms

The Cash Grain farms also sell land and fail to rent as much land
as they did in 1960. This tended to be the case for all representative
farms for the South Central area in Phase 2. There was, in general, a reduc-
tion in crop acreages and a decrease in the quantity of capital borrowed
since the land sales furnished capital and resulted in paying off the real
estate debts. On the Cash Grain farms, dairy is less competitive with other
activities in Phase 2 than in Phase 1. The optimal solutions for the Medium
Cash Grain representative farm are presented in Table 25.

TABLE 23.--OPTIMAL ORGANIZATIONS FOR MEDIUM LIVESTOCK FARM IN SOUTH CENTRAL AREA - PHASE 2

Corn Price @ $.97/Bushel		Unit	Beef Prices per Cwt.		
			$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.					
Net income		$	9,355	12,775	17,952
Soybeans		Acre	5		
Corn		"	33	24	24
Alfalfa		"	22	18	18
Oats		"	5		
Wheat		"	13	9	9
Credit used		$	12,832	14,679	14,359
Yearlings fed,	Pd. 1	Head	46	149	154
" "	Pd. 2	"		149	154
Dairy		Cow	16		
Sows farrowed,	Qu. 1	Sow	10		
" "	Qu. 2	"			
" "	Qu. 3	"			
" "	Qu. 4	"	3		
(2) Hog Price @ $13.98/Cwt.					
Net income		$	11,554	13,325	18,065
Soybeans		Acre	16		
Corn		"	33	25	25
Alfalfa		"	16	20	19
Oats		"			
Wheat		"	13	10	10
Credit used		$	25,453	17,709	14,142
Yearlings fed,	Pd. 1	Head		124	145
" "	Pd. 2	"		124	145
Dairy		Cow			
Sows farrowed,	Qu. 1	Sow	33	3	12
" "	Qu. 2	"	33	10	
" "	Qu. 3	"	33	3	
" "	Qu. 4	"	33	10	2
(3) Hog Price @ $16.82/Cwt.					
Net income		$	19,749	19,749	20,112
Soybeans		Acre			
Corn		"	17	17	19
Alfalfa		"	8	8	11
Oats		"			
Wheat		"	7	7	8
Credit used		$	29,697	29,697	24,140
Yearlings fed,	Pd. 1	Head			46
" "	Pd. 2	"			46
Dairy		Cow			
Sows farrowed,	Qu. 1	Sow	41	41	31
" "	Qu. 2	"	41	41	31
" "	Qu. 3	"	41	41	31
" "	Qu. 4	"	41	41	31

TABLE 24.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM LIVESTOCK FARM IN SOUTH CENTRAL AREA - PHASE 2

Items acquired or sold: b/	Unit	Price Combinations a/								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Seasonal labor	Man hrs.	325	297	242	208	242	286	286	196	157
Operator labor	Hour	-280	-406	-454	-489	-489	-292	-292	-489	-489
Family labor	"	-273	-273	-273	-273	-273	-273	-273	-273	-273
Managerial labor	Op. hr.									
Land										
Rented land c/	Acre	-78	-78	-78	-70	-44	-78	-78		
Buy high priced land	"	23	38	35	29	12	16	16		
Rent high cost land	"									
Grain harvest equip.	Acre cap.	-61	-59	-58	-58	-59	-62	-62	-53	-56
Corn picking	"	-79	-74	-74	-74	-73	-74	-74	-65	-71
Beef housing	An. unit		64	70	67	51				
Low mech. feeding	"		64	70	67	51				
Dairy cows	Head	-2	-2	-2	-2	-2	-2	-2	-2	14
Hog farrowing	Sow	18					28	28	20	
Hog feeding	Head	388	555				555	555	414	
Marginal value productivities:										
Capital	$	.25	.23	.23	.13	.13	.26	.26	.08	.06
August labor	$/hr.									
Oct. 15-Nov. 30 labor	"	.46	.80	.80	1.65	1.65	1.63	1.63	.68	2.41
Cropland	$/acre	22.83	21.40	21.40	18.60	18.61	20.66	20.66	8.81	7.99
Rented land	"									
Managerial labor	$/hr.	.11			1.02	1.02	1.02	1.02		.01

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

b/ A minus sign in front of the entry indicates sale and no sign indicates purchase.

c/ A minus sign in front of the entry indicates renting land out while no sign indicates renting in.

TABLE 25.--OPTIMAL ORGANIZATIONS FOR MEDIUM CASH GRAIN FARM IN SOUTH CENTRAL AREAL - PHASE 2

Corn Prices @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	11,226	13,764	18,109
Soybeans	Acre	33	30	
Corn	"	33	34	16
Alfalfa	"	14	17	20
Oats	"			
Wheat	"	19	19	12
Credit used	$	3,174	26,755	13,798
Yearlings fed, Pd. 1	Head	9	117	136
" " Pd. 2	"	9	117	136
Dairy	Cow	9	1	1
Sows farrowed, Qu. 1	Sow	4		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	1		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	12,327	13,923	18,150
Soybeans	Acre	33	25	
Corn	"	34	31	16
Alfalfa	"	14	18	20
Oats	"			
Wheat	"	19	18	12
Credit used	$	21,274	25,114	13,724
Yearlings fed, Pd. 1	Head		112	133
" " Pd. 2	"		112	133
Dairy	Cow	1	1	1
Sows farrowed, Qu. 1	Sow	24	1	4
" " Qu. 2	"	24	5	
" " Qu. 3	"	24	1	
" " Qu. 4	"	24	5	1
(3) Hog Price @ $16.82/Cwt.				
Net income	$	19,312	19,325	19,415
Soybeans	Acre			
Corn	"	9	10	11
Alfalfa	"	10	11	12
Oats	"			
Wheat	"	10	10	11
Credit used	$	24,687	24,535	23,625
Yearlings fed, Pd. 1	Head			9
" " Pd. 2	"			9
Dairy	Cow		1	1
Sows farrowed, Qu. 1	Sow	36	36	34
" " Qu. 2	"	36	36	34
" " Qu. 3	"	36	36	34
" " Qu. 4	"	36	36	34

Table 25 shows the effects of varying the prices of hogs and beef cattle with land and other major durable resources variable on the organizations of the Medium Cash Grain farm. The main differences between the solutions under Phase 1 and Phase 2 are (1) a lower level of dairy activity at MLL prices, (2) decreases in the crop activity levels, and (3) slight increases in the beef and hog activities in Phase 2. The most significant decrease in crops is the decline in soybean acreages. For example, under MMH, MHL, MHM and MHH prices there were 41 acres of soybeans in Phase 1 but no acres in Phase 2.

Table 26 shows the shows the quantities of resources bought or sold and MVP's for selected resources for the Medium Cash Grain farm. This table indicates that the farm operator's work off the farm from 645 to 1292 hours, while the family members work 347 hours per year off the farm. One hundred acres of cropland are sold under most price combinations and most of the grain harvesting and corn picking equipment are sold. The MVP's are lower for the resources than is the case for the Phase 2 solutions. Capital has an MVP ranging from 6 cents to 26 cents.

The optimal organizations for the Small and Large Cash Grain farms are very similar to those for the Medium Cash Grain farm except the levels of the activities vary directly with the size of farm. For example, at the MMM prices the level of the beef cattle enterprise is 188, 224 and 386 for Small, Medium and Large Cash Grain farms, respectively. The Medium and Large Cash Grain farms never sell land at the high corn price. All Cash Grain farms have some family members with off-farm employment, which is consistent with what cash grain farmers were doing in the South Central area in 1960.

Dairy Farms

The Dairy representative farms were not as quick to sell land as were

TABLE 26.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM CASH GRAIN FARM IN SOUTH CENTRAL AREA – PHASE 2

Items acquired or sold:[b]	Unit	MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Seasonal labor	Man hrs.	61			23	7	62	44	48	
Operator labor	Hour	-645	-691	-715	-770	-738	-651	-700	-668	-1292
Family labor	"	-347	-347	-347	-347	-347	-347	-347	-347	-347
Managerial labor	Op. hr.									
Land	Acre	-100	-100	-100	-100		-100	-100	-100	
Rented land[c]	"	13	29	29		-11	10	11	20	
Buy high priced land	"									
Rent high cost land	"									
Grain harvest equip.	Acre cap.	-96	-95	-95	-77	-82	-97	-97	-74	-74
Corn picking	"	-85	-79	-79	-61	-64	-85	-86	-61	-65
Beef housing	An. unit		81	83	70	67				
Low mech. feeding	"		81	83	70	67				
Dairy cows	Head	-1	-1	-1	-1	-1	-2		-1	
Hog farrowing	Sow	30				32	32		20	
Hog feeding	Head	501				534	540		344	7

Marginal value productivities:

	Unit	MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Capital	$	.26	.24	.24	.12	.12	.26	.26	.07	.06
August labor	$/hr.	.24	.24	.24			.26	.26		
Oct. 15 – Nov. 30 labor	"	.87	.87	.87	.54	.54	.87	.87	.44	
Cropland	$/acre	18.49	16.28	16.28	7.06	6.47	18.49	18.49	2.11	6.78
Rented land	"									
Managerial labor	$/hr.									.37

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

[b] A minus sign in front of the entry indicates sale and no sign indicates purchase.

[c] A minus sign in front of the entry indicates renting land out while no sign indicates renting in.

the Livestock and Cash Grain representative farms when product prices varied

because of the higher value on pasture. At the high corn price none of the

Dairy representative farms disposed of owned land. However, only at LLL,

MLL and HLL prices do the Dairy farms remain dairy farms. In Phase 1, the

dairy enterprise was always in the optimal organizations for the Dairy farms,

but in Phase 2 the dairy enterprise tends to be left out of the optimal

organization any time when either one or both of the livestock prices are

high. The optimal organizations for the Medium Dairy farm are presented in

Table 27.

The solutions for the Medium Dairy farm differ from those in Phase 1

in several ways. The level of the dairy enterprise is reduced and the levels

of the hog and beef activities are increased in Phase 2. Also, there is a

reduction in the crop acreages since the size of the farm has been reduced

by selling land and/or failing to rent land in. Less borrowed capital is

acquired in Phase 2, for example, at MMM prices the Medium Dairy farms obtain

$23,117 in Phase 1 and $18,995 in Phase 2. The reason for this decline in

the use of credit is the use of capital acquired by land sales and liquida-

tion of the dairy herd.

Table 28 reveals the quantities of resources bought and sold in

order to reach the optimal organizations for various price combinations for

the Medium Dairy farm in Phase 2. This table also indicates the MVP's of

specific resources. Less seasonal labor is acquired and the MVP's of the

resources are lower than in Phase 1 for the same farm. The family had off-

farm jobs up to the limits of the restrictions, and usually the operator

took off-farm employment up to the off-farm labor restriction limit. The

operators were permitted to work off the farm approximately 700 hours

annually, while the family members were permitted approximately 300 hours

of off-farm employment. Again, as is the case for all the representative

TABLE 27.—OPTIMAL ORGANIZATIONS FOR MEDIUM DAIRY FARM IN SOUTH CENTRAL AREA – PHASE 2

Corn Price @ $.97/Bushel		Unit	Beef Prices per Cwt.		
			$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.					
Net income		$	12,047	14,929	19,386
Soybeans		Acre	37	6	
Corn		"	39	23	16
Alfalfa		"	20	27	22
Oats		"			
Wheat		"	17	12	9
Credit used		$	2,100	19,063	11,951
Yearlings fed,	Pd. 1	Head	18	116	143
" "	Pd. 2	"	18	116	143
Dairy		Cow	15	10	2
Sows farrowed,	Qu. 1	Sow	2		
" "	Qu. 2	"			
" "	Qu. 3	"			
" "	Qu. 4	"	1		
(2) Hog Price @ $13.98/Cwt.					
Net income		$	13,444	15,032	19,416
Soybeans		Acre	25	6	
Corn		"	32	23	16
Alfalfa		"	22	27	22
Oats		"			
Wheat		"	15	12	9
Credit used		$	16,174	18,995	11,939
Yearlings fed,	Pd. 1	Head		113	141
" "	Pd. 2	"		113	141
Dairy		Cow	10	10	2
Sows farrowed,	Qu. 1	Sow	21	1	3
" "	Qu. 2	"	21	2	
" "	Qu. 3	"	21	1	
" "	Qu. 4	"	21	2	
(3) Hog Price @ $16.82/Cwt.					
Net income		$	20,298	20,322	20,556
Soybeans		Acre			
Corn		"	9	9	10
Alfalfa		"	13	13	14
Oats		"			
Wheat		"	7	7	7
Credit used		$	21,921	21,921	20,361
Yearlings fed,	Pd. 1	Head			27
" "	Pd. 2	"			27
Dairy		Cow	8	8	1
Sows farrowed,	Qu. 1	Sow	31	31	31
" "	Qu. 2	"	31	31	31
" "	Qu. 3	"	31	31	31
" "	Qu. 4	"	31	31	31

TABLE 28.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON MEDIUM DAIRY FARM IN SOUTH CENTRAL AREA - PHASE 2

	Unit	Price Combinations [a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired or sold: [b]										
Seasonal labor	Man hrs.	48			145	159	81	81	172	62
Operator labor	Hour	-693	-693	-693	-454	-438	-693	-693	-552	-693
Family labor	=	-291	-291	-291	-291	-291	-291	-291	-291	-291
Managerial labor	=									
Land	Op. hr.									
Rented land [c]	Acre	-94	-89	-89	-32	-32	10	10		
Buy high priced land	=	12	24	25						13
Rent high cost land	=									
Grain harvest equip.	Acre cap.	-59	-73	-73	-70	-70	-75	-75	-57	-45
Corn picking	=	-59	-53	-53	-48	-48	-59	-59	-40	-35
Beef housing	An. unit	13	75	68	71	86	-13	-13	-5	6
Low mech. feeding	Head	-14	87	88	71	86	33	33	17	6
Dairy cows	Head	27	-13	-13	-5	-5				
Hog farrowing	Sow									
Hog feeding	Head	473					566	566	315	
Marginal value productivities:										
Capital	$	.27	.25	.25	.12	.12	.29	.29	.07	.05
August labor	$/hr.	1.34			.54	.54	1.49	1.49	.43	.95
Oct. 15 - Nov. 30 labor	$/hr.		13.23	13.23						
Cropland	$/acre	14.58	13.23	13.23	6.28	6.28	13.22	13.22	8.22	9.43
Rented land	=									
Managerial labor	$/hr.									

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

[b] A minus sign in front of the entry indicates sale and no sign indicates purchase.

[c] A minus sign in front of the entry indicates renting land out while no sign indicates renting in.

farms in the South Central area for Phase 2, Dairy farms sell most of their harvesting machinery.

The optimal organizations of the Small and Large Dairy farms are very similar to those for the Medium Dairy farm except differences exist in the activity levels. In comparing the Phase 2 results for these farms with the Phase 1 results, they differed in almost every instance the same way as did the two sets of results for the Medium Dairy farm. However, the dairy enterprise on the Small Dairy farm was more competitive with the other enterprises than on the Medium Dairy farm while it was less competitive on the Large Dairy farm than the Medium Dairy farm.

<u>Comparing and Assessing the Results from the Different Phases</u>[1]

At medium and high livestock prices, tremendous increases in beef and hog production would occur if farms expanded production as the results for both Phases 1 and 2 indicate. In Phase 2, the solutions call for expansion of farm size (in land area) in the Thumb while contraction in farm size occurs in the South Central area. The discussion which follows in this chapter is based on the assumptions of this study with some indications given of important variables not considered. It should be stated at this time that large scale adoption of these results would yield aggregative price and quantity changes which would invalidate the assumptions of this study. This may be referred to as a self-vitiating hypothesis.

Thumb Area

Many-fold increases in beef cattle and hog production are indicated for the Thumb area at medium and high prices for these products. Some

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[1]The over-all aggregative effects of such increases in production will be examined by Michel Petit. He is a Ph.D. student in the Department of Agricultural Economics and a member of the NC-54 research group.

reduction in dry bean acreages occur in the Thumb. This land is taken over
for corn production since corn is a major complement to the livestock enter-
prises.

Dairy moves out of the Thumb optimal organizations when farms are
permitted to acquire more land. One reason for this is the profitability of
cash crops relative to dairy which places cash crops in a stronger bidding
position for the resources. Which farms will sell land or rent out land is
not determined by Phase 2 for the Thumb area. Both Phase 1 and Phase 2
indicate by their MVP's for cropland, sugar beet acreage, and wheat acreage
that it would be profitable to expand farm size. The MVP's for these
resources on the Small farms are larger, but ability to purchase is in favor
of the Large farms. Therefore, which farms would actually expand in size
would have to be determined by who could pay the highest price and/or make
the purchase of the land.

The levels of specific resources are compared in Table 29 for the
1960, the Phase 1 optimal, and the Phase 2 optimal organizations for the
representative farms at medium prices. This table indicates large increases
in the use of credit over what the farmers in the sample indicated that they
were using in 1960.[1] There are increases in hired seasonal labor. For
example, the Medium Cash Crop farm hired 56, 213 and 956 man hours of sea-
sonal labor in 1960, Phase 1, and Phase 2, respectively. All representative
farm organizations have people working off the farm in Phase 2. There is
a decrease in the managerial labor requirements for the Small and Medium
Cash Crop farms but more managerial labor is needed for the Large Cash Crop
farm . All farms rent in land up to the land rental limit. Only the Small
Cash Crop farm buys land at medium prices.

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[1]These results are consistent with those of Trant's study. See G. I.
Trant, Institutional Credit and the Efficiency of Selected Dairy Farms,
unpublished Ph.D. thesis, Dept. of Agri. Econ., Mich. State Univ., 1959.

TABLE 29.--THE 1960, THE OPTIMAL FOR PHASE 1, AND THE OPTIMAL FOR PHASE 2 RESOURCE LEVELS FOR REPRESENTATIVE FARMS[a] - THUMB AREA

Resource	Unit	Small Cash Crop Farm			Medium Cash Crop Farm			Large Cash Crop Farm		
		1960	Phase 1	Phase 2	1960	Phase 1	Phase 2	1960	Phase 1	Phase 2
Total credit used	$	4,741	27,977	34,382	4,123	36,302	36,607	11,927	54,242	54,399
Seasonal labor hired	Man hr.	24	0[b]	540	56	213	956	572	1,333	1,820
Off-farm work by oper.	Hour	516	NV	540	213	NV	351	267	NV	172
Off-farm work/family	"	125	NV	201	408	NV	683	899	NV	1,556
Managerial labor	Op. hr.	2,604	NV	1,996	2,948	NV	2,596	3,879	NV	4,255
Cropland owned	Acre	62	NV	77	89	NV	89	105	NV	105
Cropland rented	"	19	NV	59	58	NV	98	154	NV	194
Power & tillage equip.	Acre cap.	243	NV	187	278	NV	264	427	NV	397
Grain har. equip.	"	81	NV	30	108	NV	38	121	NV	60
Corn picking equip.	"	27	NV	87	28	NV	113	61	NV	168
Sugar beet har. equip.	"	10	NV	14	25	NV	19	38	NV	25
Sugar beet haul.	"	9	NV	14	16	NV	19	23	NV	25
Beef housing	Animal	6	61	70	9	90	101	10	151	156
Beef feed. fac.	"	6	61	70	9	90	101	10	151	156
Milk cows	Head	1	1	0	1	0	0	6	4	0
Hog farrowing fac.	Sow	2	2	2	3	3	3	3	4	3
Hog feeding fac.	Head	36	50	36	44	44	44	124	124	124

a/ The medium prices are used for corn, hogs and beef cattle in these comparisons for Phases 1 and 2.

b/ NV denotes this resource was not allowed to vary in Phase 1.

TABLE 29.--continued

Resource	Unit	Small-Medium Dairy Farm			Large Dairy Farm		
		1960	Phase 1	Phase 2	1960	Phase 1	Phase 2
Total credit used	$	3,593	30,367	30,401	17,314	90,932	92,011
Seasonal labor hired	Man hr.	501	498	764	1,905	4,919	2,378
Off-farm work by operator	Hour	369	NV	446	0	NV	0
Off-farm work by family	"	163	NV	340	594	NV	934
Managerial labor	Op. hr.	2,995	NV	2,526	4,253	NV	5,272
Cropland owned	Acre	76	NV	76	242	NV	242
Cropland rented	"	30	NV	110	101	NV	181
Power & tillage equipment	Acre cap.	282	NV	221	411	NV	514
Grain harvesting equipment	"	76	NV	37	113	NV	93
Corn picking equipment	"	57	NV	93	95	NV	215
Sugar beet harvesting equipment	"	19	NV	10	14	NV	22
Sugar beet hauling equipment	"	10	NV	10	27	NV	22
Beef housing	Animal	5	73	74	5	225	264
Beef feeding facilities	"	5	77	110	5	225	319
Milk cows	Head	22	22	0	41	38	0
Hog farrowing facilities	Sow	3	3	3	2	2	2
Hog feeding facilities	Head	28	28	93	24	24	24

In general, there are increases in corn picking equipment required and decreases in power and tillage and grain harvesting equipment. For all Cash Crop farms, there is an increase in beet hauling capacity but a decrease in beet harvesting capacity on the Medium and Large Cash Crop farms. The solutions indicate that the Large Dairy farm would purchase some sugar beet harvesting capacity, while the Small-Medium Dairy farm sells some beet harvesting capacity.

At _medium_ projected prices, dairy production remains in the optimal organizations of the Dairy farms for Phase 1 (land fixed) but is left completely out of the optimal organizations for Phase 2 (land variable). The solutions under Phase 1 are consistent with the results form the Lake States Dairy Study for Michigan.[1] However, the shift in the dairy enterprise that occurs when moving from Phase 1 to Phase 2 is more consistent with current trends for dairying in the Thumb area. In reality, when the farms in the Thumb area expand in land area and family members obtain off-farm employment, dairying becomes less attractive and is usually reduced or sold out. The results of this study indicate that this trend will continue as cash crop acreages, feed grain acreages, beef production, and hog production expand on farms in the Thumb area.

The tremendous increases in beef and hog production and use of credit indicated by the programmed solutions depend upon many factors not considered in the model. The risks associated with beef production were not taken into account in the model. In addition, in the real world farmers may not be aware of the supplies of institutional credit available to them.[2] Also, when

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[1]Dean E. McKee, _op. cit._ Since the Lake States Dairy Study considered dairying in more detail than this NC-54 study, the results from both studies should be considered to determine the comparative advantages of crops, beef, hogs and dairy.

[2]G. I. Trant, _op. cit._ He found that many farmers were not aware of available institutional credit and the conditions surrounding the acquisition of such credit.

all farmers are bidding for resources, input prices are likely to increase while product prices are likely to decrease, tending to limit expansion.[1]

The pressure to expand farm size as indicated by the results of this study for the Thumb area leads to the conclusions that (1) land values will continue to increase in the Thumb area and (2) the price of $575 per acre used in this model was too low for land for farm uses, inasmuch as farm sizes in the Thumb area tend to be stable. Thus, as prices of land are bid up cash crops, feed grains, and livestock (beef and hogs) will become more and more attractive to this area since these enterprises have greater returns for resources than dairying.

South Central Area

The optimal organizations for both Phase 1 and Phase 2 for the representative farms in the South Central area indicate large increases in beef cattle and hog production, as well as increases of 8 to 18 times in the use of credit over what the representative farms were using in 1960. Since this difference in credit use is so great, it seems likely that farmers did not report all credit which they were using in 1960. It is possible that many short term credit contracts were overlooked. Also, the net worth of farmers may not be accurately estimated since real estate values may have been over-estimated.

In Phase 1, the solutions for the South Central farms have MVP's for cropland, except for the Small farms, that indicate contraction in farm size (land area) might be profitable. This does not agree with present trends. Thus, the price of $283 per cropland acre used in the model may be

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[1]The NC-54 Study, "Supply Response and Adjustments for Hog and Beef Cattle Production," plans to consider the aggregate effects of the optimal farm organizations. Harald Jensen of the Univ. of Minn. is Chairman on the NC-54 Committee.

too high for farm use. However, the MVP's for wheat acreage and corn land, in most cases, appear to be high enough to allow further expansion if these specific acreages can be obtained. Another important reason for holding land was not considered in this study. This was land value appreciation due to urbanization and inflation.

The results of this study do not agree with Heady and Egbert's[1] findings for this section of Michigan. This difference may be explained, in part, by two things: (1) Different input-output coefficients were used and (2) the two studies had different objectives and price assumptions. Nevertheless, with beef cattle and hog expansion taking place in the South Central area, feed grains and wheat will continue to be attractive alternatives for this area at current prices. If wheat prices should fall to $1.10 per bushel (or feed grain price for wheat with corn at medium price) with other crop prices constant at current prices, wheat would likely leave the optimal organizations of farms.

In Phase 1, expansion occurs in soybean acreages and reductions occur in hay crop production. The optimal use of specific resources for the representative farms are compared in Table 30 for the South Central area at _medium_ prices.

Table 30 indicates the adjustments in the resource base of the representative farms from one resulting organization to another. Less seasonal labor is hired in Phase 2 than was hired in 1960 except on the Large Dairy, Large Livestock, and Medium Livestock farms which have increases in seasonal labor requirements. Less managerial labor is required except on the Large Livestock farm where there is an increase from 2118 to 2671 operator hours.

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[1]Earl O. Heady and Alvin C. Egbert, op. cit.

TABLE 30.--THE 1960, THE OPTIMAL FOR PHASE 1, AND THE OPTIMAL FOR PHASE 2 RESOURCE LEVELS FOR REPRESENTA-
TIVE FARMS[a] - SOUTH CENTRAL AREA

Resource	Unit	Small Livestock Farm			Medium Livestock Farm			Large Livestock Farm		
		1960	Phase 1	Phase 2	1960	Phase 1	Phase 2	1960	Phase 1	Phase 2
Total credit used	$	1,050	19,256	14,401	2,329	24,438	17,909	7,808	55,215	55,163
Seasonal labor hired	Man hr.	198	0	13	80	452	242	426	3,274	904
Off-farm work by oper.	Hour	850	NV[b]	789	485	NV	489	209	NV	366
Off-farm work/ family	"	337	NV	404	240	NV	273	100	NV	282
Managerial labor	Op. hr.	2,069	NV	1,181	2,168	NV	1,618	2,118	NV	2,671
Cropland owned	Acre	55	NV	33	78	NV	34	145	NV	145
Cropland rented	"	6	NV	0	39	NV	12	161	NV	0
Power & tillage equipment	Acre cap.	156	NV	35	213	NV	44	312	NV	170
Grain har. equipment	"	37	NV	5	69	NV	10	115	NV	25
Corn picking equipment	"	57	NV	21	98	NV	25	123	NV	108
Beef housing	Animal	20	20	20	30	68	81	66	162	170
Beef feed. fac.	"	20	20	20	30	68	81	66	162	170
Milk cows	Head	0	6	0	2	2	0	3	0	0
Hog farrowing fac.	Sow	15	17	33	13	13	13	11	11	11
Hog feed. fac.	Head	250	357	522	214	235	235	228	228	228

a/ The medium prices are used for corn, hogs and beef cattle in these comparisons for Phases 1 and 2.

b/ NV denotes this resource was not allowed to vary in Phase 1.

TABLE 30.--continued

Resource	Unit	Small Cash Grain Farm			Medium Cash Grain Farm			Large Cash Grain Farm		
		1960	Phase 1	Phase 2	1960	Phase 1	Phase 2	1960	Phase 1	Phase 2
Total credit used	$	560	18,765	11,495	3,025	26,731	25,114	4,791	44,198	39,929
Seasonal labor hired	Man hr.	47	0	0	104	125	7	650	1,969	317
Off-farm work by oper.	Hour	1,276	NV	1,456	1,167	NV	738	313	NV	684
Off-farm work/family	"	380	NV	458	287	NV	347	540	NV	691
Managerial labor	Op. hr.	2,700	NV	1,062	2,600	NV	1,770	3,148	NV	2,378
Cropland owned	Acre	59	NV	6	100	NV	89	107	NV	75
Cropland rented	"	8	NV	22	26	NV	0	196	NV	0
Power & tillage equip.	Acre cap.	140	NV	22	218	NV	96	342	NV	72
Grain har. equip.	"	56	NV	12	107	NV	25	112	NV	12
Corn picking equip.	"	50	NV	13	95	NV	31	138	NV	41
Beef housing	Animal	5	40	61	6	63	73	14	118	126
Beef feed. fac.	"	5	40	61	6	63	73	14	118	126
Milk cows	Head	1	1	0	2	2	1	2	1	1
Hog farrowing fac.	Sow	3	3	3	4	4	4	4	4	4
Hog feeding fac.	Head	12	36	12	72	100	72	46	63	46

TABLE 30.--continued

Resource	Unit	Small Dairy Farm			Medium Dairy Farm			Large Dairy Farm		
		1960	Phase 1	Phase 2	1960	Phase 1	Phase 2	1960	Phase 1	Phase 2
Total credit used	$	2,060	20,074	20,965	3,871	23,117	18,995	6,203	45,465	32,340
Seasonal labor hired	Man hr.	104	75	86	201	555	159	752	2,620	895
Off-farm work by oper.	Hour	424	NV	624	314	NV	693	181	NV	310
Off-farm work/family	"	0	NV	0	157	NV	291	336	NV	695
Managerial labor	Op. hr.	2,357	NV	1,655	2,663	NV	1,883	3,443	NV	3,094
Cropland owned	Acre	58	NV	58	94	NV	62	155	NV	61
Cropland rented	"	21	NV	19	32	NV	0	107	NV	0
Power & tillage equip.	Acre cap.	141	NV	76	216	NV	51	379	NV	48
Grain har. equip.	"	56	NV	16	82	NV	12	98	NV	7
Corn picking equip.	"	62	NV	24	68	NV	20	95	NV	24
Beef housing	Animal	0	42	54	5	60	91	5	109	117
Beef feed. fac.	"	0	42	54	5	60	91	5	120	150
Milk cows	Head	12	14	7	15	18	10	29	27	11
Hog farrowing fac.	Sow	4	4	4	4	4	4	5	5	5
Hog feeding fac.	Head	50	50	70	46	46	46	78	78	78

There is a general decrease in the quantities of field crop machinery services required on the representative farm from the 1960 organization to the Phase 2 optimal organization. This would indicate slower machinery purchases, given the usual attitudes of owning machinery and the assumed prices.

The increases indicated in livestock facilities are not nearly so great as for the Thumb area. Cash Grain and Dairy farms have larger increases in beef cattle and hog facilities than the Livestock farms since the initial quantities of such facilities were greater on the Livestock farms.

This indicated expansion in the beef cattle and hog enterprises for the South Central area is consistent with present trends in south central Michigan and northeastern Indiana. The optimal beef system is the low mechanized system (feed delivered to bunks by wagon) for short fed yearlings on drylot. The highly mechanized feeding system was on the verge of coming into many of the optimal organizations, that is, the solutions indicated that one unit of this system could enter the optimal organization without changing total revenue. Since the highly mechanized system uses less labor and the fact that it was near to entering the optimal organizations, indicate that further restrictions on labor would have brought the highly mechanized system in at positive levels. If farmers have difficulty in obtaining adequate supplies of labor and feed grains, they would use the highly mechanized (automated feeding) systems rather than the low mechanized (no automated feed) feeding systems as indicated by this study. Also, since there exists high opportunity cost for labor in industry, the marginal factor cost for labor in agriculture is high.

Dairy herds are reduced in size but do not go completely out as they did in the Phase 2 solutions for the Thumb area. The reduction in the size of the dairy herd on the Large Dairy farm from 1960 to Phase 2 is from 29

to 11 cows. For practical reasons, this would indicate that dairying would be out of the optimal organization because an 11 cow dairy herd is uneconomic in dairying today.

The dairy enterprise is relatively more attractive in the South Central area than in the Thumb area when farms are allowed (in the model) to vary their supplies of stock resources (land, managerial labor and machinery). The South Central area does not have attractive high valued cash crops alternatives such as are available in the Thumb. However, the off-farm employment opportunity for the family labor is somewhat greater in the South Central area. Therefore, with the high opportunity costs for labor and increased expansion in beef and hog production, dairymen will find it more and more difficult to remain in dairying with their current inefficient systems. This is not to say that the very efficient parlor systems are maladjustments. The model did not permit stanchion dairy systems to be converted to parlor-loose housing systems, therefore, the results from this study have little to say about an efficient dairy system versus beef cattle and hog enterprises. However, the parlor-loose housing system was allowed to come into the solutions for the representative farms that did not already have dairy, but it entered only when hog and beef prices were low.

Results of the model indicated that all farms sell land at medium prices in Phase 2 except the Small Dairy and the Large Livestock farms. In Phase 2 every reorganized farm except the Small Cash Grain farm rents less land than it did in 1960. The farms sold land in the Phase 2 optimal organizations to acquire capital to invest in the livestock enterprises. This might not be best in the real world since the model fails to take into account all the advantages of owning land. The solutions indicated that farms with larger net worths (for example Large Livestock) were not as likely to sell land to get capital as farms with low net worths. Also,

with constant costs and linearity of the input-output coefficients, the farms purchase feeds rather than growing them, thereby making the labor and capital needed in crop production available for livestock (beef and hogs) enterprises.

The price used for land in the South Central area model may be higher than what farmers would get when they sold land. If all farmers should want to sell land, then the selling price would fall until some type of equilibrium would be reached. The indication that farm land should be sold to achieve the optimal organizations implies that land is overpriced for farm use in the South Central area. However, land may have other values that were not taken into account in this analysis. These other values could include holding land for urban uses, inflation protection, prestige and family purposes.

CHAPTER VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS

The main objective of this study was to determine optimal farm organizations which would serve as guides to profitable adjustments for representative Michigan and northeastern Indiana farms having a potential for raising feed grains, beef cattle and hogs. Linear programming was used to determine the organizations that would maximize net farm incomes under varying prices for corn, hogs and beef cattle subject to the resource restrictions found on the representative farms in a survey covering 1960 data. Three price levels, low, medium and high, were used for corn, hogs and beef in the analysis.

Representative farms were defined by size and type of farm. Size of farm in this study was defined in terms of total acres operated, while the type of farm was determined by the enterprise contributing the greatest percentage of gross income in 1960. Farms were classified as Large, Medium and Small farms and as Livestock, Cash Crop (Cash Grain in the South Central area) and Dairy farms.

The analysis was repeated for two phases and for two geographic areas. Phase 1 was the traditional linear programming model where land and associated durable resources were assumed fixed. Phase 2 permitted land and associated durable resources whose acquisition prices and salvage values differed to vary where profitable. Separate analyses for the Thumb-Saginaw Valley and for the South Central (including northeastern Indiana) areas took into account differences in soil productivity, urbanization, land prices, and crops grown in the two areas.

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In the remaining sections of this chapter the conclusions, implications of the conclusions, and suggestions for further research are presented.

Conclusions

The general conclusion from this study is that farms similar to the representative Cash Crop and Dairy farms studied could profitably specialize in livestock (beef and hog) production under the assumed conditions. For most of the representative farm situations, beef and hog production dominated. Since this study only considered the production side of the picture at the individual farm level, all these conclusions must be conditioned by the undetermined price impacts of widespread adoption of the conclusions.

First, results of this study will be summarized by Phases. Then, the major conclusions will be stated.

The solutions to the linear programming model for Phase 1 and Phase 2 indicated major changes in the organizations of farms. These changes were shifts into specialized beef and hog farms with field crops using up the remainder of the farm resources.

Phase 2

Phase 2 permitted the expansion or contraction of land, machinery, managerial labor and the sale of operator and family labor off the farm.

The effects on farm organizations of varying the price of corn (with all other product and input prices held constant at the _medium_ projected levels) with land price constant were (1) to produce more corn and buy less corn at high corn prices and (2) to produce less corn and buy more corn at low corn prices. Also, as corn prices moved from medium to high there was a substitution of beef for pork production and vice versa as corn prices were lowered. With medium and high prices for hogs and beef cattle, the production from the beef enterprises experienced many-fold

increases. At medium prices for hogs and beef, hog production increased moderately in the Thumb-Saginaw Valley and South Central areas. However, at low beef prices and medium or high hog prices, hogs replaced beef cattle as the major farm enterprise. At low prices for hogs and beef cattle, dairying became the major enterprise.

The Phase 2 solutions also indicated important changes in crop enterprises and the dairy enterprise. In the Thumb area, corn tended to replace dry beans when hog and beef cattle production entered the optimal organizations. This adjustment was limited in the model by the crop rotations and/or acreage restrictions. In the South Central area there was a substantial increase indicated for soybean acreages. In both areas, the Phase 2 model indicated a reduction from the 1960 acreages in forage crops, as dairy was replaced on the Dairy farms. The dairy enterprise was reduced except at low prices for beef and hogs. The adjustment in the dairy enterprise as indicated by the Phase 2 model is consistent with what is and has been taking place in the Thumb-Saginaw Valley area. With present technology and milk prices for most dairy farms in the Thumb-Saginaw Valley area, dairymen find it increasingly difficult to obtain competitive returns to labor and capital. Unless dairy farms are now organized to make efficient use of labor and grow large quantities of roughages, farmers operating farms similar to the Dairy representative farms in this study should very seriously consider converting their dairy facilities to hog and beef facilities and their roughage growing acreages to cash crops and feed grains. This conclusion does not apply to farms of less desirable soils in the Thumb-Saginaw Valley area that are not adapted to growing cash crops.

In the South Central area, the Phase 2 solutions indicated considerable expansion in beef cattle and hog production. The results from Phase 2 for the South Central area indicated some sales of land or reduction in farm

sizes in order to obtain capital for investing in more beef cattle and hog facilities. However, for larger net worths the analysis indicated that it would be unprofitable to sell such a high proportion of the total land. Sales of the type of land on the representative farms in the South Central area are probably unrealistic. This seems to be the case in view of the current expansion in farm size in the South Central area. The price of land assumed in the model was probably too high. At high corn prices, the model indicated no land sales except on farms with low net worths. Further, the sale of real estate property to maximize profit is not the whole picture. Farmers have other motives. Land serves as a means to security, prestige, inflation protection, etc. Also, present long term rental arrangements may be inappropriate. Further, if all farmers should go "all out" in producing beef and pork, the quantities of resources such as corn, hay and credit would not be available at a constant price, i.e., the farmers would face increasing acquisition prices for these resources. At the same time, the prices for their products would decline as larger quantities are produced over and above that which consumers would accept at the assumed prices.

In both geographic areas, the Phase 2 model indicated that off-farm employment for the family members and the operator usually expanded to the limit permitted in the model except for the case of operator labor when livestock prices were high.

Phase 1

In Phase 1 where land, machinery and managerial labor were fixed and no off-farm employment of family labor was allowed, the results were different than those for Phase 2. However, the general expansion that occurred in Phase 2 for beef cattle (fed steers) and hog production occurred in Phase 1 as well but the enterprises were smaller. The main differences from Phase

2 were (1) more dairying in the optimal organizations than in Phase 2, (2)
smaller crop acreages in the Thumb-Saginaw Valley area and larger crop
acreages in the South Central area than in Phase 2, (3) less seasonal labor
hired for the Thumb-Saginaw Valley area and larger purchases of seasonal labor
for the South Central area than in Phase 2, and (4) the machinery and
machinery services were different than for Phase 2 since the model permitted
buying and selling of machinery in Phase 2. Additional corn picking capacity
was required in Phase 2.

The effects of Phase 2 are more consistent with present trends for
dairying, beef and hog production in both the Thumb-Saginaw Valley and South
Central areas than the results for Phase 1. The Phase 2 results indicated
(1) a reduction in dairying on productive cash crop soils, (2) that the
farms in the Thumb-Saginaw Valley could pay high wages for labor (even includ-
ing managerial labor) while the South Central farms could not, and (3)
changes in machinery inventories in line with shifts to more feed grain and
beef and hog production. These results or indications could not have been
concluded from Phase 1 alone.

The major conclusions from this study can be summarized as follows:

1. The representative farms studied for Michigan and northeastern
   Indiana are not organized to maximize profits.

2. Many resources were not fully utilized on the representative
   farms in 1960.

3. It would be profitable for a large number of Michigan and
   northeastern Indiana farms similar to the representative
   farms to increase their production of beef and prok and
   feed their feed grains to such livestock rather than sell-
   ing feed grains.

4. The results indicate expansion in feed grain acreages in the
   Thumb-Saginaw Valley area and a reduction in forage crops as
   dairying is reduced.

5. The indicated expansion in beef and hogs would require large
   investments in livestock facilities. Also, the large increases
   indicated in beef feeding operations imply a very large
   increase in demand for feeders.
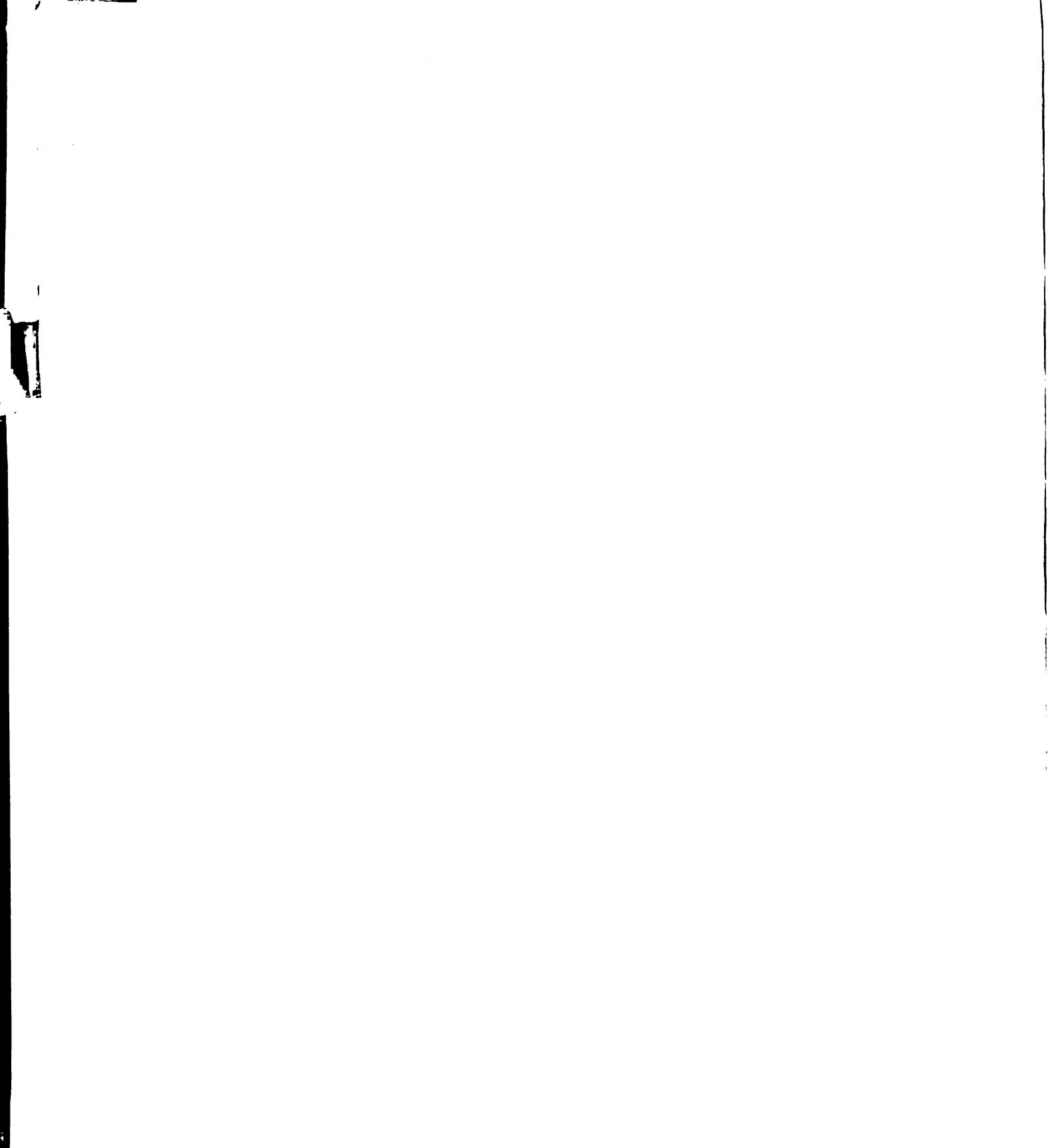
6. Further use of credit on farms similar to the representative farms would be profitable in Michigan and northeastern Indiana.

7. At the same relative price levels (for example, medium prices for hogs and beef), beef production is more competitive for resources than hog production in both the Thumb-Saginaw Valley and the South Central areas. However, hogs are in a stronger position relative to beef cattle in the South Central area than in the Thumb-Saginaw Valley area.

8. Cash cropping and livestock (hog and beef cattle) production are attractive alternatives to dairying for all the representative farms studied. This is due primarily to possibilities of growing more profitable crops on land now allocated to forage crops.

9. Dairymen with stanchion dairy systems on their farms in both the Thumb-Saginaw Valley and South Central areas will find that rising wages for labor make it difficult to obtain profitable returns on their capital. The results indicated that such dairy enterprises should be substantially reduced in both areas. For the Thumb-Saginaw Valley representative farms, the programming model drives dairying completely out in the case of the Phase 2 (land variable) model. However, it should be pointed out that the modern labor efficiency dairy systems were not considered in the model as alternatives for present Dairy farms with stanchion systems.

10. Returns to land in the South Central area were low in comparison to the assumed land price of $283 per acre whereas, in the Thumb-Saginaw Valley area returns were more in line with assumed land price of $575 per acre.

11. It is profitable for family members (excluding the operator) to work off the farm. In many cases, it would be profitable for the operator to have off-farm employment, especially in the winter months.

12. Price, resource base and type of farm affect optimal farm organizations. The effects of these variables on farm organizations were presented in the above section of this chapter.

The above conclusions have important implications and require careful interpretation for Michigan and northeast Indiana agriculture.

Limitations, Other Implications, and Further Study

All solutions for both Phase 1 and Phase 2 for the Thumb-Saginaw Valley and South Central areas show increases in net incomes (gross incomes less variable costs) to representative farms over their 1960 incomes. These

estimates are those that would be obtained if the farms were organized to maximize profits subject to the levels of technology, input-output relations, and other conditions assumed for this linear programming model.

There are many reasons why these organizations and adjustments may differ from what farmers will do. First of all, it would be unprofitable for all of them to make the indicated changes because of the aggregate impacts of these adjustments on product and input markets. Also, farmers may desire a steady flow of income, minimum levels of income, specific enterprises, free week-ends, winter vacations in Florida, etc. In addition, as perfect knowledge does not exist, risk and uncertainty will affect adjustments and sizes of enterprises. Further, some of the optimal solutions for enterprises may be substantially smaller or larger than assumed when constructing the input-output coefficients.

Other reasons why the programmed organizations may not agree with what actually happens surround the characteristics of the linear programming model itself. The solutions are in some cases fractional and impractical, for example, .2 milk cow and a 2 cow dairy herd.[1] Also, the assumption of linearity in the input-output coefficients does not correspond to reality in all cases. In addition, some activities may not be independent. In such instances, the technical input-output coefficients used are inappropriate. For example, feeding purchased feeder pigs and farm raised pigs would not be independent activities since the addition of purchased feeders would necessitate additional expenditures for disease prevention and control when added to the herd.

The optimal solutions for average or medium prices call for several

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[1] The problem of fractional or impractical levels of enterprises could have been handled, in part, by reprogramming the farms with such enterprises blocked out of the solutions.

fold increases in the use of credit. Whether or not farmers expand their use of credit to the extent indicated will affect the attainment of the optimal organizations. Few provisions were made in the model for internal credit rationing; however, external or institutional credit rationing was built into the credit restrictions by taking into account present debts and net worth. Other factors such as age, successfulness, managerial ability, etc., are also important when an institution is lending funds to farmers.

The effects of varying hog, beef and corn prices indicate that beef cattle production has a competitive advantage over swine production on Michigan farms. However, the beef cattle enterprises which enter the optimal solutions are the short fed, drylot, low mechanized feeding systems, while the most common found on the farms surveyed was drylot long fed cattle. Whether or not farmers would be able to find an adequate supply of six to seven hundred pound feeders at the proper time and at the assumed prices is something that would require further investigation of the feeder cattle market. Also, there are more risks associated with buying and selling short fed cattle, especially for inexperienced cattlemen.

The general conclusion implies that the Thumb-Saginaw Valley and South Central areas would change _from_ a feed grain exporting and meat importing area _to_ a feed grain deficient and potential meat exporting area. Whether this development takes place depends in part upon the relationship of supply to demand. The comparative advantage of these areas will be better understood after the results of this study are combined with the results of similar substudies in the NC-54 Study. This will be done after all other states have completed their individual projects. At that time (1) the individual state results will be aggregated[1] and analyzed to determine the optimal adjustments

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[1]An example of aggregating results has been done by James T. Bonnen, Dean E. McKee, and W. B. Sundquist, "Equilibrium Analysis of Profitable Adjustments in Lake States Dairying, 1965," Technical Bulletin in progress at Univ. of Minn. This study was carried out in cooperation with Farm Production Economics Division, Economic Research Service, U.S. Dept. of Agri.

and organization of agriculture for the North Central Region and (2) the demand side of the feed grain-livestock complex will be taken into consideration.

The results from this study and from other theses studies can also be consolidated and compared with those from the functional analysis, time series analysis, and other relevant outlook and projection work to appraise and predict the potential for Michigan agriculture.

Since linear programming results can never be better than the data and ideas fed into the computer, cross-checks should be performed. One such check can be made by comparing the results of the functional analysis of data from the same farms used to define the representative farms programmed in this study with the linear programming results. Such analyses have been performed by this author. However, critical evaluation and some statistical testing of these results are not yet complete and a careful comparison of the linear programming and functional analysis results has not been made. These are to be carried out by this author and reported in another publication.

The conclusions of this study must be examined in light of what the investigations by Brooke,[1] Wagley,[2] Trant[3] and others indicated for farming in the Thumb-Saginaw Valley and South Central areas. Their studies have indicated (1) high returns to cash expenses, (2) low returns to labor in the South Central area, (3) high returns to land in the Thumb-Saginaw Valley area and low returns to land in the South Central area, and (4) dairy "losing out" in the Thumb-Saginaw Valley area and only "fair" in the South Central area. The findings of this study, by and large, agree with their results.

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[1]Brooke, op. cit.

[2]Robert Vance Wagley, Marginal Productivities of Investments and Expenditures, Selected Ingham County Farms, 1952, unpublished M.S. thesis, Ag. Econ. Dept., Mich. State Univ., 1953.

[3]Trant, op. cit.

Results of this study indicate that other activities and restrictions should be added to the linear programming model used. These activities would include activities to permit changes in technologies (using multi-period models), adjustments in existing hog, beef and dairy facilities, and varying the prices of land and labor. Different restrictions should be placed on off-farm employment opportunities by age categories. To see which farms would go out of farming, this restriction should permit full time off-farm employment. Also, additional restrictions should be considered for seasonal labor, credit and extent of adjustments permitted. Another area which merits further study is the effects of weather conditions on input-output coefficients. The feeder pig activities and the fed dairy steer activities should be deleted from the model when sow farrowing systems and beef feeding systems are in the model because the beef and hog activities are always dominant under the assumed conditions. Studies are needed with respect to the resource markets such as credit, feeder cattle and land markets. In addition, the demand for the products studied in this investigation should be examined as well as the demand for factor or inputs demanded by the feed grain-livestock complex.
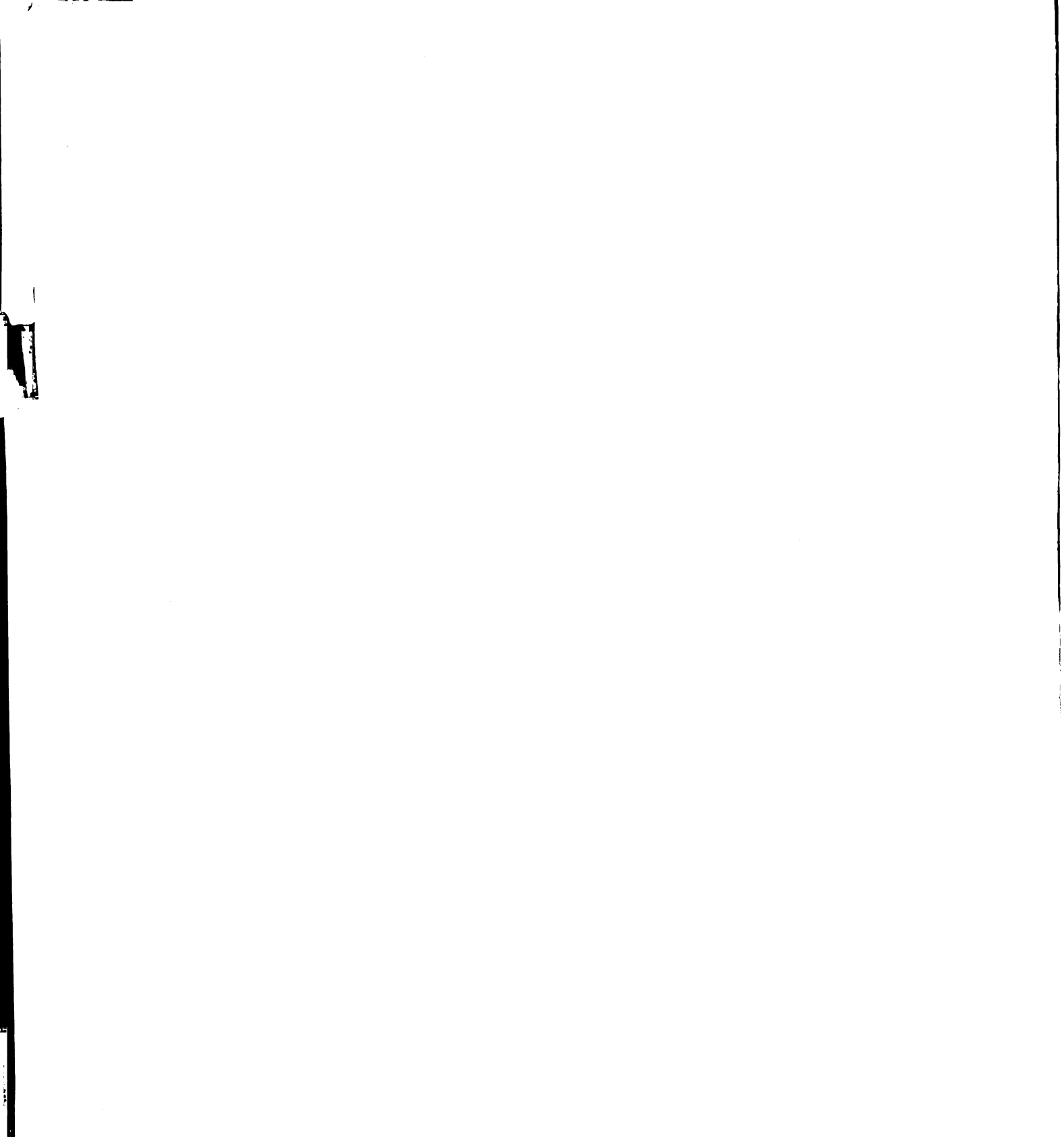
APPENDIX A

Appendix A presents much of the basic data and lists sources of data used in deriving the coefficients and restrictions for the linear programming model. A more detailed presentation of the pre-budgets and calendars of operations for the activities can be found in R. A. Young's Ph.D. thesis, "An Economic Study of the Eastern Beet Sugar Industry," Department of Agricultural Economics, Michigan State University.

TABLE A-1.--TOWNSHIPS AND COUNTIES QUALIFYING FOR THE SURVEY BY AREAS

Thumb Area Townships by County

Bay

		Saginaw	
Williams	McKinley	Brady	*Custer
Kawkawlin	Winsor	Maple Grove	Watertown
Monitor	Chandler	Swan Creek	Elmer
Frankenlust	Oliver	James	Marlette
Portsmouth	Colfax	Kochville	Buell
Merritt	Meade	Buena Vista	Elk
	Hume	*Blumfield	Flynn
Gratiot	Dwight	Frankenmuth	Maple Valley
	*Lincoln	*Thomas	Fremont
Elba	Huron	Saginaw	
Washington	Gore		Tuscola
*North Star	Bloomfield	Sanilac	
Emerson	Rubicon		Denmark
Lafayette	Siegel	Delaware	Gilford
Bethany	Sand Beach	Evergreen	Wisner
Wheeler	Sherman	Argyle	Akron
		Wheatland	Fairgrove
Huron	Midland	Lamotte	Columbia
		Moore	Elmwood
*Sebewaing	*Ingersoll		
Brookfield			
*Fairhaven			

South Central Area Counties by State

Michigan		Indiana
Shiawassee	Jackson	Elkhart
Clinton	Calhoun	Lagrange
Ionia	Kalamazoo	Marshall
Eaton	Cass	Kosciusko
Ingham	St. Joseph	Noble
Livingston	Branch	Fulton

*Denotes sampled townships.

TABLE A-2.--HOURS OF ANNUAL OVERHEAD LABOR PER FARM BY SIZE AND TYPE OF
FARM BY GEOGRAPHIC AREA

Size of Farm by Area	Type of Farm		
	Livestock	Cash Crop	Dairy
Thumb Area			
Small (less than 120 acres)	--*	410	480
Medium (120-180 acres)	--*	500	600
Large (over 180 acres)	--*	650	930
South Central Area			
Small (less than 100 acres)	550	400	500
Medium (100-200 acres)	650	500	600
Large (over 200 acres)	1,065	680	830

*Not enough schedules were obtained in these cells to merit an analysis
of these farm classifications; therefore, no estimates were includes for
these.

Source: Calculated from survey data and Illinois detailed labor records
from 1951-1958, Farm Management Manual, Univ. of Ill., AE-3349,
Oct. 1960, p. 18.

The annual values in Table A-2 were distributed into seasonal periods
for this study as follows:[1]

Dec. - Mar.	22.4%	August	11.2%
Apr. - May	14.4%	Sept.-Oct. 15	16.8%
June-July	21.7%	Oct. 15-Nov. 30	13.5%

[1]Paul R. Hasbargen and George A. Pond, Planning Farms for Increased
Profits, Minnesota Agricultural Experiment Station, Bulletin 445, 1956,
p. 25.

TABLE A-3.--ASSUMED RATES FOR CUSTOM WORK IN MICHIGAN

Custom Job	Unit	Geographic Area	Charge
Corn picking	Acre	Thumb and South Central	$ 6.00
Silage harvesting	Acre	Thumb	18.00
" "	"	South Central	15.00
Dry bean combining	"	Thumb	7.00
Soybean combining	"	South Central	6.00
Plowing	"	Thumb and South Central	6.50
Hay baling	Bale	" " " "	.12
Harvesting sugar beets	Acre	Thumb	20.00
Hauling sugar beets	Tons	"	1.50
Corn shelling	Bu.	Thumb and South Central	.05

Source: The 1960 farm survey data for this study and "Rates for Custom
Work in Michigan," revised by Charles Beer, Department of
Agricultural Economics, Michigan State University.

TABLE A-4.--MACHINERY PERFORMANCE RATES AND COST

Operation - Size of Implement	Speed (MPH)	Effective Width (ft.)	Field Effi- ciency	Acres per Hour	Hours per Acre	Variable Cost/Hr. Implement	Variable Cost/Hr. Tractor
Plow - 3 x 14"	3.0	3.5	.82	1.04	.96	.30	.75
Plow - 3 x 14"	3.5	3.5	.82	1.21	.83	.30	.80
Plow - 4 x 14"	3.5	4.67	.82	1.62	.62	.40	.93
Disk - 8'	3.5	8	.82	2.75	.36	.10	.75
Disk - 10'	3.5	10	.82	3.4	.29	.13	.93
Grain Drill - 8'	3.5	8	.76	2.6	.38	.10	.55
Planter 4R, 28"	3.0	9.33	.70	2.4	.42	.12	.55
" 2R, 28"	3.0	4.67	.70	1.2	.88	.10	.55
" 4R, 36"	3.0	12.0	.70	3.05	.33	.12	.55
" 2R, 36"	3.0	6.0	.70	1.55	.65	.10	.55
Cultivator - 4R, 28"	3.0	9.33	.80	2.7	.37	.08	.55
" 2R, 28"	3.0	4.67	.80	1.35	.74	.06	.55
" 4R, 36"	3.0	12.0	.80	2.9	.34	.08	.55
" 2R, 36"	3.0	6.0	.80	1.45	.68	.06	.55
Mower	3.5	7	.75	1.84	.54	.20	.55
Rake, Side Delivery	3.5	8	.76	2.6	.38	.12	.55
Bean Puller 2R	3.0	4.67	.82	1.39	.72	.12	.55
Combine, 7'	3.0	7.0	.67	1.58	.63	1.00	.75
" 10' SP	3.0	10.0	.67	2.30	.43	1.40	--
" 12' SP	3.0	12.0	.67	2.79	.36	1.50	--
(For bean combining reduce speed)							
Beet Harvester 1R	3.0	2.33	.60	.50	2.0	2.50	.55
" " 2R	3.0	4.67	.50	.85	1.18	3.40	.75
Hay Baler				2.0	1.0	1.40	.75
Sprayer - 16' boom	3.0	16	.60	3.50	.29	.45	.55
Sprayer - 4R	3.0	12.00	.60	2.18	.46	.40	.55
Corn Picker - 1R	3.0	1R	.68	.74	1.35	.80	.75
" " 2R	3.0	2R	.60	1.28	.78	.95	.75
Tractor - 20 DBH							.55
" 30 DBH							.75
" 40 DBH							.93
Hay Chopper	3.0	5'	.75	1.35	.74	.40	.55
Corn Silage Chopper	3.0	1R	.75	.70	1.43	.45	.75
Rotary Hoe	5.0	12'	.8	4.5	.22	.12	.55

Source: Roy Bainer, R. A. Kepner and E. L. Barger, Principles of Farm Machinery, New York: John Wiley and Sons, Inc., 1955, and "Cost Planning for Farm Machinery," Doane Agricultural Digest, Doane Agricultural Service, Inc., 1960.

TABLE A-5.--PRODUCT AND FACTOR 1966 PROJECTED PRICES USED IN THIS STUDY

Item	Unit	Area	Price Low	Price Medium	Price High
Corn sales	Bu.	Thumb	$ .84	$ 1.04	$ 1.24
Corn sales	"	South Central	.82	1.02	1.22
Corn purchased	"	Thumb	.94	1.14	1.34
Corn purchased	"	South Central	.92	1.12	1.32
Sugar beets	Tons	Thumb		12.85	
Dry beans	Cwt.	"		6.00	
Soybeans	Bu.	South Central		2.04	
Oats	Bu.	" "		.65	
Oats	"	Thumb		.65	
Wheat	"	"		1.84	
Wheat	"	South Central		1.78	
Alfalfa hay sales	Tons	Thumb & S.C.		18.00	
" " purchase	"	" "		20.30	
Milk (mfg.)	Cwt.	Thumb & S.C.		3.24	
Milk, Grade A	"	" "		4.22	
Seed					
Corn	Bu.	Thumb & S.C.		12.00	
Sugar beets	Lb.	"		1.00	
Dry beans	Bu.	"		4.20	
Soybeans	Lb.	South Central		.05	
Oats	Bu.	Thumb & S.C.		1.74	
Wheat	Bu.	" "		2.76	
Alfalfa	Lb.	" "		.49	
Fertilizer					
N	Lb.	Thumb & S.C.		.13	
P_2O_5	Lb.	" "		.10	
K_2O	Lb.	" "		.05	
Labor					
Seasonal	Hour	Thumb		1.21	
"	"	South Central		1.23	
Milking	"	" "		1.55	
"	"	Thumb		1.52	
Managerial	Mo.	Thumb & S.C.		700.00	
*Hogs (choice bar. & gilts)					
Quarter 1	Cwt.	Thumb & S.C.	11.24	14.20	17.16
" 2	"	" "	13.08	16.04	19.00
" 3	"	" "	13.03	15.99	18.95
" 4	"	" "	11.01	13.97	16.93
*Choice Slaughter Steers					
Quarter 1	Cwt.	Thumb & S.C.	16.76	20.92	25.08
" 2	"	" "	16.81	20.97	25.13
" 3	"	" "	17.06	21.22	25.38
" 4	"	" "	16.94	21.10	25.26

*These prices were adjusted by seasonal weights, geographic differences and for marketing charges to arrive at the prices used in the linear programming model.

TABLE A-6.--INPUTS AND YIELDS PER ACRE FOR CROPS IN THE THUMB AND SOUTH CENTRAL AREAS

Inputs	Unit	Thumb Area								South Central Area			
		Sugar Beets	Edible Dry Beans	Corn for Grain	Corn for Silage	Oats	Wheat	Alfalfa Brome Hay[a]	Soybeans	Corn for Grain	Corn for Silage	Oats	Wheat
Seed	Lb.	1.5	35	12	12	72	105	8	70	11	11	72	105
Fertilizer													
Nitrogen	Lb.	80	10	50	50	20	60	0	20	50	50	30	60
Phosphate	Lb.	120	40	60	60	40	60	60	30	60	60	50	60
Potash	Lb.	60	20	30	30	20	30	20	30	60	60	50	60
Tractor hours													
2-plow	Hours	2.10	2.80	2.70	2.90	1.15	1.25	4.85	2.01	3.37	3.56	.70	.83
3-plow	"	3.30	1.30	2.95	3.10	1.60	.70	0	2.13	2.38	3.10	2.23	1.88
Labor[b]	"	12.75[c]	8.00	5.65	10.60	3.40	2.40	7.85	4.64	5.75	9.91	3.38	3.16
Yields		18ton	18cwt	100bu	18ton	80bu	55bu	3ton	25bu	80bu	15ton	65bu	40bu

[a] This was assumed to be the same for both areas for input requirements and yields.

[b] These labor requirements are stated in terms of average or normal weather conditions. These labor requirements were used in connection with data prepared by J. H. Sitterley and Richard Bere, op. cit., to derive the labor coefficients which occur in the tableaus for the crop enterprises in Chapter IV. The weather condition assumed for the labor coefficients in the linear programming model was the average for the worst 16 years out of 20 years.

[c] This does not include hired migrant labor for thinning and hoeing the sugar beets.

Hog Enterprise

The swine production activities are stated as a series of one litter hog systems that include both the farrowing and feeding of the pigs.

TABLE A-7.--LABOR REQUIREMENTS FOR HOG ACTIVITIES*

Type of System	Hours of Labor Required by Period						
	Dec. Mar.	April May	June July	Aug.	Sept. Oct. 15	Oct. 15 Nov. 30	Total
Central farrow & confinement finish:							
Quarter 1	5.30	3.25	3.00	1.00	.34	.44	13.34
Quarter 2	1.10	3.23	3.50	1.50	2.25	1.75	13.34
Quarter 3	4.23	.54	.99	2.56	2.64	2.37	13.34
Quarter 4	6.50	2.50	.46	.32	.65	2.90	13.34
Central farrow & portable finish:							
Quarter 1	6.35	3.25	3.00	1.00	.34	.44	14.38
Quarter 2	2.00	3.68	3.50	1.50	2.25	1.75	14.68
Quarter 3	4.23	.84	.99	2.56	2.64	2.37	13.63
Quarter 4	6.50	2.50	.46	.32	.65	2.90	13.34
Portable farrow and finish:							
Quarter 1	6.69	3.25	3.00	1.00	.34	.44	14.72
Quarter 2	2.00	3.83	3.69	1.50	2.25	1.75	15.02
Quarter 3	4.23	.84	.99	2.82	2.72	2.37	13.97
Quarter 4	6.60	2.50	.46	.32	.65	3.14	13.67

*For convenience, it was assumed that sows farrowed and feeders were purchased at the mid-point of the quarter.

TABLE A-8.--FEED REQUIREMENTS FOR SOW AND EIGHT PIGS[a]

System	Corn Equivalents Cwt.	Protein Cwt.	Pasture Animal Unit Pasture Days
Central farrow and confinement finish:			
All farrowings	59.25	11.96	0
Central farrow and portable finish:			
Quarter 1	59.36	11.86	20
Quarter 2	59.32	11.86	19
Quarter 3	62.78	12.30	13
Quarter 4	60.73	11.68	15
Portable farrow and finish:			
Quarter 1	59.36	11.86	20
Quarter 2	59.32	11.86	25
Quarter 3	62.78	12.30	19
Quarter 4	60.73	11.68	15

[a] These feed requirements are for feeding out seven 210 pound hogs, 1 gilt until farrowing, and 1 sow until 3 months after farrowing. The sources of these data were: D. A. Becker, "Balancing Swine Rations," Univ. of Ill., Circular No. 811; "Your 1962 Hog Business," AS-377, Univ. of Ill., Ext. Ser.; and Karl Wright and J. A. Hoefer of Michigan State University.

Beef Enterprise

The beef activities include a beef cow-calf herd, two calf feeding systems, and two 6 months short-fed yearling systems. Period 1 begins in October and period 2 begins in April.

TABLE A-9.--HOURS OF LABOR REQUIRED FOR DIFFERENT BEEF CATTLE SYSTEMS

| Labor Period | Beef-Cow Calf Herd | Low Mechanization[a] | | | | High Mechanization[a] | | | |
| | | Calf Systems | | Yearlings | | Calf Systems | | Yearlings | |
		Drylot	Pas.	Pd. 1	Pd. 2	Drylot	Pas.	Pd. 1	Pd. 2
Total labor	20.00	9.58	7.73	5.28	5.28	6.42	5.18	3.54	3.54
Dec.-Mar.	10.44	2.32	2.94	3.52	0	1.55	1.97	2.36	0
Apr.-May	3.86	2.62	1.29	.22	1.54	1.75	.87	.15	1.03
June-July	1.04	1.96	1.03	0	1.76	1.32	.69	0	1.18
August	.62	.90	.51	0	.90	.60	.34	0	.60
Sept.-Oct. 15	1.32	.89	.93	0	1.08	.60	.62	0	.73
Oct. 15-Nov. 30	2.72	.89	1.03	1.54	0	.60	.69	1.03	0

[a]These are based on lot sizes of 100 head.

TABLE A-10.--TOTAL FEED REQUIREMENTS PER HEAD BY BEEF CATTLE SYSTEM

Feed Requirements	Cow-Calf Herd	Calves Drylot	Calves Pasture	Yearlings
Corn equivalents (cwt.)	2.69	35.00	30.35	21.50
Protein (cwt.)	.98	3.72	1.24	1.57
Hay equivalents (tons)	2.00	.94	.74	.21
Pasture (tons H.E.)	3.00	0	1.00	0

Dairy Enterprises

The dairy activities included in the model were of the stanchion and parlor types. The stanchion system included both grade A and grade B alternatives where appropriate. The labor requirements by system are presented in Table A-11.

TABLE A-11.--HOURS OF LABOR REQUIRED PER DAIRY COW BY SYSTEM[a]

| | Milking System | | |
| Labor Period | Stanchion | | Parlor |
	Grade A	Grade B	Grade A
Dec. - Mar.	31.95	28.44	23.14
April - May	13.43	9.00	10.68
June - July	10.29	6.38	9.24
August	5.23	3.29	4.70
Sept. - Oct. 15	7.69	5.23	6.92
Oct. 15 - Nov. 30	10.68	9.08	8.13

[a] These requirements are based on a herd size of 20 to 30 cows.

Source: H. J. Aune and L. M. Day, "Effects of Herd Size on Dairy Chore Labor," Bulletin 449, Minnesota Agricultural Experiment Station, St. Paul, Minn., and E. I. Fuller and H. R. Jensen, "Alternative Dairy Chore Systems in Loose Housing," Bulletin 457, Minn. Agricultural Experiment Station, St. Paul, Minn.

The grade A cow and replacements (.9 young stock per cow) had feed requirements of 37.98 cwt. corn equivalents, 574 lbs. protein, and 7.85 tons hay equivalents. The grade B cow and replacements (.7 young stock per cow) consume 35.4 cwt. of corn equivalents, 200 lbs. of protein, and 6.72 tons of hay equivalents. It was assumed the grade A cow produces 11,500 lbs. milk (3.5% FCM basis) and the grade B cow produces 10,036 lbs. of milk (3.5% FCM basis) per lactation.

APPENDIX B

Appendix B includes tables depicting Phase 1 optimal organizations
for the small and large size representative farms for the Thumb and South Central
areas. The prices used were the medium price for corn and various prices for
hogs and beef cattle,
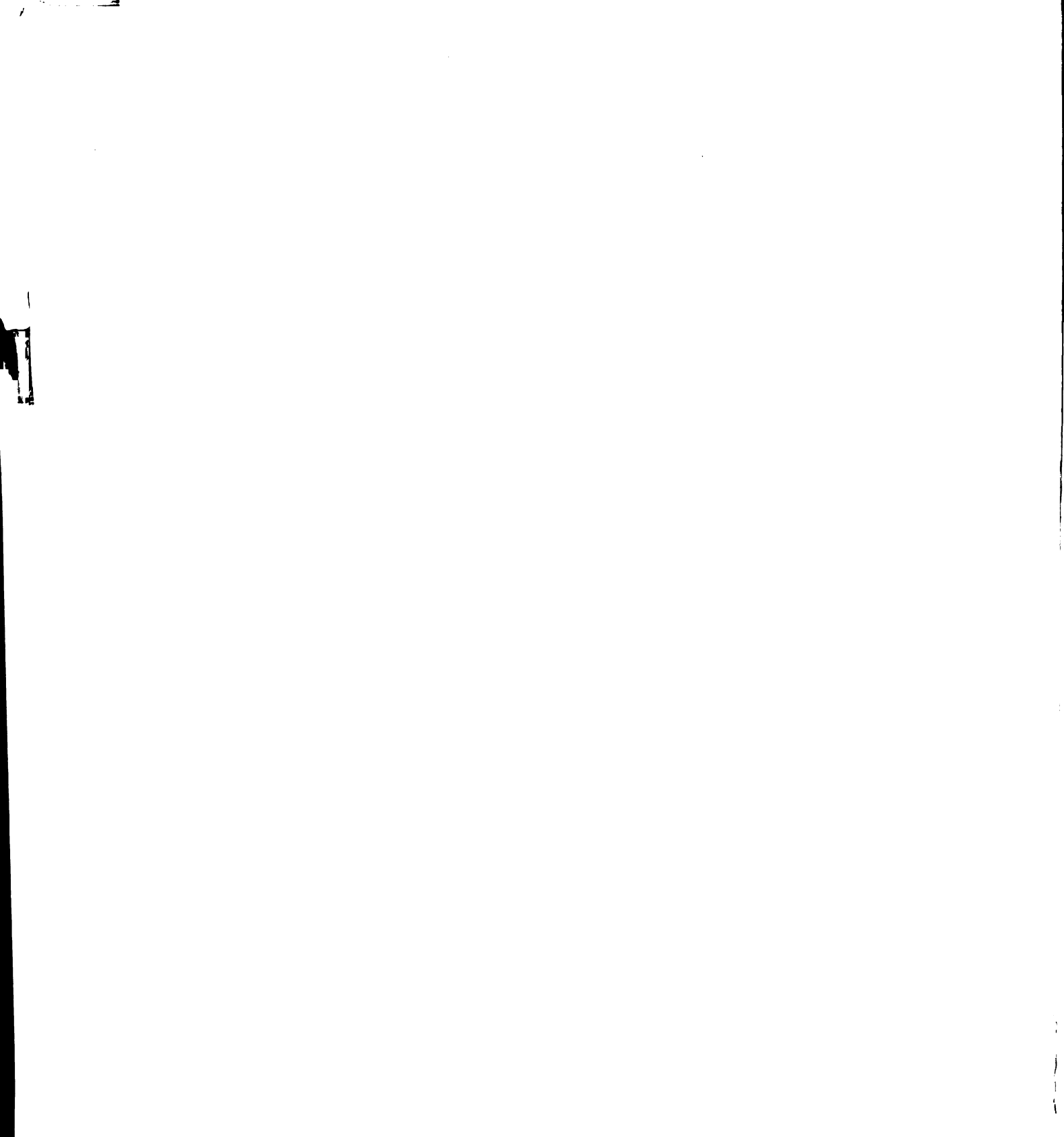
TABLE B.1.--OPTIMAL ORGANIZATIONS FOR SMALL CASH CROP FARMS IN THUMB AREA - PHASE 1

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	7,806	10,609	14,005
Dry beans	Acre	24	20	20
Corn	"	30	34	34
Alfalfa	"	3	3	3
Oats	"			
Sugar beets	"	7	7	7
Wheat	"	17	17	17
Real estate credit	$	22,345	15,982	15,785
Chattel and private credit	$	9,706	11,680	11,680
Yearlings fed, Pd. 1	Head	9	99	101
" " Pd. 2	"	9	99	101
Dairy	Cow	26	1	
Sows farrowed, Qu. 1	Sow	2		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"			
(2) Hog Price @ $13.73/Cwt.				
Net income	$	9,317	10,753	14,060
Dry beans	Acre	20	20	20
Corn	"	34	34	34
Alfalfa	"	6	3	3
Oats	"			
Sugar beets	"	7	7	7
Wheat	"	13	17	17
Real estate credit	$	24,935	16,297	15,758
Chattel and private credit	$	10,138	11,680	11,680
Yearlings fed, Pd. 1	Head		93	99
" " Pd. 2	"		93	99
Dairy	Cow	1	1	
Sows farrowed, Qu. 1	Sow	26	2	2
" " Qu. 2	"	26	2	1
" " Qu. 3	"	26	2	
" " Qu. 4	"	26	2	
(3) Hog Price @ $16.57/Cwt.				
Net income	$	14,948	14,948	15,264
Dry beans	Acre	20	20	20
Corn	"	34	34	34
Alfalfa	"	11	11	3
Oats	"			
Sugar beets	"	7	7	7
Wheat	"	9	9	17
Real estate credit	$	21,745	21,745	25,335
Chattel and private credit	$	11,680	11,680	11,680
Yearlings fed, Pd. 1	Head			26
" " Pd. 2	"			26
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	27	27	21
" " Qu. 2	"	27	27	21
" " Qu. 3	"	27	27	21
" " Qu. 4	"	27	27	21

TABLE B-2.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL CASH CROP FARMS IN THUMB AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MIM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	8,005	4,488	4,330	4,265	4,719	8,730	8,730	8,110	504
Hay purchased	Tons	11	33	34	35	33			2	150
Silo constructed	"									130
Beef housing	A. units	11	58	59	58	55				
Low mech. feeding	Head	11	58	59	58	55				
Dairy cows	"									25
Hog farrowing	Sow	19				25	25	25	24	
Hog feeding	Head	323			14	416	416	416	394	
Seasonal labor	Man hr.									
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn acreage limit	"	29.74	22.71	22.71	10.52	10.52	31.94	31.94	7.20	
Sugar beet contract	"	64.50	66.68	66.68	70.47	70.47	63.81	63.81	71.51	71.73
Wheat acreage limit	"	1.31	6.68	6.68	15.37	15.37				25.11
Capital	$	.38	.31	.31	.19	.19	.40	.40	.15	.08
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"									
Apr. - May	"								.56	
June - July	"									
August	"									.60
Sept. - Oct. 15	"									
Oct. 15 - Nov. 30	"									
Cropland	$/acre	67.04	62.98	62.98	56.55	56.55	67.95	67.95	72.55	48.04
Land rented	"	62.18	61.25	61.25	59.72	59.72	62.43	62.43	61.07	55.16

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-3.--OPTIMAL ORGANIZATIONS FOR LARGE CASH CROP FARM IN THE THUMB AREA - PHASE 1

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	20,777	25,832	34,105
Dry beans	Acre	129	46	46
Corn	"	46	129	129
Alfalfa	"			
Oats	"	24	24	24
Sugar beets	"	20	20	20
Wheat	"	40	40	40
Real estate credit	$	20,421	21,627	21,627
Chattel and private credit	$	5,300	32,617	32,617
Yearlings fed, Pd. 1	Head	36	242	242
" " Pd. 2	"	20	242	242
Dairy	Cow	29	4	4
Sows farrowed, Qu. 1	Sow	3		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	3		
(2) Hog Price @ $13.73/Cwt.				
Net income	$	22,438	26,145	34,209
Dry beans	Acre	46	46	46
Corn	"	129	129	129
Alfalfa	"	24		
Oats	"		24	24
Sugar beets	"	20	20	20
Wheat	"	40	40	40
Real estate credit	$	30,089	21,625	21,560
Chattel and private credit	$	25,860	32,617	32,617
Yearlings fed, Pd. 1	Head		232	238
" " Pd. 2	"		232	238
Dairy	Cow	12	4	4
Sows farrowed, Qu. 1	Sow	52	4	3
" " Qu. 2	"	52	4	
" " Qu. 3	"	52	4	
" " Qu. 4	"	52	4	3
(3) Hog Price @ $16.57/Cwt.				
Net income	$	34,478	34,560	35,748
Dry beans	Acre	46	46	46
Corn	"	129	129	129
Alfalfa	"	27	27	8
Oats	"			16
Sugar beets	"	20	20	20
Wheat	"	37	38	40
Real estate credit	$	28,770	28,543	32,690
Chattel and private credit	$	26,103	26,800	32,617
Yearlings fed, Pd. 1	Head		15	115
" " Pd. 2	"			115
Dairy	Cow	4	4	4
Sows farrowed, Qu. 1	Sow	57	56	35
" " Qu. 2	"	57	56	35
" " Qu. 3	"	57	56	35
" " Qu. 4	"	57	56	35

TABLE B-4.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON LARGE CASH CROP FARM IN THUMB AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	11,232	5,343	4,975	4,975	5,910	13,457	13,366	11,564	
Hay purchased	Tons	61	113	115	115	110	16	13	39	107
Silo constructed	"									93
Beef housing	A.Units	65	145	147	147	141				14
Low mechanized feeding	Head	65	145	147	147	141				14
Dairy cows	"									19
Hog farrowing	Sow	32				1	56	54	49	2
Hog feeding	Head	502					840	858	767	
Seasonal labor	Man hr.	1,546	1,295	1,278	1,278	1,333	1,601	1,455	1,575	950
Marginal value productivities:										
Bean acreage limit	$/acre									14.76
Corn acreage limit	"	23.01	18.64	18.64	6.84	6.84	25.50	25.50	4.48	4.48
Sugar beet contract	"	46.59	48.61	48.61	54.08	54.08	45.43	45.43	60.86	73.83
Wheat acreage limit	"	31.19	33.63	33.63	40.23	40.22	45.43	45.43	45.11	51.85
Capital	$	.30	.25	.25	.14	.14	.32	.32	.08	.06
Labor:	$/hr.									
Jan., Feb., Mar., Dec.	"	2.62	2.53	2.53	2.30	2.30	2.67	2.67	2.17	2.14
Apr. - May	"	2.62	2.53	2.53	2.30	2.30	2.67	2.67	2.17	2.14
June - July	"									
August	"									.72
Sept. - Oct. 15	"	2.62	2.53	2.53	2.30	2.30	2.67	2.67	2.17	2.14
Oct. 15 - Nov. 30	"	2.62	2.53	2.53	2.30	2.30	2.67	2.67	2.17	2.14
Cropland	$/acre	29.67	28.33	28.33	24.72	24.72	60.23	60.23	20.68	21.83
Land rented	"	39.51	38.44	38.44	35.56	35.56	43.10	43.10	32.16	31.34

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-5.—OPTIMAL ORGANIZATIONS FOR LARGE DAIRY FARM IN THE THUMB AREA -
PHASE 1

Corn Price @ $.99/Bushel	Unit	Beef Prices per Cwt.		
		$16.08	$20.20	$24.31
(1) Hog Price @ $10.89/Cwt.				
Net income	$	33,323	39,713	53,092
Dry beans	Acre	172	70	70
Corn	"	70	172	172
Alfalfa	"	26	26	45
Oats	"	19	19	
Sugar beets	"	16	16	16
Wheat	"	40	40	40
Real estate credit	$	2,516	46,360	46,249
Chattel and private credit	$	3,800	44,607	44,607
Yearlings fed, Pd. 1	Head	104	347	399
" " Pd. 2	"		347	399
Dairy	Cow	38	38	12
Sows farrowed, Qu. 1	Sow			
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	2		
(2) Hog Price @ $13.73/Cwt.				
Net income	$	34,868	39,769	53,113
Dry beans	Acre	81	70	70
Corn	"	161	172	172
Alfalfa	"	26	26	45
Oats	"	19	19	
Sugar beets	"	16	16	16
Wheat	"	40	40	40
Real estate credit	$	13,364	46,325	46,231
Chattel and private credit	$	3,800	44,607	44,607
Yearlings fed, Pd. 1	Head		345	398
" " Pd. 2	"		345	398
Dairy	Cow	38	38	12
Sows farrowed, Qu. 1	Sow	29		2
" " Qu. 2	"	29	2	
" " Qu. 3	"	29		
" " Qu. 4	"	29	2	
(3) Hog Price @ $16.57/Cwt.				
Net income	$	52,356	52,362	54,616
Dry beans	Acre	70	70	70
Corn	"	172	172	172
Alfalfa	"	45	45	42
Oats	"			3
Sugar beets	"	16	16	16
Wheat	"	40	40	40
Real estate credit	$	64,032	64,032	71,840
Chattel and private credit	$	36,230	36,230	44,607
Yearlings fed, Pd. 1	Head			155
" " Pd. 2	"			155
Dairy	Cow	1	1	2
Sows farrowed, Qu. 1	Sow	99	99	70
" " Qu. 2	"	99	99	70
" " Qu. 3	"	99	99	70
" " Qu. 4	"	99	99	70

TABLE B-6.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON LARGE DAIRY FARM IN THUMB AREA - PHASE 1

Items acquired:	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Corn purchased	Bu.	26,111	14,750	14,652	12,385	12,564	27,436	27,436		
Hay purchased	Tons		72	72	193	192	2	2	90	69
Silo constructed	"									
Beef housing	A.Units	44	216	217	221	220				62
Low mechanized feeding	Head	96	254	254	221	220				62
Dairy cows	"									
Hog farrowing	Sow	68					97	97	29	
Hog feeding	Head	1,115					1,573	1,573	458	
Seasonal labor	Man hr.	3,495	3,395	3,395	4,949	4,919	3,022	3,022	2,607	2,140
Marginal value productivities:										
Bean acreage limit	$/acre									12.22
Corn acreage limit	"	23.91	20.57	20.57	6.98	6.98	24.02	24.93		
Sugar beet contract	"	52.84	54.22	54.22	59.83	59.83	52.80	52.42	61.61	73.83
Wheat acreage limit	"	34.87	35.05	35.05	43.79	43.79	5.59	2.05	47.26	52.76
Capital	$	.26	.23	.23	.10	.10	.26	.27	.06	.06
Labor:	$/hr									
Jan., Feb., Mar. Dec.	"									
Apr. - May	"	1.43	1.25	1.25			.54	1.03	.58	2.14
June - July	"	1.43	1.25	1.25			.54	1.03	.58	2.14
August	"	1.43	1.25	1.25			.54	1.03	.58	2.14
Sept. - Oct. 15	"	1.43	1.25	1.25			.54	1.03	.58	2.14
Oct. 15 - Nov. 30	"	1.43	1.25	1.25			.54	1.03	.58	2.14
Cropland	$/acre	26.05	26.70	26.70	27.62	27.62	55.30	58.62	24.10	18.02
Land rented	"	35.54	34.88	34.88	32.52	32.52	37.79	38.66	30.36	28.70

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-7.--OPTIMAL ORGANIZATIONS FOR SMALL LIVESTOCK FARM IN THE SOUTH
CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	5,098	7,290	10,247
Soybeans	Acre		9	8
Corn	"	28	28	28
Alfalfa	"	11	17	17
Wheat	"	8	8	8
Real estate credit	$	14,417	12,047	10,544
Chattel credit	$	2,821	5,017	5,017
Private credit	$	2,600	2,600	2,600
Yearlings fed, Pd. 1	Head	31	75	90
" " Pd. 2	"	31	75	90
Dairy	Cow	16	6	
Sows farrowed, Qu. 1	Sow	9		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	3		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	7,670	8,304	10,553
Soybeans	Acre	6	9	10
Corn	"	28	28	28
Alfalfa	"	19	17	15
Wheat	"	8	8	8
Real estate credit	$	13,024	11,639	10,378
Chattel credit	$	5,017	5,017	5,017
Private credit	$	2,600	2,600	2,600
Yearlings fed, Pd. 1	Head		31	80
" " Pd. 2	"		31	80
Dairy	Cow	8	6	
Sows farrowed, Qu. 1	Sow	20	12	9
" " Qu. 2	"	20	17	3
" " Qu. 3	"	20	12	
" " Qu. 4	"	20	17	3
(3) Hog Price @ $16.82/Cwt.				
Net income	$	12,885	12,885	13,078
Soybeans	Acre	4	4	4
Corn	"	28	28	28
Alfalfa	"	21	21	21
Wheat	"	8	8	8
Real estate credit	$	15,965	15,965	11,071
Chattel credit	$	5,017	5,017	5,017
Private credit	$	2,600	2,600	2,600
Yearlings fed, Pd. 1	Head			31
" " Pd. 2	"			31
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	26	26	19
" " Qu. 2	"	26	26	19
" " Qu. 3	"	26	26	19
" " Qu. 4	"	26	26	19

TABLE B-8.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL LIVESTOCK FARM IN SOUTH CENTRAL AREA - PHASE 1

	Unit	Price Combinations [a]								
		MHH	MMH	MLH	MLM	MMM	MHL	MML	MLL	
Items acquired:										
Corn purchased	Bu.	8,427	5,575	4,640	4,078	7,179	9,251	9,251	7,298	2,474
Hay purchased	Tons									39
Silo constructed	"									54
Beef housing	A.Units		32	38	29					14
Low mechanized feeding	Head		32	38	29					
Dairy cows	"				6	6			8	16
Hog farrowing	Sow	4				2	11	11	5	
Hog feeding	Head	172				107	288	288	188	
Seasonal labor	Man hrs.				25					
Marginal value productivities:										
Bean acreage limit	$/acre	55.44	51.17	51.17	40.32	41.03	55.44	55.44	38.85	25.27
Corn acreage limit	"									
Wheat acreage limit	"	7.73	8.51	8.51	11.58	10.68	7.73	7.73	12.68	29.44
Capital	$	.39	.34	.34	.19	.20	.39	.39	.18	.08
Labor:										
Jan., Feb., Mar., Dec.	$/hr.									
Apr. - May	"									.23
June - July	"	.49	.51	.51	2.70	1.15	.49	.49	.54	1.40
August	"									
Sept. - Oct. 15	"									
Oct. 15 - Nov. 30	"									
Cropland	$/acre	31.39	31.72	31.72	26.61	30.81	31.39	31.39	32.67	35.86
Land rented	"	30.36	29.28	29.28	18.76	24.49	30.36	30.36	26.38	25.94

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-9.--OPTIMAL ORGANIZATIONS FOR LARGE LIVESTOCK FARM IN THE SOUTH
CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	10,518	17,185	26,340
Soybeans	Acre	52	52	52
Corn	"	153	153	153
Alfalfa	"	57	37	37
Wheat	"	44	44	44
Real estate credit	$	25,762	22,904	22,918
Chattel credit	$		26,001	26,001
Private credit	$	6,600	6,600	6,600
Yearlings fed, Pd. 1	Head	102	266	267
" " Pd. 2	"	102	266	267
Dairy	Cow	22		
Sows farrowed, Qu. 1	Sow	11		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	3		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	13,616	17,758	26,422
Soybeans	Acre	52	52	52
Corn	"	153	153	153
Alfalfa	"	57	57	37
Wheat	"	44	44	44
Real estate credit	$	28,139	22,614	22,752
Chattel credit	$	7,695	26,001	26,001
Private credit	$	6,600	6,600	6,600
Yearlings fed, Pd. 1	Head		250	258
" " Pd. 2	"		250	258
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	51	8	11
" " Qu. 2	"	51	6	
" " Qu. 3	"	51		
" " Qu. 4	"	51	6	3
(3) Hog Price @ $16.82/Cwt.				
Net income	$	26,741	26,741	28,512
Soybeans	Acre	52	52	52
Corn	"	153	153	153
Alfalfa	"	31	31	28
Wheat	"	44	44	44
Real estate credit	$	30,728	30,728	35,421
Chattel credit	$	21,904	21,904	26,001
Private credit	$	6,600	6,600	6,600
Yearlings fed, Pd. 1	Head			102
" " Pd. 2	"			102
Dairy	Cow			
Sows farrowed, Qu. 1	Sow	63	63	46
" " Qu. 2	"	63	63	46
" " Qu. 3	"	63	63	46
" " Qu. 4	"	63	63	46

TABLE B-10.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON LARGE LIVESTOCK FARM IN SOUTH CENTRAL AREA - PHASE 1

	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	15,034	8,421	7,573	8,166	9,157	15,434	15,434	10,598	
Hay purchased	Tons									
Silo constructed	"									
Beef housing	A.Units		101	107	107	96				
Low mechanized feeding	Head		101	107	107	96				
Dairy cows	"									19
Hog farrowing	Sow	35					52	52	40	
Hog feeding	Head	623					901	901	699	
Seasonal labor	Man hrs.	3,564	3,132	3,075	2,921	3,274	3,298	3,298	2,507	3,078
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn acreage limit	"	40.42	39.22	41.76	32.99	30.63	44.31	44.31	27.85	13.58
Wheat acreage limit	"	28.97	29.67	29.06	33.74	32.72	26.73	26.73	32.65	32.44
Capital	$	.24	.23	.26	.14	.11	.29	.29	.08	.06
Labor:										
Jan., Feb., Mar., Dec.	$/hr.									.95
Apr. - May	"			2.87	2.61		1.03			.95
June - July	"			2.87	2.61		1.03			.95
August	"			2.87	2.61		1.03			.95
Sept. - Oct. 15	"			2.87	2.61		1.03			.95
Oct. 15 - Nov. 30	"			2.87	2.61		1.03			.95
Cropland	$/acre	.86	.67	1.07		1.23	1.47	1.47	2.78	3.49
Land rented	"	-7.07	-7.06	-4.34	-4.44	-6.57	-7.11	-7.11	-5.13	-9.55

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-11.—OPTIMAL ORGANIZATIONS FOR SMALL CASH GRAIN FARM IN THE SOUTH
CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel		Unit	Beef Prices per Cwt.		
			$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.					
Net income		$	4,807	6,180	8,543
Soybeans		Acre			
Corn		"	23	23	23
Alfalfa		"	26	28	28
Wheat		"	16	16	16
Real estate credit		$	16,997	11,641	11,371
Chattel credit		$	4,361	4,361	4,361
Private credit		$	2,800	2,800	2,800
Yearlings fed,	Pd. 1	Head	8	67	70
" "	Pd. 2	"	8	67	70
Dairy		Cow	21	1	
Sows farrowed,	Qu. 1	Sow			
" "	Qu. 2	"			
" "	Qu. 3	"			
" "	Qu. 4	"			
(2) Hog Price @ $13.98/Cwt.					
Net income		$	5,674	6,232	8,543
Soybeans		Acre			
Corn		"	23	23	23
Alfalfa		"	28	28	28
Wheat		"	16	16	16
Real estate credit		$	16,812	11,604	11,371
Chattel credit		$	4,361	4,361	4,361
Private credit		$	2,800	2,800	2,800
Yearlings fed,	Pd. 1	Head		61	70
" "	Pd. 2	"		61	70
Dairy		Cow	9	1	
Sows farrowed,	Qu. 1	Sow	12	1	
" "	Qu. 2	"	12	3	
" "	Qu. 3	"	12		
" "	Qu. 4	"	12	4	
(3) Hog Price @ $16.82/Cwt.					
Net income		$	9,576	9,576	9,658
Soybeans		Acre			
Corn		"	23	23	23
Alfalfa		"	28	28	28
Wheat		"	16	16	16
Real estate credit		$	19,536	19,536	19,890
Chattel credit		$	4,361	4,361	4,361
Private credit		$	2,800	2,800	2,800
Yearlings fed,	Pd. 1	Head			8
" "	Pd. 2	"			8
Dairy		Cow			
Sows farrowed,	Qu. 1	Sow	19	19	17
" "	Qu. 2	"	19	19	17
" "	Qu. 3	"	19	19	17
" "	Qu. 4	"	19	19	17

TABLE B-12.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL CASH GRAIN FARM IN SOUTH CENTRAL AREA - PHASE 1

Items acquired:	Unit	MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Corn purchased	Bu.	6,499	3,551	3,551	3,447	3,791	6,619	6,619	4,219	759
Hay purchased	Tons									25
Silo constructed	"								51	115
Beef housing	A. Units		41	41	5	5				
Low mech. feeding	Head		41	41	39	35				
Dairy cows	"								8	20
Hog farrowing	Sow	14				16	16		9	
Hog feeding	Head	274				299	299		178	
Seasonal	Man hr.					24				
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn acreage limit	"	51.78	47.36	47.36	37.29	37.29	52.47	52.47	34.42	25.41
Wheat acreage limit	"	3.66	4.36	4.36	5.95	5.95	3.56	3.56	10.42	28.30
Capital	$	.39	.34	.34	.21	.21	.40	.40	.18	.08
Labor:										
Jan., Feb., Mar., Dec.	$/hr.									
Apr. - May	"									
June - July	"							1.28		
August	"									
Sept. - Oct. 15	"									
Oct. 15 - Nov. 30	"									
Cropland	$/acre	36.53	36.98	36.98	38.02	38.02	36.46	36.46	38.31	37.32
Land rented	"	34.17	33.16	33.16	30.86	30.86	34.33	34.33	30.69	27.53

Price Combinations[a]

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-13.--OPTIMAL ORGANIZATIONS FOR LARGE CASH GRAIN FARM IN THE SOUTH CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	8,688	13,695	20,154
Soybeans	Acre	84	84	84
Corn	"	119	119	119
Alfalfa	"	62	28	28
Wheat	"	39	39	39
Real estate credit	$	24,832	18,171	18,171
Chattel credit	$	16,398	22,061	22,061
Private credit	$	4,100	4,100.	4,100
Yearlings fed, Pd. 1	Head	84	190	190
" " Pd. 2	"	84	190	190
Dairy	Cow	28	1	1
Sows farrowed, Qu. 1	Sow	7		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"			
(2) Hog Price @ $13.98/Cwt.				
Net income	$	11,440	13,826	20,210
Soybeans	Acre	84	84	84
Corn	"	119	119	119
Alfalfa	"	62	28	28
Wheat	"	39	39	39
Real estate credit	$	23,256	18,037	18,139
Chattel credit	$	17,918	22,061	22,061
Private credit	$	4,100	4,100	4,100
Yearlings fed, Pd. 1	Head		182	188
" " Pd. 2	"		182	188
Dairy	Cow	1	1	1
Sows farrowed, Qu. 1	Sow	43	5	3
" " Qu. 2	"	43	1	
" " Qu. 3	"	43	4	
" " Qu. 4	"	43	1	
(3) Hog Price @ $16.82/Cwt.				
Net income	$	21,097	21,153	21,833
Soybeans	Acre	84	84	84
Corn	"	119	119	119
Alfalfa	"	24	25	27
Wheat	"	39	39	39
Real estate credit	$	23,759	23,457	22,739
Chattel credit	$	18,686	19,684	22,061
Private credit	$	4,100	4,100	4,100
Yearlings fed, Pd. 1	Head		22	39
" " Pd. 2	"			39
Dairy	Cow	1	1	1
Sows farrowed, Qu. 1	Sow	46	44	39
" " Qu. 2	"	46	44	39
" " Qu. 3	"	46	44	40
" " Qu. 4	"	46	44	39

TABLE B-14.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON LARGE CASH GRAIN FARM IN SOUTH CENTRAL AREA - PHASE 1

		Price Combinations[a]							
	Unit	MHH	MMH	MLH	MLM	MMM	MHM	MML	MLL
Items acquired:									
Corn purchased	Bu.	10,157	4,204	4,024	4,024	4,579	10,193	10,006	10,158
Hay purchased	Tons								
Silo constructed	"								
Beef housing	A.Units	12	108	109	109	104			94
Low mech. feeding	Head	12	108	109	109	104			41
Dairy cows	"							41	26
Hog farrowing	Sow	35				17	40	42	39
Hog feeding	Head	606					687	711	671
Seasonal labor	Man hr.	2,039	1,964	1,959	1,959	1,969	1,940	2,139	2,612
Marginal value productivities:									
Bean acreage limit	$/acre	46.56	42.31	42.31	33.50	33.50	49.32	31.03	14.94
Corn acreage limit	"	26.34	26.67	26.67	31.87	31.87	24.77	34.16	39.06
Wheat acreage limit	$								
Capital	$	.32	.27	.27	.15	.15	.36	.12	.08
Labor:									
Jan., Feb., Mar., Dec.	$/hr.								
Apr. - May	"	3.02	2.89	2.89	2.62	2.62	3.10	2.55	2.45
June - July	"	3.02	2.89	2.89	2.62	2.62	3.10	2.55	2.45
August	"	3.02					3.10	1.16	
Sept. - Oct. 15	"	3.02	2.89	2.89	2.62	2.62	3.10	2.55	2.45
Oct. 15 - Nov. 30	"	3.02	2.89	2.89	2.62	2.62	3.10	2.55	2.45
Cropland	$/acre	1.83	4.54	4.54	2.84	2.84	2.26	1.01	2.78
Land rented	"	-4.25	-2.25	-2.25	-2.60	-2.60	-4.20	-3.54	-6.55

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-15.—OPTIMAL ORGANIZATIONS FOR SMALL DAIRY FARM IN THE SOUTH CENTRAL AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	6,925	9,367	12,261
Soybeans	Acre			
Corn	"	27	27	27
Alfalfa	"	40	27	23
Wheat	"	12	12	12
Real estate credit	$	4,196	9,367	9,447
Chattel credit	$		5,991	5,991
Private credit	$	4,900	4,900	4,900
Yearlings fed, Pd. 1	Head		78	83
" " Pd. 2	"		78	83
Dairy	Cow	34	14	11
Sows farrowed, Qu. 1	Sow	1		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"	1		
(2) Hog Price @ $13.98/Cwt.				
Net income	$	8,746	9,569	12,321
Soybeans	Acre			
Corn	"	27	27	27
Alfalfa	"	39	32	24
Wheat	"	12	12	12
Real estate credit	$	11,439	9,183	9,406
Chattel credit	$	5,991	5,991	5,991
Private credit	$	4,900	4,900	4,900
Yearlings fed, Pd. 1	Head		64	80
" " Pd. 2	"		64	80
Dairy	Cow	14	14	11
Sows farrowed, Qu. 1	Sow	21	4	1
" " Qu. 2	"	21	4	1
" " Qu. 3	"	21	4	
" " Qu. 4	"	21	4	
(3) Hog Price @ $16.82/Cwt.				
Net income	$	13,473	13,608	13,773
Soybeans	Acre	21		
Corn	"	27	27	27
Alfalfa	"	15	19	19
Wheat	"	12	12	12
Real estate credit	$	16,158	16,763	16,763
Chattel credit	$	5,991	5,991	5,991
Private credit	$	4,900	4,900	4,900
Yearlings fed, Pd. 1	Head			
" " Pd. 2	"			
Dairy	Cow	7	12	12
Sows farrowed, Qu. 1	Sow	23	23	23
" " Qu. 2	"	23	23	23
" " Qu. 3	"	23	23	23
" " Qu. 4	"	23	23	23

TABLE B-16.--INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON SMALL DAIRY FARM IN SOUTH CENTRAL AREA - PHASE 1

Item	Unit	Price Combinations[a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items acquired:										
Corn purchased	Bu.	8,167	4,751	4,503	4,507	5,517	8,167	8,753	8,275	494
Hay purchased	Tons			2	19	12				115
Silo constructed	"									
Beef housing	A. units	52	52	54	51	42				
Low mech. feeding	Head	52	52	54	51	42				
Dairy cows	"			2	2	2			2	22
Hog farrowing	Sow	19					19	19	17	
Hog feeding	Head	338					338	348	309	
Seasonal labor	Man hr.	152	102	100	69	75	152	47	65	36
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn acreage limit	"	41.17	37.60	36.75	31.80	31.80	44.93	45.96	29.30	18.78
Wheat acreage limit	"	28.23	28.39	23.15	29.88	29.88	27.94	28.34	36.78	31.58
Capital	$	.33	.29	.30	.17	.17	.33	.33	.12	.06
Labor:	$/hr.									
Jan., Feb.,Mar., Dec.	"									
Apr. - May	"	3.02	2.66	1.53	1.64	1.64	3.04	3.04	2.55	.69
June - July	"	3.02	2.94	2.95	2.68	2.68	3.04	2.35	2.55	1.53
August	"									
Sept. - Oct. 15	"									
Oct. 15 - Nov. 30	"	1.70					.74	1.22	2.55	2.41
Cropland	$/acre	17.27	24.06	30.40	26.83	26.83	16.07	15.75	15.76	33.27
Land rented	"	8.85	15.57	21.60	17.29	17.29	9.40	9.86	4.46	19.69

[a] The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-17.--OPTIMAL ORGANIZATIONS FOR LARGE DAIRY FARM IN THE SOUTH CENTRAL
AREA - PHASE 1

Corn Price @ $.97/Bushel	Unit	Beef Prices per Cwt.		
		$16.33	$20.45	$24.56
(1) Hog Price @ $11.14/Cwt.				
Net income	$	15,815	20,495	27,332
Soybeans	Acre	83	83	83
Corn	"	92	92	92
Alfalfa	"	53	56	55
Wheat	"	29	29	29
Real estate credit	$	4,881	23,726	23,722
Chattel credit	$		18,920	18,920
Private credit	$	2,900	2,900	2,900
Yearlings fed, Pd. 1	Head	96	189	191
" " Pd. 2	"		189	191
Dairy	Cow	34	27	26
Sows farrowed, Qu. 1	Sow	5		
" " Qu. 2	"			
" " Qu. 3	"			
" " Qu. 4	"			
(2) Hog Price @ $13.98/Cwt.				
Net income	$	17,723	20,657	27,395
Soybeans	Acre	83	83	83
Corn	"	92	92	92
Alfalfa	"	58	56	55
Wheat	"	29	29	29
Real estate credit	$	21,707	23,645	23,660
Chattel credit	$		18,920	18,920
Private credit	$	2,900	2,900	2,900
Yearlings fed, Pd. 1	Head		184	189
" " Pd. 2	"		184	189
Dairy	Cow	33	27	25
Sows farrowed, Qu. 1	Sow	28	4	5
" " Qu. 2	"	28	1	
" " Qu. 3	"	28	1	
" " Qu. 4	"	28	1	
(3) Hog Price @ $16.82/Cwt.				
Net income	$	28,158	28,376	28,994
Soybeans	Acre	83	83	83
Corn	"	92	92	92
Alfalfa	"	41	41	37
Wheat	"	29	29	29
Real estate credit	$	33,282	33,282	37,943
Chattel credit	$	18,920	18,920	18,920
Private credit	$	2,900	2,900	2,900
Yearlings fed, Pd. 1	Head			46
" " Pd. 2	"			46
Dairy	Cow	15	15	17
Sows farrowed, Qu. 1	Sow	54	54	44
" " Qu. 2	"	54	54	44
" " Qu. 3	"	54	54	44
" " Qu. 4	"	54	54	44

TABLE B-18.—INVESTMENTS AND PURCHASES REQUIRED TO ACHIEVE OPTIMAL ORGANIZATIONS AND MARGINAL VALUE PRODUCTIVITIES FOR SELECTED RESOURCES ON LARGE DAIRY FARM IN THE SOUTH CENTRAL AREA - PHASE 1

	Unit	Price Combinations [a]								
		MHH	MMH	MLH	MLM	MMM	MHM	MHL	MML	MLL
Items required:										
Corn purchased	Bu.	16,708	10,042	9,729	9,701	10,108	17,779	17,779	8,231	
Hay purchased	Tons									
Silo constructed	"									
Beef housing	A.Units	25	105	107	107	104				57
Low mech. feeding	Head		118	119	118	115				57
Dairy cows	"								3	5
Hog farrowing	Sow	39					49	49	23	
Hog feeding	Head	665					824	824	402	
Seasonal labor	Man hr.	2,353	2,503	2,519	2,585	2,620	2,172	2,172	2,274	1,763
Marginal value productivities:										
Bean acreage limit	$/acre									
Corn acreage limit	"	42.15	40.83	40.83	30.96	30.96	42.51	43.24	26.57	18.29
Wheat acreage limit	"	28.40	27.06	27.06	32.61	32.61	28.19	27.96	35.32	39.44
Capital	$	.27	.25	.25	.12	.12	.27	.28	.06	.06
Labor:										
Jan., Feb., Mar., Dec.	$/hr.	1.44	1.62	1.62	2.55	2.55	1.42	2.04	.80	2.41
Apr. - May	"	1.44	2.84	2.84	2.55	2.55	1.42	2.04	.80	2.41
June - July	"	1.44	2.84	2.84	2.55	2.55	1.42	2.04	.80	2.41
August	"	1.44					1.42	2.04		
Sept. - Oct. 15	"	1.44	2.84	2.84	2.55	2.55	1.42	2.04	.80	2.41
Oct. 15 - Nov. 30	"	1.44	2.84	2.84	2.55	2.55	1.42	2.04	.80	2.41
Cropland	$/acre	1.13	4.25	4.25	8.51	8.51	1.19	1.31	12.12	6.77
Land rented	"	-5.71	-3.86	-3.86	-3.11	-3.11	-5.74	-5.15	-2.35	-3.62

a/ The upper case letters H, M and L refer to high, medium and low prices, respectively. The first letter in the sequence refers to the level of the corn price, the second to hog price, and the third to beef price. This ordering is retained throughout.

TABLE B-19.—ORGANIZATION OF THE LARGE CASH CROP FARM IN THE THUMB AREA

Activity or Resource	Unit	Original (1960)	Phase 1 Model	Phase 2 Model	Phase 2 Extended Model
Net Income	$	21,897[a]	26,145	31,313	32,152
Activities					
Dry beans	Acres	97	46	60	75
Corn	"	41	129	169	210
Alfalfa	"	15	0	0	0
Oats	"	16	24	32	40
Sugar beets	"	18	20	25	31
Wheat	"	39	40	52	64
Yearlings fed	Head	4	464	482	544
Dairy	Cow	6	4	4	4
Sows farrowed	Sow	1	16	8	15
Resources Acquired or Sold[b]					
Total credit used	$	11,927	54,242	54,399	64,190
Seasonal labor	Man hrs.	572	1,333	1,820	2,052
Operator labor	Hour	-267	NA	-172	-301
Family labor	"	-899	NA	-1,556	-1,556
Managerial labor	Op. hrs.	NA[c]	NA	570	1,600
Land 1	Acre	NA	NA	0	0
Rent land 1	"	154	154	194	194
Land 2	"	NA	NA	0	0
Rent land 2	"	NA	NA	40	120
Grain harvest equip.	Acre cap.	NA	NA	-61	-46
Corn picking equip.	"	NA	NA	107	147
Beef housing	An. unit	NA	141	146	167
Low mech. feeding	"	NA	141	146	167
Dairy cows	Head	NA	-2	-2	-2
Hog farrowing facilities	Sow	NA	1	0	1
Hog feeding facilities	Head	NA	0	0	0

[a] This is the estimated gross income for 1960.

[b] A minus sign in front of the entry indicates sale and no sign indicates purchase.

[c] NA denotes does not apply

APPENDIX C

Schedule No. _____

Date _____

Enumerator _____   CONFIDENTIAL

Segment Sample_____   MICHIGAN STATE UNIVERSITY

Department of Agricultural Economics

East Lansing, Michigan

FARM MANAGEMENT SURVEY

I.   Farm Size, Type, Control and Tenure

(1) Did gross income (sales) from this farm exceed $2,500 in 1960? Yes____No____
     (If NO, do not complete the schedule.)

(2) About what percent of your gross farm income (sales) from the farm came
     from:

     Beef cattle   _____%
     Hogs   _____%
     Dairy   _____%
     Cash grain   _____%
     Conservation reserve
       payments   _____%
     Sugar beets   _____%
     Other sales   _____% (If over 50% do not complete
                                              the schedule.)

(3) How many acres did you own in 1960? _____ Value per acre $_____.

     How many acres did you rent in last year? _____ Value per acre $_____.

     How many acres did you rent out last year? _____ Value per acre $_____.

     How many acres did you operate? _____.

     How many were tillable acres? _____.

(4) Was this farm managed in 1960 by: (a) an owner   Yes_____ No_____

                                       (b) a tenant   Yes_____ No_____

                                       (c) a partnership   Yes_____ No_____

                                       (d) a corporation   Yes_____ No_____

                                       (e) a hired manager   Yes_____ No_____

                                       (f) tenant and land-
                                            lord jointly   Yes_____ No_____

                                       (October 2, 1961)

(5) IF LAND WAS RENTED, what was the leasing arrangement in 1960:

Rented land parcel   __A__   __B__   __C__

     (a) Acres   _____ _____ _____

     (b)   _____ % _____ % _____ %
              _____ % _____ % _____ %
              _____ % _____ % _____ %
              _____ % _____ % _____ %

     (c) Percentage share of each class of livestock _____% _____% _____%

     (d) Cash rent paid per acre $_____ $_____ $_____

     (e) Percentage share of operating expenses _____% _____% _____%

     (f) Relation of tenant to landlord _____.

(6) How many years do you now plan to continue to operate this farm? _____

(7) (If he has any sons) do you expect that any of your boys will take over the operations of the farm eventually? Yes _____ No _____.

(8) Would you prefer your children to choose some other occupation? _____.

(9) When you cease to operate this farm, how do you plan to transfer control of it to another operator? (check)

     (a) Sale   _____   (c) Transfer to heir(s) _____

     (b) Lease to a tenant   _____   (d) Other   _____

(10) When you quit operating this farm, do you expect this farm to be:

     (a) Operated by another person _____

     (b) Consolidated with another farm unit _____

     (c) Absorbed in a nonfarm use - completely _____ partially _____

     (d) Other (specify) _____

II. Farm Labor Force

Family Labor Force

Person	Age	Education		Hrs. Farm Work/Wk.		Max. hrs. per Wk. Rush Periods	Off-farm Work, 1960				Days Farm Production Work in 1960	
		Highest Grade Attained	Now in School (√)	School Year	Summer Vacation		Weeks	Income	Hrs. per Week		Actual	Man Days
1) Operator												
2) Wife												
3) Sons												
4) Daughter												
5) Other family												

Hired Labor

	January – March	April May	June July	August September	October – December	Total for Year	
			Days Worked			Days	Wages
1) Regular							
2) Seasonal							
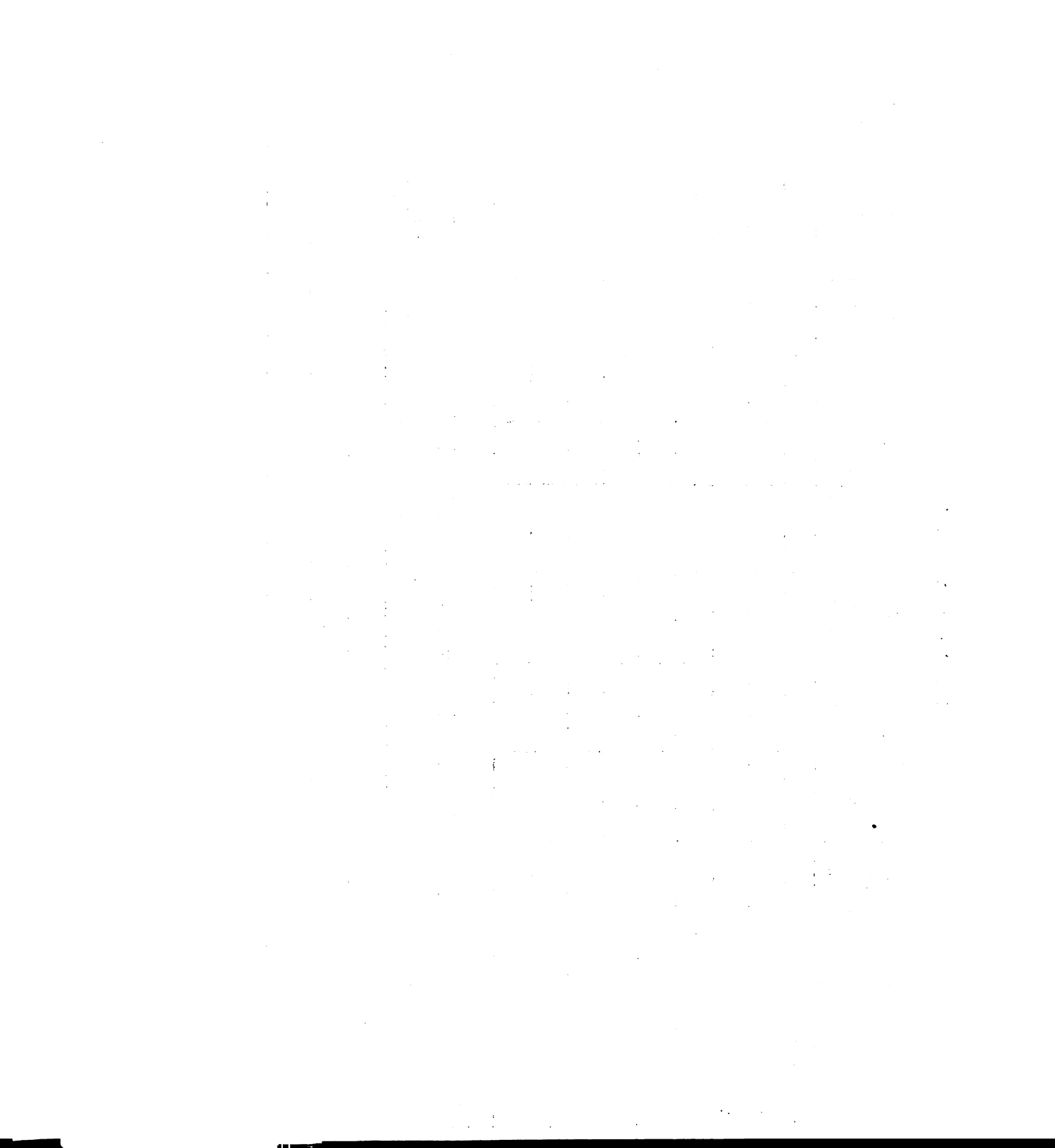
C. Custom Work and Equipment Rental

Operation	Work Hired			Worked for Hire			Remarks
	Units	Value	Rented 1/	Units	Value	Rented 1/	
(a) Baling							
(b) Combining							
(c) Corn picking							
(d) Field chopping							
(e) Hauling							
(f) Silo filling							
(g) Other							

1/ Check (√) if equipment only rented.

D. Non-Farm Work of Operator

(a) Did you have a non-farm job at any time in 1960? Yes_____ No_____
     If NO, skip to E (i)

(b) Was this job year around_____or seasonal? _____ If so, when_____

(c) What kind of work did you do?_____

(d) What was your wage rate per hour?_____

(e) Name of Employer_____Location_____

(f) How many miles was your job from home?_____

(g) How many days of paid vacation did you have during the year?_____

(h) If any, could you choose your vacation period? Yes_____ No _____

E. IF NO OFF-FARM WORK,

(i) Have you tried to obtain off-farm work? Yes_____ No_____

(j) What kind of work do you think you are qualified for (1) without further
     training?_____ Expected pay: $_____per week. (2)
     With further training_____ Expected pay: $_____per week.
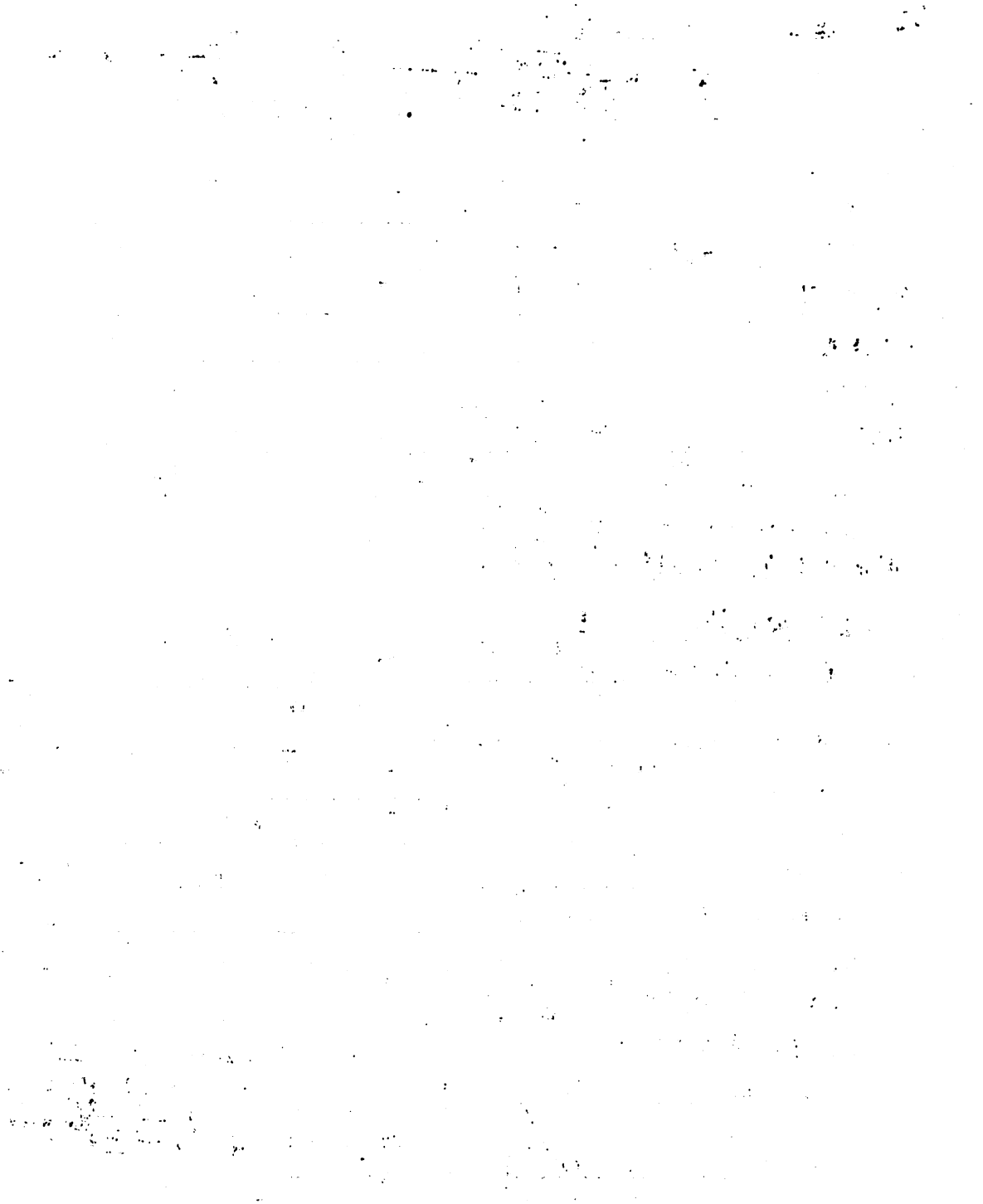
III. Machinery and Equipment

A. Owned

Item	No. / Size	Model Year	Present Value	Years Remaining Life	Description (of Special Equip. Only)
(a) Tractor					
(b) Plow					
(c) Disc					
(d) Corn planter					
(e) Cultivator					
(f) Combine					
(g) Corn picker					
(h) Hay baler					
(i) Field chopper					
(j) Grain drying equipment					
(k) Grain drill					
(l) Hay rake					
(m) Truck					
(n) Other major equipment*					

*Automatic feed handling systems, bulk milk tanks, pipeline milker, hay drying equipment, etc.

IV. Land Use, Crop Production, Sales and Purchases, Including Landlord's Share, 1960

(1) Land Use	(2) Acres		(3) Yield per Acre		(4) Unit	(5) Quantity Sold 1/	(6) Quantity Bought
	Owned	Rented	Owned	Rented			
Corn for grain, 1st yr					Bu.		
2nd yr					Bu.		
Corn for silage					Ton		
Soybeans					Bu.		
Dry beans					Cwt.		
Sugar beets					Ton		
Potatoes					Bu.		
Oats					Bu.		
Wheat					Bu.		
Barley					Bu.		
Grass silage					Ton		
Hay: legume					Ton		
grass					Ton		
mixed					Ton		

(1) Land Use	(2) Acres		(7) Commercial Feed and Additives Bought			
	Owned	Rented	Kind	Unit	Quantity	Value
Rotation pasture						
Acreage reserve						
Conservation reserve						
Idle						
TOTAL Cropland						
Permanent pasture: Open						
Woods						
Other land						
TOTAL Operated						

1/ Include only 1960 crops sold or held for sale.

V. Fertilizer Use and Application

Crop	Fertilizer		Rate Applied per Acre	Method of Application	Equipment		Custom Cost
	Acres	Rented			Owned	Rented	
1st year corn							
2nd year corn							
3rd year corn							
Soybeans							
Oats							
Meadow							
Wheat							

(11) How many tons of lime did you apply in 1960? _____

(12) Were any of your crops sprayed in 1960? Yes_____ No_____

(13) IF YES, complete the following information:

Crop	Materials Used	Quantity/Acre	Acres Sprayed	Cost per Acre

VI. Forage Handling

(1) What type of silo(s) do you have? (check) Tower_____ Bunker_____ None_____

    (a) If TOWER, capacity (tons)_____Method of feeding: Unloading___ Other___

    (b) If BUNKER, capacity (tons)_____ Method of feeding: Self-feed_____
        Manure Scoop_____ Hand-feed_____

    (c) Method of filling: Blower_____ Elevator _____ Other _____

(2) How is your hay stored? Baled_____ Chopped_____ Loose_____

(3) Are your fields fenced for rotation grazing?_____ How many acres? _____
    How many rods of fence? _____

VII. Hog Enterprise, 1960
Purchases, Sales, and Inventory of Hogs

	Bought, 1960			Sold, 1960			On Hand Dec. 31, 1960		
	No.	Wt.	Value	No.	Wt.	Value	No.	Wt.	Value
(a) Sows									
(b) Boars									
(c) Spring pigs born in 1959	XX	XX	XX				XX	XX	XX
(d) Spring pigs born in 1960									
(e) Fall pigs born in 1959							XX	XX	XX
(f) Fall pigs born in 1960									

(1) What type of farrowing house do you have? Central____ Portable____ None____

(2) What is the maximum number of sows that could be farrowed at one time in facilities now on this farm? _____

(3) How many sows farrowed in each month in 1960?

    January _____   May_____   September_____

    February_____   June_____   October_____

    March_____   July_____   November_____

    April_____   August_____   December_____

(4) How are your hogs finished for market? Confinement_____ On pasture_____

(5) How many pigs can be fed at one time on the farm? _____

(6) Number of litters farrowed - Spring_____ Fall _____

(7) Number of pigs weaned per litter - Spring_____ Fall _____

VIII. Major Buildings

Kind of Building	Miles from Hdq.	Bu. of Small Grain	Bu. of Ear Corn	Capacity Tons of		Housing Square Ft.		Insured Value	Replacement Value	Remaining Life a/	Description b/
				Hay	Silage	Loose	Tight				
Barn											
Barn											
Milk house											
Silo											
Silo											
Hog house											
Corn crib											
Corn crib											
Grain storage											

a/ Estimated life assuming minor maintenance and repair.

b/ Indicate if barns can be cleaned mechanically, feeding facilities available, limitations on efficient use of labor, and built-in facilities that aid in efficient use of labor.

IX. Dairy Enterprise, 1960
Purchases, Sales, and Inventory of Dairy Animals

	(2) Number Bought in 1960		(3) Number Sold in 1960		(4) On Hand December 31, 1960	
	No.	Value	No.	Value	No.	Value
(a) Milk cows						
(b) Dairy heifers, 1 yr.						
(c) 2 yr.						
(d) Dairy calves						
(e) Dairy bull						
(f) Steers	XX	XX				

(3) How many cows freshened in each month?

January_____   May_____   September _____

February_____   June_____   October _____

March_____   July_____   November_____

April_____   August_____   December_____

(4) What was the average production of milk per cow (pounds)_____B.F.test____%.

(5) Did you sell dairy products on a grade A___ grade B___ or cream_____ market?_____%

(6) Is your dairy barn a stanchion_____or loose housing_____type?

A. IF A STANCHION BARN:

(7) Number of stanchions_____

(8) Number of single milking units_____

(9) Number of double milking units_____

(10) Number of milkers per milking _____

(11) Pipeline, yes_____ no _____

(12) Bulk tank, yes_____ no _____

B. IF LOOSE HOUSING:

(13) Square feet of loading shed_____

(14) Type of milking parlor:
   (a) Single lane, yes____ no_____
   (b) Double lane, yes____ no_____
   (c) Walk through,yes____ no_____
   (d) Side opening,yes____ no_____
   (e) Herringbone, yes____ no_____
   (f) No. cows on side_____

(15) No. of single milking units_____

(16) No. of double milking units_____

(17) No. of milkers per milking _____

(18) Pipeline, yes_____ no_____

(19) Bulk tank, yes_____ no _____

X. Beef Cattle Enterprise, 1960

A. Did you have a beef breeding herd on this farm in 1960?

IF YES:

(1) Purchases, Sales, and Inventory of Beef Cattle, 1960

	Bought in 1960			Sold in 1960			On Hand, 12-31-61		
	No.	Wt.	Value	No.	Wt.	Value	No.	Wt.	Value
(a) Beef cows									
(b) Beef heifers, 1 year.									
(c) Beef heifers, 2 year									
(d) Beef calves									
(e) Beef bull									
(f) Stocker cattle, 1 yr. & over									
(g) Fattening cattle, farm raised									

(2) How many beef calves were:
  (a) Born on this farm   _____
  (b) Sold in 1960 at weaning age   _____
  (c) Put in feedlot on this farm after weaning   _____
  (d) Carried over on this farm   _____
  (e) % Calf crop   _____

(3) How many beef cattle can you house in present buildings?

Cows_____ Young stock_____

B. Were any purchased feeder or stocker cattle sold from this farm in 1960?
Yes_____ No_____

If YES, obtain the following information for cattle handled between fall of 1959 and fall of 1960:

Feeding System for Feeder Cattle

(1) Item	(2) Long-Fed Drylot	(3) Short-Fed Drylot	(4) Wintered and Fed on Pasture	(5) Winter and Fed on Pasture and in Drylot	(6) Stocker Cattle
(a) Number of steers					
(b) Number of heifers					
(c) Month bought					
(d) Age when bought					
(e) Weight when bought					
(f) Method of wintering	XX	XX	XX	XX	
(g) Month started on grain					XX
(h) Month put on drylot	XX	XX	XX		XX
(i) Kind of roughage fed					
(j) Type of pasturing	XX	XX			
(k) No. of grain feedings daily					XX
(l) Month sold					
(m) Weight when sold					
(n) Grade when sold					

(1) In how many of the last 10 years were cattle bought for: Fattening_____

XI. Other Livestock
Purchases, Sales and Inventory, 1960

		Bought, 1960		Sold, 1960		Consumed, 1960		On Hand, 12/60	
		No.	Value	No.	Value	No.	Value	No.	Value
(a) Ewes	wool meat	xx		lb._					
(b) Lambs	wool meat	xx		lb._					
(c) Feeder lambs									
(d) Other sheep	wool meat	xx		lb._					
(e) Laying hens	eggs meat	xx		doz.					
(f) Pullets									
(g) Broilers and Fryers									
(h) Turkeys									

(i) Eggs per hen for year_____

(j) Percent lamb crop _____

XII. Capital Position

You have given me considerable information about your farm and your farming operations last year and the changes that you have made in the last few years. Now I would like to ask you about your situation with respect to the use of investment capital and how it might influence your decision about making further changes in your farming operations.

1. How much would you estimate you had invested in your farm business on December 31, 1960, at current market values?

   (a) Real Estate $_____
   (b) Machinery, equipment and supplies   _____
   (c) Livestock   _____
   (d) Crops held for sale and feed inventories   _____
   (e) Cash for operation   _____
   (f) Total   _____

2. Do you have any additional funds and nonfarm investments which you could transfer to farm use to increase your investment in your farm business?

   Yes_____   No _____

   IF YES, what is the total amount? $_____

3. Do you have any outstanding loans which were made for the purchase or operation of your farm? Yes _____ No _____

IF YES, in order to estimate how much farmers could expand production, we need to know some details on the kinds of loans you have: (For each loan).

Property Mortgaged	Amount		Owed to	Purpose	Repayment schedule		
	Original	Bal.			Payment due date	Rate %	Am't due each pay date
(a) Real Estate							
(b) Livestock							
(c) Farm Machinery and equipment							
(d) Auto & Hsld. appliances							

Do you owe any money for other purposes? If so, we need to know some details about this.

Purpose	Current Amount	Date due	Owed to	Int. rate	Other charges	Total credit for year
(e) Feed						
(f) Fuel & lubr.						
(g) Repairs						
(h) Fertilizer						
(i) Doctor & hospital						
(j) Other						

(k) Do you have any other unsecured loans including promissory notes, etc.?
Yes _____ No _____

How much? $_____

Source? _____ (Bank, individual, etc.)

(1) Do you think you could borrow additional funds from any private individual?
_____. If so, how much? $_____. At what rate of interest?_____
What kind of security would be required? $_____

Do you think there would be any restrictions on how you used this money?
_____. If so, what restrictions?_____

(m) List up to the four best "land rental" opportunities in your neighborhood for the next year.

Acres	Quality Relative to Present Farm			Annual Rent	Kind of Contract	Duration of Lease
	Better	Same	Poorer			
1.						
2.						
3.						
4.						

(n) List up to the four best "land buys" which you know of in your neighborhood for the next year.

Acreage	Quality Relative to Present Farm			Price per acre	Financing			
	Better	Same	Poorer		Kind	Down pymt.	Yrs.	Percent Interest
1.								
2.								
3.								
4.								

XIII. Annual Operating Expenses on all the Land Operated

Expense	Amount	Expense	Amount
Fuel & lubricant for tractor, truck & farm share of auto		Taxes & interest on all land operated	
Machinery & equipment repair		Buildings & Repairs	
Veterinary - medicines Breeding fees		Chemicals	
Electricity			

XIV. Inventories, Purchases and Sales of Crops, Feed and Seed

Crop supplies, or livestock	1960 Inventory Jan. 1, 1960 Amount	Dec. 31, 1960 Amount	Purchases No.	Price	Value	Sales No.	Price	Value
Corn								
Soybeans								
Oats								
Wheat								
Other grains								
Silage								
Hay								
Other crops								
Dry beans								
Seeds								
Fertilizer								
Limestone								
Protein Supplements								
Feed Grain								
Supplies*								

*Chemicals, Dairy supplies, etc.

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