

ABSTRACT

AN ECONOMIC COMPARISON OF MAJOR FARMING SYSTEMS ON SOUTHERN MICHIGAN CASH-GRAIN FARMS

By

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The major purpose of this study was to provide information to farmers, agricultural workers, and policy-makers about potential incomes associated with alternative farming systems on cash-grain farms in Southern Michigan. The specific objectives of the study were to: (1) describe major farming systems on Southern Michigan cash-grain farms; (2) determine the optimum farm organization associated with each farming system and varying farm sizes; (3) compare the potential incomes associated with these farming systems over varying farm size levels; and (4) appraise the adjustment implications for cash-grain farmers.

Nine farming systems were studied, each differentiated from the other by the manner in which land, labor, machinery, or capital were acquired. These farming systems were: complete ownership, ownership plus crop-share rent-in, ownership plus cash rent-in, ownership plus custom harvesting, crop-share rent-in, cash rent-in, complete custom hire, cash rent-out, and crop-share rent-out.

The "synthetic firm" approach, with linear programming and partial budgeting, was used to estimate potential income and the optimal organization associated with the alternative farming systems. Four farm sizes were assumed for each farming system: 160 acres, 320 acres, 480 acres, and 640 acres. A comparative analysis of the various farming systems was based on the returns over cash costs; returns to risk, management, and unallocated capital; operating capital; labor utilized; optimal enterprise organization; and the farm size necessary to provide an income equal to that of an average Michigan durable goods manufacturing worker in 1967. Enterprises included in the analysis were corn, wheat, oats, soybeans, and alfalfa.

The farming systems were analyzed with and without off-farm work assumed for some of the farming systems. When off-farm work was assumed, it was considered for only three systems: crop-share rent-out system, cash rent-out system, and complete custom hire system.

As farm size increased, the farming system (no labor sold off-farm) which produced the largest returns over cash costs changed also. For the 160 acre farm size, the complete custom hire system is the largest income producer because of lower total machinery costs. In second place was the ownership plus custom harvesting system. The custom hiring of harvesting operations kept the machinery investment down and returns up compared to the other farming systems at this

level. As the farm size increased to 320 acres, the complete ownership system became the largest income producer with a range of \$441 between this system and the second place system. The complete custom hire system ranked third. Apparently the economies of size of the machinery complement lowered the ownership costs below the custom charges, thereby pushing the complete ownership system into first place. For the 480 acre and 640 acre farm sizes, the complete ownership system was the largest income producer.

The introduction of off-farm work resulted in a rearrangement of the standings of the various systems, based on income earning potential. For all farm sizes, the complete custom hire plus off-farm work system was the largest income producing system. As farm size increased, the cash rent-out plus off-farm work system and the crop-share rent-out plus off-farm work system lost in ranking of importance and the complete ownership system increased.

The optimal organization for the complete ownership, ownership plus custom harvesting, crop-share rent-in, complete custom hire, and crop-share rent-out farming systems for all farm study sizes had the same proportions for each crop.

The enterprise organization of the cash rent-out system was not under the control of the operator of this farm system, and therefore was not considered. The ownership plus crop-share rent-in and ownership plus cash rent-in systems

had identical enterprise organizations which differed from the other systems in that they had a larger percentage of corn and a smaller percentage of wheat and soybeans at the larger farm sizes.

There appeared to be little relationship between potential incomes associated with the alternative farming systems of various sizes and wages of industrial workers. However, as might be expected, those farming systems which had lower productivity required more acreage to provide the income level desired.

Based on the returns over cash costs, it appears that the larger farm sizes with the operator employed full-time on the farm are relatively profitable which may result in larger and fewer farms in the future. At the smaller farm sizes, based on the larger associated incomes, the operator will tend to custom hire part or all of the required machinery services, which may result in an increased demand for custom services. The smaller operators (less than 320 acres) will tend to enlarge their operations or to take off-farm jobs in order that they might maintain or raise their incomes. Pure tenancy will tend to decrease because of low returns to these operations relative to other farming systems and its low capital generating ability. Corn and soybeans with a minimum acreage of wheat allowable to maintain the allotment will become the dominant crops provided the government programs assumed for this

study do not change. Based on the relatively low returns over cash costs, it appears that the smaller rent-in and rent-out farming systems will have little chance for growth unless off-farm work is undertaken to raise the income of these systems. Finally, the more resources that can be acquired, the better opportunity it appears there is for a higher income.

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1969

ACKNOWLEDGMENTS

Appreciation is extended to the Department of Agricultural Economics for the financial assistance given the author which enabled him to start and complete his graduate study on the master's level.

The author extends sincere appreciation to Dr. Larry J. Connor, Graduate Committee Chairman, for his encouragement, helpful advice, and assistance through the author's course of study and preparation of the thesis. Thanks are also extended to Drs. Lester Manderscheid and David Armstrong, members of the graduate committee, for reading earlier drafts and offering helpful suggestions and comments for improvement.

The author is indebted to Carole Mills for typing the preliminary draft of the thesis.

Finally, special thanks are due to the author's parents, Mr. and Mrs. Oliver Wegenhoft, for their encouragement and understanding throughout the author's graduate program.

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CHAPTER I

INTRODUCTION

United States and Michigan agriculture are changing rapidly in structure and resource usage. Farms are becoming larger in size and fewer in number. Types of farms which were predominate in the past are losing place to other, different types. More capital and less labor are being used in the productive processes.¹ Likewise, management is increasing in importance as farming becomes more complex in its technical and economic problems.² The allocation of resources for an individual farm in this period of change to maximize returns is an ever present and growing problem. As change takes place, each firm has to adjust to the new environment to attain the goals of the operator.

Problem Setting

In Michigan, farms with an annual sales of less than \$10,000 have declined in both absolute (from 47,372 farms in 1959³ to 37,377 farms in 1964⁴) and relative terms (42.4 percent and 39.9 percent in 1959 and 1964, respectively, of all farms). At the same time, those farms with an annual sales of more than \$10,000 have increased. In

1959, the above \$10,000 sales range accounted for 17,670 farms or 15.8 percent of all farms while in 1964 this same sales range accounted for 22,810 farms or 24.4 percent of all farms. In this same time period, the number of all farms declined by 16.3 percent. These statistics indicate that farms are becoming fewer in number and larger in size over time.

The farms are also growing in size and declining in number at different rates. The \$10,000 annual sales group is declining at a rate of 4.6 percent per year while the above \$10,000 annual sales farms are growing at a rate of 5.2 percent per year.

There have also been changes in the proportions of the various types of farms. The three most numerous farm types in Michigan are dairy, cash-grain, and livestock with dairying being the most important. However, from 1950 to 1964, the number of dairy farms declined by 55.8 percent while cash-grain farms increased by 3.0 percent. In this same time period, livestock farm numbers declined by 19.6 percent. The relative importance of farm type has also changed. In 1950, 45,800⁵ dairy farms accounted for 29.4 percent of all farms while in 1964 there were only 20,230 dairy farms which accounted for 21.6 percent of all farms. This is a 5.7 percent rate of decline. The same downward trend is evident in livestock farm numbers. There were 10,857 livestock farms (7.0 percent of all farms) in 1950.

By 1964, the number had declined to 8,725 livestock farms (9.3 percent of all farms), at a 1.5 percent rate per year.

The exception to the general declining trend in declining farm numbers is the cash-grain farm. From 1950 to 1964 the number of cash-grain farms increased from 14,972 farms to 15,418 farms or by 3.0 percent. This is a .1 percent per year rate of growth. The importance of cash-grain farms increased from 9.6 percent to 16.5 percent of all farms in the same time period. If the present trend continues, cash-grain farming will soon be the predominant type of farming in Southern Michigan.

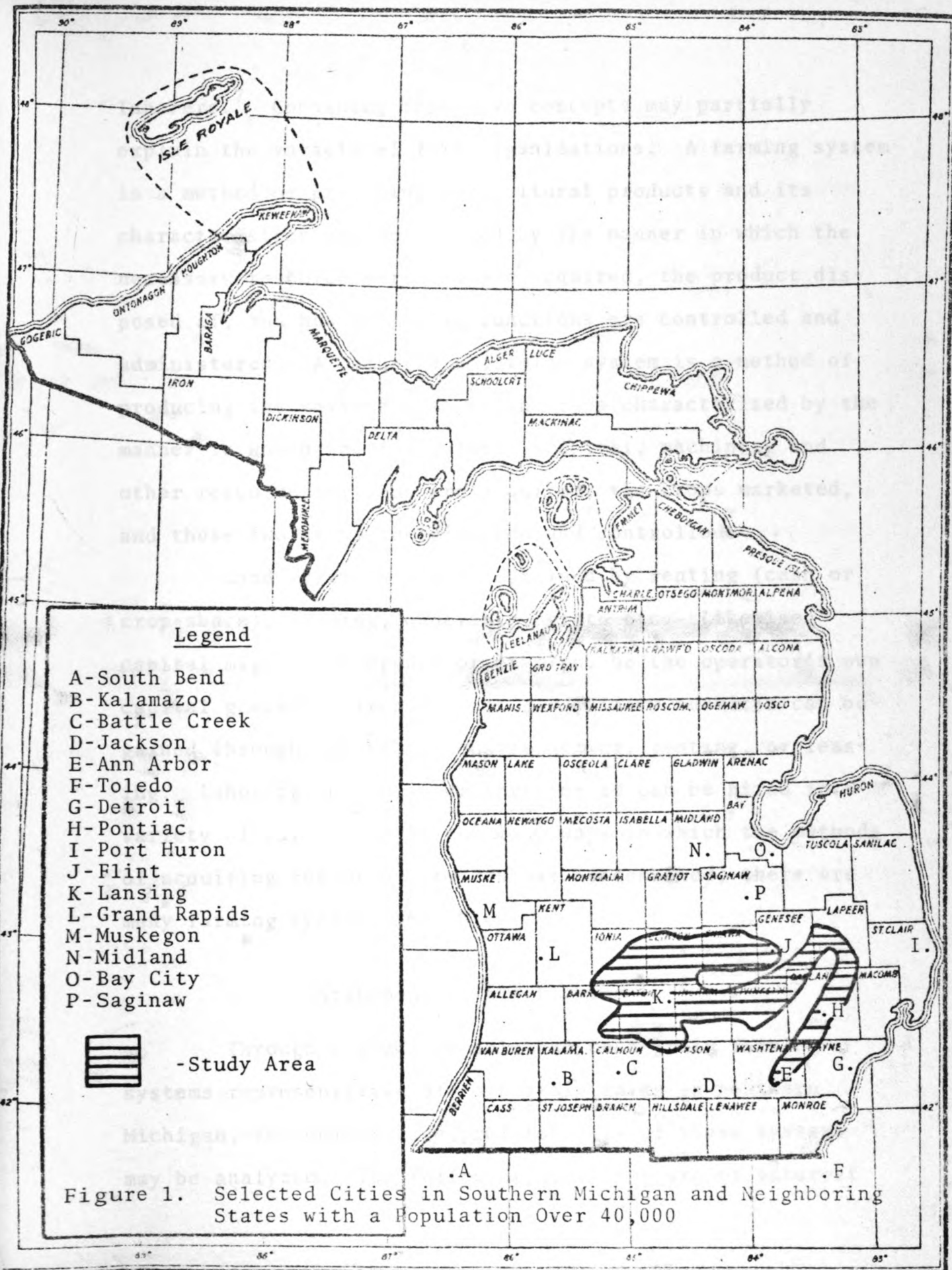
The question arises as to why there are fewer and larger farms? Also, why have cash-grain and livestock farms risen in importance and dairying declined?

A number of reasons may be advanced. Agriculture in general is faced with serious overproduction problems which lead to low prices for agricultural products. Also, many input prices have been rising steadily. With stable prices and rising costs, the per unit margin is falling. One way to maintain or raise a level of income is to expand the number of producing units. More units of production even at low margins can often mean more income. But to expand production facilities requires access to the necessary capital, the ability to manage the expanded operation, and other factors. Not all farm people have the resources (human and physical) or want to expand their farming operation.

Those farmers which cannot or do not want to expand are faced with lower total returns from agriculture. Many of these, if they are able, seek off-farm employment to supplement their farm incomes. Some may sell or rent-out the farm and move to town, others may live on the farm and work it in their spare time while being employed off the farm.

Most of the agriculture in Michigan is located south of a line drawn east and west from Bay City to Muskegon. In this area, also, are many of the industrial centers of Michigan. By looking at a map and drawing a circle around each industrial center with a radius of 25 miles and a second circle with a radius of 40 miles, it can be seen that almost no area in Southern Michigan is more than 40 miles from at least one industrial center and many are within 25 miles (see Figure 1). This location enables many farmers, if they so desire and have the skills necessary, to work at off-farm jobs.

Within the Southern Michigan area, there are quite a variety of cash-grain farming systems. According to McMillan and Gonzales, "A system is a set of objects together with relationships between the objects and their attributes."⁶ In other words, a system is any method or way in which an objective is attained and the characteristics of the method. Lee asserts that farmers are more and more becoming organizers of resource services and less



laborers.⁷ Combining these two concepts may partially explain the variety of farm organizations. A farming system is a method of producing agricultural products and its characteristics are determined by the manner in which the necessary resource services are acquired, the product disposed of, and how these two functions are controlled and administered. A cash-grain farming system is a method of producing the various cash-grain crops characterized by the manner in which the land, labor, capital; machinery and other resource services are acquired, the crops marketed, and these two areas administered and controlled.

Land services may be obtained by renting (cash or crop-share), leasing, ownership, gift, etc. Likewise, capital might be borrowed or it might be the operator's own capital generated from savings. Machinery services can be gained through ownership, custom hiring, renting, or leasing. Labor can be the operator's or it can be hired in a variety of ways. Due to the many ways in which the methods of acquiring resource services may be combined, there are many farming systems possible.

Statement of the Problem

Through a study of selected cash-grain farming systems representative of cash-grain farms in Southern Michigan, the comparative profitability of these systems may be analyzed. The following questions are of interest

to many farmers and agricultural workers: What size of operation is necessary to provide an income comparable to that which the operator might earn off farm? What is the relative profitability of these alternative systems of cash-grain farms where the farmer: works full time on the farm, or part or full time in off-farm work; custom hires all or part of the operation; rents out the land (cash or crop-share basis); rents in land (cash or crop-share basis); and owns the land he works.

By determining how large a farm has to be to return an income comparable to that of an industrial worker, some indication of the comparative welfare of farm operators using the various farming systems is obtained. It also gives some indication of how much a small farm will have to expand to obtain a comparable income. If this expansion is not possible, other alternative actions might be sought.

The second focus of the study is on the alternative farming systems by which a farmer can maximize his income. The two most important variables in determining income are labor and capital. Labor is important in that it can be used in two alternatives: (1) off-farm as a laborer, or (2) on the farm. Due to the accessibility of high-paying off-farm jobs and low returns in agriculture, it is very important to the individual to know how to divide his time. For a given amount of time spent in farming, it is necessary to know which farming system to use to maximize income.

Capital can be used in various ways to acquire resource services. It can be used either to purchase land or to rent it. Also, capital can be used to acquire machinery services. Is it more profitable to custom hire all or part of the operations or to own the machinery to do it? Should capital to cover operating expenses be borrowed or provided by the operator?

Objectives of the Study

The major purpose of the study is to provide information to farmers, agricultural workers, and policy makers about potential incomes associated with alternative farming systems on cash-grain farms in Southern Michigan. Specifically, this study is aimed at estimating the income possibilities for the farm operator under different labor usages (on-farm versus off-farm), farming systems, and farm sizes.

The specific objectives of the study are:

- (1) Describe major farming systems on Southern Michigan cash-grain farms.
- (2) Determine the optimum farm organization associated with selected farming systems for varying farm sizes.
- (3) Compare the potential incomes associated with these farming systems over varying farm size levels.
- (4) Appraise the adjustment implications for cash-grain farmers.

Organization of the Remainder of the Thesis

The organization of the remainder of the thesis is given in the discussion below. Chapter II--Conceptual Framework and Research Procedures. The conceptual framework of the study and the selection of the research techniques used are discussed in this chapter. The sources of the data, how the study situation was selected, and the assumptions of the study are also given. Chapter III--Results of the Analysis. The optimum organization of the resources and potential incomes for the various farm sizes and farming systems are presented. Chapter IV--Comparison of the Alternatives and Implications of the Study. A comparison of the alternative cash-grain farming systems and the implications of the study are presented. Chapter V--Summary. A brief summary of the objectives, results, and implications of the study are presented in this chapter.

Footnotes

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²George F. Patrick and Ludwig M. Eisgruber, "The Impact of Managerial Ability and Capital Structure on Growth of the Farm Firm," American Journal of Agricultural Economics, L, No. 3 (1968), pp. 499-503.

³U.S. Bureau of the Census, Statistical Abstract of the United States: 1964, 85th ed. (Washington, D. C.: Government Printing Office, 1964), p. 613.

⁴U.S. Bureau of the Census, Statistical Abstract of the United States: 1968, 89th ed. (Washington, D. C.: Government Printing Office, 1968), p. 598.

⁵U.S. Bureau of the Census, Statistical Abstract of the United States: 1954, 75th ed. (Washington, D. C.: Government Printing Office, 1954), p. 662.

⁶Claude McMillan and Richard F. Gonzales, Systems Analysis: A Computer Approach to Decision Models, Irwin Series in Quantitative Analysis for Business (Homewood, Ill.: Richard D. Irwin, Inc., 1965), p. 1.

⁷John E. Lee, Jr., "Resource Ownership and Use-Rights in Agriculture" in The Structure of Southern Farms in the Future, ed. by Charles R. Pugh, Agricultural Policy Series 30 (Raleigh: Agricultural Policy Institute, North Carolina State University, 1968), p. 83.

CHAPTER II

CONCEPTUAL FRAMEWORK AND RESEARCH PROCEDURE

This chapter contains the framework and procedures used to evaluate the relative profitability of alternative cash-grain farming systems in Southern Michigan. The first part of this chapter presents the farming systems and the geographic area under consideration. The latter part of the chapter contains the research techniques, general assumptions, and the sources of data.

Farming Systems

"A system is a set of objects together with relationships between the objects and their attributes," according to McMillan and Gonzales.¹ Or, in other words, a system is any method or way in which an objective is attained and the characteristics of the method. In addition to this, Lee asserts that farmers are becoming more and more organizers or managers of resource services and less laborers.² By combining these two ideas a partial explanation of the variety of farming systems may be found. A farming system is a method of producing agricultural products and its characteristics are determined by the

manner in which the resource services are acquired, the product disposed of, and how these two functions are controlled and administered. Inherent in the resource services are considerations of technical variations which arise. If the technology by which a resource service is provided is changed, the farming system is changed.

However, a farming system does not operate in a vacuum. It is a part of a universe, which also may be thought of as a system. Obviously, the farming system is affected by, but has little or no control over many parts of the universe. Those parts of the universe which the farming system has no control over, may be said to be external to the farming system. This is the environment in which the farming system operates. That which the farming system has control of, is internal to the farming system. The farming system is composed of subsystems just as the farming system is a subsystem of the universe. These subsystems are often interrelated and interconnected. Parts of one system are at the same time parts of other systems.

In general, a farming system may be depicted as being composed of three related systems: (1) the administrative-control system, (2) the input system, and (3) the output system. In turn, each of these three systems are composed of two systems. They are: (a) the environmental or external system over which the farming system has no

control, and (b) the internal system which is controlled by the farming system. Furthermore, these two systems may be made up of numerous subsystems.

The input system is composed of the: (a) environmental system, and (b) internal support system. The internal support system is made up of the general support system and the specific support systems. The general support system is associated with all enterprises whereas the specific support systems are concerned with a given enterprise or activity.³

This study is concerned with the general support system and the effects on the income producing ability of the farming system. Specifically, the study is concerned with income variability due to different manners of acquiring the services of land, labor, machinery, and capital. For purposes of this study, a farming system is a method of producing the various cash-grain crops (corn, wheat, oats, soybeans, and alfalfa) characterized by the manner in which the land, labor, capital, and machinery services are acquired.

By changing the manner of acquiring resource services the system is changed. By analyzing the results of the changes in the manner of resource service acquisition, an appraisal of the various systems can be made.

The ways that the services of the various inputs are acquired are as follows: (1) land services are acquired

through operator ownership, cash rent-in, crop-share rent-in, or a combination ownership and rent-in. In addition, returns on land services are received by cash rent-out or crop-share rent-out. (2) Machinery services are acquired by operator ownership or by custom hiring or a combination of both. (3) Labor services are provided by the operator, are hired when the operator is unable to provide the hours of labor required, or are received in conjunction with the custom hiring of machinery services. (4) Capital services are obtained through the use of equity capital (internal financing) or borrowing (external financing). (5) Management services are provided by the operator for all systems.

The farming systems analyzed in this study are:

- (1) Complete Ownership Farming System--the services of land and machinery are acquired through operator ownership. Labor is provided by the operator as available and additional labor is hired on an hourly basis as needed. Operating capital services are acquired by borrowing. Fixed capital in terms of land, machinery, and buildings are gained through ownership.
- (2) Ownership and Crop-Share Rent-In Farming System--land services up to 320 acres are acquired by operator ownership. Additional acreage is acquired by crop-share rent-in. Machinery services are acquired by operator ownership. Labor services are

furnished by the operator until this source is no longer able to provide them, in which case, additional labor services are hired on an hourly basis as needed. Operating capital services are acquired by borrowing. Fixed capital in the form of machinery, buildings, and some land is acquired through ownership. Additional fixed capital in terms of land is rented.

- (3) Ownership and Cash Rent-In Farming System--land services up to 320 acres are provided by operator ownership. Additional land services are acquired by cash rent-in. Machinery services are acquired through operator ownership. Operating capital services are acquired by borrowing. Fixed capital in terms of land, machinery, and buildings is acquired through ownership and renting. Labor services are provided by the operator until this source is exhausted, then additional labor is hired on an hourly basis.
- (4) Ownership and Custom Hiring Farming System--land services are obtained through operator ownership. Machinery services except for harvesting are acquired by operator ownership. Harvest services, machinery and labor, are obtained by custom hire. Labor services except for harvest are procured from the operator and if this source is insufficient,

additional labor services are acquired on an hourly basis. Operating capital services are acquired by borrowing. Fixed capital in terms of land, machinery and buildings are acquired by ownership or custom hiring, as the case may be.

- (5) Cash Rent-In Farming System--all land services are acquired by cash rent-in. Machinery services are procured through operator ownership. Labor services are provided by the operator and if more hours of labor service are required than the operator can provide, this is hired on an hourly basis. Operating capital services are acquired by borrowing. Fixed capital in terms of land, machinery, and buildings are acquired by rent, or ownership as the case may be.
- (6) Crop-Share Rent-In Farming System--land services are obtained by crop-share rent-in. Machinery services are acquired through operator ownership. Operating capital services are acquired by borrowing. Fixed capital in terms of machinery, land, and buildings is acquired by ownership or rent as the case may be. Labor services are provided by the operator and when this supply is expended, additional labor services are acquired by hiring on an hourly basis.

- (7) Complete Custom Hiring Farming System--all machinery and labor services are obtained by custom hiring. Land services are provided by the owner-operator. Operating capital services are acquired by borrowing. Fixed capital in terms of land and buildings is acquired through ownership.
- (8) Cash Rent-Out Farming System--the purpose of this farming system is to provide land services to other people for cash rent. The rented-out services are owned by the operator of the system. No machinery, labor, or operating capital services are required by the operator for this system. Fixed capital in terms of land and buildings is acquired by ownership. This system differs from the other farming system in that the manager is only concerned with selecting someone to do the actual farming. Managerial requirements are less here.
- (9) Crop-Share Rent-Out Farming System--the purpose of this system is to provide land services to other people for a share of the harvest as rent. Labor, operating capital, and machinery services are not provided by the operator. As with the cash rent-out farming system, this system is different from the systems that actually produce cash grain crops in that the manager is only concerned with selecting someone to farm the land. Managerial requirements are not too great for this task.

Area of Study

The study area is restricted to dryland culture cropland located primarily in Eaton, Ingham, Clinton, and parts of Ionia, Barry, Shiawassee, and Livingston counties of South Central Michigan (see Figure 1). The dominant soils are Gray-Brown Podzolic Soils (Limy Materials) of the Miami and Conover soil associations.

The soils of the study area are derived for the most part from glacial till, level to rolling. The drainage of the soils vary from well to imperfect depending on the slope of the land. They are deep, relatively high in fertility, and durable under cultivation, except for the steeper slopes. With a proper system of management, the soils can be maintained in a good productive state. The soils are suitable for growing corn, wheat, oats, alfalfa, beans, and sugar beets. The muck soils which are closely associated in the region, may be used to produce onions, mint, and truck crops. The principal soil series are Miami and Conover.⁴

Between the seasons, average monthly temperatures have a range of approximately 50°F. The lowest average monthly temperature is 21.7°F. in January. August has the highest monthly average with 71.0°F. The average annual temperature is approximately 48.0°F. Within the study area, average annual temperatures may fluctuate ± 1 or 2 degrees depending on the local conditions. There are approximately

173 frost free days per year starting in April and ending in early October.

Soil temperatures (2 inches below the surface) at East Lansing, Michigan have a larger range than does the air temperature. The average low temperature is 23°F. in February and rises to an average high of 87°F. in July-August. The average annual soil temperature is about 53°F.

Average annual precipitation is approximately 32 inches. The wettest months are May-June, September, and November.⁵

The sizes of the representative farms under study were partially determined from Agricultural Economics Report No. 99, Business Analysis Summary for Cash-Grain Farms, 1967.⁶ It was found that farm sizes ranged from 117.5 acres to 944.0 acres in 1967. For those farms with an investment over \$160,000, the size range was from 252.0 acres to 944.0 acres with a mean of 486.5 acres and a standard deviation of 168.9 acres. In the under \$160,000 investment class, farm size ranged from a low of 117.5 acres to a high of 486.0 acres. This investment class mean was 294.8 acres with a standard deviation of 104.0 acres. However, this farm size data cannot be said to be representative of the farms of the state because it is based on information provided by members of the Telefarm computerized record keeping project.

Other factors which went into the determination of the study farm sizes were a 4-row equipment and power complement. Also, the labor source is primarily the owner-operator with hired labor used when the operator is unable to provide the amount of labor necessary to complete the farming operations. Based on the above mentioned factors, the study farm sizes of 160 acres, 320 acres, 480 acres, and 640 acres were chosen.

Research Techniques

The "synthetic firm" approach, with linear programming and partial budgeting, was used as the research technique for this study.

The synthetic firm approach was used to insure comparability between farming systems with respect to management, resources, and technology. In a comparative study it is important that the differences in the results are inherent in the study variables and are not due to outside factors.

Linear programming was chosen for its ease of calculating maximum potential income and the associated optimal organization for a given farming system. Three requirements are prerequisite to the use of linear programming. The requirements and corresponding satisfactions for the study are: (1) have an objective--to maximize potential incomes and ascertain the associated optimal organization

of each farming system, (2) alternative means of attaining the goal--different combinations of the various crops, and (3) have resource restrictions--limits on the availability of land, labor, and capital services. Partial budgeting was used in those cases involving a very limited number of alternative activities.

Each farming system and each farm size was programmed separately. Those farming systems with few alternative activities were partially budgeted because linear programming was not necessary. The resulting programmed output and budgeting results (potential income and optimal organization) are presented in Chapter III. The programmed returns are the returns over variable cash costs. Overhead costs consisting of machinery overhead, real estate taxes, interest on land investment, and operator labor costs were handled outside of the linear program or partial budgets.

The operational linear programming model for each farming system and each farming size may be summarized in a context as follows for the objective of maximization of income:

$$(1) \quad \sum_{j=1}^n r_j x_j = \text{maximum}$$

where x_j represents activity levels and r_j represents the net revenues of the activities, subject to the constant resource constraints (b_i) , with

$$(2) \quad \sum_{j=1}^n a_{ij} x_j \leq b_i, \text{ and}$$

$$(3) \quad x_j \geq 0, \text{ for all } j,$$

where a_{ij} represents the technical input-output coefficients for each activity.⁷

The linear programming tableau for each farming system and each farm size programmed for this study has 18 activities and 20 restrictions and accounting equations. The activities and the resource constraints and accounting equations are listed in Table 1 and Table 2, respectively. The activities and the resource constraints and accounting equations are the same for all systems programmed. The a_{ij} and b_i values change from input system to input system and for farm size changes with each system. The a_{ij} values that change as farm size changes within an input system are the labor requirements by months for the various production activities. The r_j values change from system to system but not within an input system. The b_i values which change within an input system are the acreage restriction, and an operating capital restraint which is based in part on the farm size.

The between input system coefficient changes are the a_{ij} values for labor utilization by months, the capital borrowing coefficients for each activity, and the grain transfer coefficients in the case of crop-sharing systems.

Table 1

Linear Programming Model Activities

Activity Number	Activity Name	Activity Description
P ₁	CØRN	Corn production
P ₂	WHEAT	Wheat production
P ₃	ØATS	Oat production
P ₄	SOYBN	Soybean production
P ₅	ALFAL	Alfalfa production
P ₆	SLCRN	Corn selling
P ₇	SLWHT	Wheat selling
P ₈	SLSØY	Soybean selling
P ₉	HLRNM	Labor hiring for Nov.-March
P ₁₀	HLRAP	Labor hiring for April
P ₁₁	HLRMY	Labor hiring for May
P ₁₂	HLRJE	Labor hiring for June
P ₁₃	HLRJY	Labor hiring for July
P ₁₄	HLRAT	Labor hiring for August
P ₁₅	HLRSR	Labor hiring for September
P ₁₆	HLRØR	Labor hiring for October
P ₁₇	SLLR	Labor selling
P ₁₈	CPTBW	Capital borrowing

Table 2
Resource Restraints and Accounting Equations

Row No.	Row Code Name	Row Description
1	PRØFIT	Profit equation
2	LANDC	Maximum acreage to put into corn
3	LANDW	Minimum acreage to put into wheat
4	LANDT	Maximum acres to all crops
5	LRØNM	Maximum operator labor available in Nov.-March
6	LRØAP	Maximum operator labor available in April
7	LRØMY	Maximum operator labor available in May
8	LRØJE	Maximum operator labor available in June
9	LRØJY	Maximum operator labor available in July
10	LRØAT	Maximum operator labor available in August
11	LRØSR	Maximum operator labor available in September
12	LRØOR	Maximum operator labor available in October
13	LRØTØ	Total labor utilized
14	LRHIR	Total hired labor utilized
15	LRTØT	Total operator labor utilized
16	SLTRC	Corn transfer from production to sale activity
17	SLTRW	Wheat transfer from production to sale activity
18	SLTRS	Soybean transfer from production to sale activity
19	CPTLAN	Total annual capital utilized
20	CPTLTC	Maximum capital borrowable at any time during the year

The r_j values change between systems. The b_i values for capital change between input systems.

In short, there are 9 different systems of which 6 were solved by linear programming, 1 by partial budgeting, and 2 by a combination of linear programming and partial budgeting.

For each farming system, land is restricted to four farm sizes: 160 acres, 320 acres, 480 acres, and 640 acres. These farm sizes are based on information from Agricultural Economics Report No. 99, Business Analysis Summary for Cash-Grain Farms, 1967.

The operator is considered to be the major source of labor. The total operator labor available is 3,000 hours per year. The monthly operator labor available is given in Appendix 9. Additional labor is hired as needed at \$1.50 per hour. There is no restriction on the amount of labor hired.

Operating capital is restricted to 70 percent of the machinery investment plus 40 percent of the land investment.⁸ An interest rate of 7 percent is paid on borrowed capital. All funds necessary to put in a crop are borrowed at the beginning of the production period and paid at harvest.

Operating capital requirements for the various enterprises are divided into annual operating capital and total operating capital. The model is constructed so as to

determine the minimum resource service requirements and optimal organizations based on total operating capital, but to calculate interest only on annual operating capital utilized. Total operating capital was chosen as the limiting factor because when borrowing, the total amount borrowed at any one point of time determines what can be borrowed, not a historic annual figure which is calculated after repayment. The annual operating capital figure is the total operating capital borrowed, adjusted to an annual basis determined by the length of time that the money is borrowed. The interest charge is deducted from the income earned by the use of the borrowed funds.

The income earning enterprises are the production and sale of corn, wheat, oats, soybeans, and alfalfa. Field beans were not considered an important enough crop for the area under consideration to be analyzed as part of the study. No livestock, fruit, or truck crops were considered. The input-output relationships for the assumed level of production are given in Appendix 2.

For purposes of comparing the farming systems where no off-farm work is performed and those where it is, the unutilized labor of 2 farming systems, cash rent-out and crop-share rent-out, is sold at the average annual wage rate for a durable goods industry worker (\$7,289 or \$3.47 per hour) for Michigan. For the complete custom hire farming system, 80 percent of the unused labor is sold at the

same rate. The remaining 20 percent is assumed to be used in management of the custom hiring operations. A comparison of hourly wage rates of various industries in Michigan is presented in Table 3.

Table 3
Hourly Wages for Selected Industry
Classifications in Michigan

Industry Classification	Wage Rate
Manufacturing	\$3.47/hour
Transportation Equipment	\$3.71/hour
Machinery except electrical	\$3.58/hour
Food and Kindred Products	\$3.08/hour
Paper and Allied Products	\$3.04/hour

Source: Michigan Manpower Quarterly Review, Vol. III, No. 4, p. 27.

Sources of Data

Much of the data used in this study was drawn from Agricultural Economics Report No. 87, Costs and Returns for Major Cash Crops in Southern Michigan. This publication presents an abundance of information on the costs and returns of many cash crops, based on a synthetic firm approach. Much useful information on technical coefficients--fertilizer requirements per yield level, machinery and labor requirements, machinery costs, etc.,--are given.

Labor requirements per acre for the selected crops were drawn from unpublished research by Armstrong.⁹ In his study a Cobb-Douglas function was fitted to Telfarm data to estimate labor requirements per acre for various enterprises.

Machinery systems and requirements information were based on Benjamin's M.S. thesis, "An Economic Analysis of Acquiring Farm Machinery Services for Southern Michigan Cash-Grain Farms."

Agricultural Economics Report No: 99, Business Analysis Summary for Cash-Grain Farms, 1967 provided information on farm size and enterprise organization.

A mail survey was conducted to determine the prevailing cropland rental arrangements in Southern Michigan. The questionnaire was sent to the county agents of the counties whose soils were predominantly of the types in this study. A sample questionnaire and the results of the survey are included in Appendices 11 and 12.

Footnotes

¹McMillan and Gonzales, Systems Analysis, p. 1.

²Lee, "Resource Ownership and Use-Rights in Agriculture" in The Structure of Southern Farms in the Future, p. 83.

³Warren Vincent, "A Management Information System as a Basis for Organizing Farm Management Resources" (paper presented during a Computer Application Program, Department of Agricultural Economics, Michigan State University, 1969), pp. 4-12.

⁴E. B. Hill and Russell G. Mawby, Types of Farming in Michigan, Agricultural Experiment Station Special Bulletin 206 (East Lansing, Michigan: Agricultural Experiment Station, 1954), p. 77.

⁵U.S. Department of Commerce, Environmental Science Services Administration, Environment Data Service, Climatological Data: Michigan Annual Summary, 1968, LXXXIII, No. 13 (Washington, D. C.: Government Printing Office, 1968), pp. 191-197.

⁶Leonard R. Kyle, Business Analysis Summary for Cash Grain Farms, 1967, Agricultural Economics Report No. 99 (East Lansing, Michigan: Department of Agricultural Economics, 1968), pp. 6-11.

⁷Earl O. Heady and Wilfred Candler, Linear Programming Methods (Ames, Iowa: Iowa State University Press, 1958), pp. 1-52.

⁸Based on information provided by Dr. John Brake, Department of Agricultural Economics, Michigan State University, 1969.

⁹Based on unpublished data by Dr. David Armstrong, Department of Agricultural Economics, Michigan State University, 1968.

CHAPTER III

RESULTS OF THE ANALYSIS

This chapter contains the optimal organization and associated potential income for the various farming systems described in Chapter I and arrived at through the research procedures explained in Chapter II.

Three potential incomes are presented in the analysis. They are returns over variable cash costs, returns over cash costs, and returns to risk, management, and unallocated capital. These income estimates are residual returns, or in other words, income that remains after certain costs have been paid. These are: (1) Returns over variable cash costs. This figure represents gross income less the variable cash expenses for seed, fertilizer, herbicide, custom hauling, preharvest machinery usage, harvest machinery usage, and rent. (2) Returns over cash costs. This is returns over variable cash costs less machinery ownership costs and real estate taxes. Ownership costs include depreciation, interest, and insurance. (3) Returns to risk, management, and unallocated capital. This figure represents returns over cash costs less interest on land investment and opportunity costs for operator labor.

If this estimate is negative for a particular system, producers might want to look at alternative farming systems in which to employ their resources.¹

Complete Ownership Farming System

This farming system is one in which the owner-operator has full equity in land and machinery. He is the main labor supply with outside labor being hired when the labor requirements exceed the capacity of the operator to supply them. Operating capital is borrowed at the beginning of the production period and repaid at harvest at an annual rate of 7 percent. Opportunity costs are considered for the investment in land and operator labor.

The organization necessary to provide the maximum income is presented in Table 4. The returns to risk, management, and unallocated capital for this farming system range from -\$91 for the 160 acre farm size to \$11,592 for the 640 acre farm size. Returns over variable cash costs range from \$8,398 for the 160 acre farm size to \$32,848 for the 640 acre farm size. Returns over cash costs range upward from \$4,357 for the smallest farm size to \$26,876 for the largest farm size.

The enterprise organization is proportionally the same for the three crops grown. Percentage wise, soybeans rank first with 45.0 percent; corn ranks second with 38.7 percent; and wheat ranks last with 16.2 percent. For the

Table 4
Optimal Organizations and Associated Potential Incomes for a
Complete Ownership Farming System

Item	Unit	Farm Size(Acres)		
		160	320	480
				640
Enterprise Organization:				
Corn	Acre	62.0	124.0	186.0
Wheat	Acre	26.0	52.0	79.0
Soybeans	Acre	72.0	144.0	215.0
				287.0
Labor Utilized:				
Total Operator Labor	Hour	885.0	1323.0	1655.0
Total Hired Labor	Hour	---	114.0	259.0
Total Labor Utilized	Hour	885.0	1437.0	1914.0
				2343.0
Operating Capital: ¹				
Total Operating Capital	Dol.	4225.00	8450.00	12677.00
Annual Operating Capital	Dol.	2435.00	4956.00	7513.00
				10110.00
Returns Over ₂ Variable Cash Costs ²				
	Dol.	8398.00	16619.00	24784.00
				32848.00
Cash Overhead Costs:				
Machinery Ownership	Dol.	3561.00	3561.00	3706.00
Real Estate Taxes	Dol.	480.00	960.00	1440.00
Total Cash Overhead	Dol.	4041.00	4521.00	5146.00
				5972.00

Returns Over Cash Costs ³	Dol.	4357.00	12098.00	19638.00	26876.00
Noncash Overhead Costs:					
Interest on Land Investment	Dol.	3120.00	6240.00	9360.00	12480.00
Operator Labor	Dol.	1328.00	1985.00	2483.00	2804.00
Total Noncash Overhead	Dol.	4448.00	8225.00	11843.00	15284.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	-91.00	3873.00	7795.00	11592.00

¹ Total operation capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

² Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³ Returns available for consumption, growth, and general farm overhead.

⁴ Returns over cash costs after specified overhead costs. General farm overhead is not considered.

160 acre operation, there are 62 acres, corn; 26 acres wheat; and 72 acres, soybeans. In the largest farm size, there are 248 acres, corn; 105 acres, wheat; and 287 acres, soybeans.

The labor utilized for the 160 acre farm consists entirely of operator labor, 885 hours per year. Beginning with the 320 acre study size, hired labor is utilized at an increasing rate, in addition to operator labor. There are 114 hours of hired labor utilized along with 1,323 hours of operator labor at the 320 acre size. For the 640 acre farm size, a total of 2,343 hours was utilized of which 474 hours were hired and 1,869 hours were operator and family time.

The operating capital requirements range from \$4,225 total operating capital or \$2,435 annual operating capital for the 160 acre farm size to \$16,902 total operating capital or \$10,110 annual operating capital for the 640 acre farm size.

Ownership Plus Crop-Share Rent-In Farming System

In this farming system, the operator has full equity in machinery and the first 320 acres of land. The additional 160 acres and 320 acres are rented-in under a crop-share rent-in agreement in which the operator receives two-thirds of the harvest and pays two-thirds of the seed, fertilizer, and herbicide costs, and all other operating

costs. The landlord receives one-third of the harvest as rent and pays one-third of the seed, fertilizer, and herbicide costs. The operator is the major source of labor with extra labor being hired if the requirements exceed the capability of this supply. Operating capital is borrowed at the beginning of the production period and repaid at the end of harvest at a 7 percent annual rate of interest. Opportunity costs are charged for the interest on the land investment, and operator labor.

Table 5 provides a summary of the optimal enterprise organization, returns, operating capital, and labor utilized for the 4 farm sizes studied under this system. The optimal enterprise organization consists of corn, wheat, and soybeans in the solutions for all farm sizes. The corn acreage ranges from 62 acres for the 160 acre farm size to 444 acres for the 640 acre farm size class. All of the rented land is in corn. Wheat acreage in the 160 acre farm size is 26 acres, increasing to 52 acres in the 320 acre farm size and remaining at that level for the other two farm sizes. Soybeans account for 72 acres in the smallest farm size and 144 in the remaining 3 size classifications.

Returns over variable costs for the 160 acre farm size are \$8,398 and range upward to \$28,408 for the 640 acre category. The range for the returns to risk, management, and unallocated capital is -\$91 for the smallest farm size up to \$14,352 for the largest. Returns over cash

Table 5
Optimal Organizations and Associated Potential Incomes for an
Ownership Plus Crop-Share Rent-In Farming System

Item	Unit	Farm Size(Acres)		
		160	320	480
				640
Enterprise Organization:				
Corn	Acre	62.0	124.0	284.0
Wheat	Acre	26.0	52.0	52.0
Soybeans	Acre	72.0	144.0	144.0
Labor Utilized:				
Total Operator Labor	Hour	885.0	1323.0	1655.0
Total Hired Labor	Hour	---	114.0	259.0
Total Labor Utilized	Hour	885.0	1437.0	1914.0
Operating Capital ¹				
Total Operating Capital	Dol.	4225.00	8450.00	12372.00
Annual Operating Capital	Dol.	2435.00	4956.00	7222.00
Returns Over Variable				
Cash Costs ²	Dol.	8398.00	16619.00	22513.00
Cash Overhead Costs:				
Machinery Ownership	Dol.	3561.00	3561.00	3706.00
Real Estate Taxes	Dol.	480.00	960.00	960.00
Total Cash Overhead	Dol.	4041.00	4521.00	4666.00
				5012.00
				4052.00
				960.00
				5012.00

Returns Over Cash Costs ³	Dol.	4357.00	12098.00	17847.00	23396.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	3120.00	6240.00	6240.00	6240.00
Operator Labor	Dol.	1328.00	1985.00	2483.00	2804.00
Total Noncash Overhead	Dol.	4448.00	8225.00	8723.00	9044.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	-91.00	3873.00	9124.00	14352.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

costs range from \$4,357 to \$23,396 for the 160 acre and 640 acre farm sizes, respectively.

The labor utilization for this farming system is the same as that for the complete ownership farming system. For the 160 acre farm size, 885 hours of labor are utilized. This is operator labor only. Starting with the 320 acre farm size, hired labor is used increasingly as farm size increases. Hired labor accounts for 114 hours of the 1,437 hours of labor utilized at the 320 acre farm size and 474 hours of the 2,343 hours utilized at the 640 acre farm size.

Operating capital amounts to \$4,225 total operating capital or \$2,435 annual operating capital at the 160 acre farm size, and ranges up to \$16,293 total operating capital or \$9,487 annual operating capital for the 640 acre farm size.

Ownership Plus Cash Rent-In Farming System

The owner-operator has full equity in the machinery complement and up to 320 acres of land. The additional land services are acquired through cash rent-in. The operator is the major source of labor with additional labor being hired if the operator is not able to provide the labor services when needed. Capital sufficient to cover variable cash costs and interest is borrowed at an annual rate of 7 percent at the beginning of the production period.

and repaid at the end of harvest. Opportunity cost is charged for operator labor utilized at \$1.50 per hour and the land investment at 6-1/2 percent per year.

The optimal organizations and their selected returns and utilizations for this system are shown in Table 6.

The optimal enterprise organizations for this system are: 160 acre farm size--62 acres, corn; 26 acres, wheat; and 72 acres, soybeans. The same ratio of corn, wheat, and soybeans applies to the 320 acre farm size with 124 acres, 52 acres, and 144 acres, respectively. The optimal crop organization changes as the rented land is introduced in the study situation. For the 480 acre farm size, there are 284 acres, corn; 52 acres, wheat; and 144 acres, soybeans. The 640 acre size farm has 444 acres, corn; 52 acres, wheat; and 144 acres, soybeans.

The returns over variable cash costs range upward from \$8,398 for the 160 acre farm size to \$29,733 for the 640 acre size farm. The range on the returns to risk, management, and unallocated capital is smaller with -\$91 for the 160 acre farm size and \$15,677 for the 640 acre farm. The returns over cash costs range upward from \$4,357 for the smallest farm size to \$24,721 for the largest farm size.

As with the preceding descriptions of farming systems, the 160 acre farm utilizes only operator labor at a rate of 885 hours per year. Hired labor is utilized on

Table 6
Optimal Organizations and Associated Potential Incomes for an
Ownership Plus Cash Rent-In Farming System

Item	Unit	Farm Size (Acres)		
		160	320	480
				640
Enterprise Organization:				
Corn	Acre	62.0	124.0	284.0
Wheat	Acre	26.0	52.0	52.0
Soybeans	Acre	72.0	144.0	144.0
Labor Utilized:				
Total Operator Labor	Hour	885.0	1323.0	1655.0
Total Hired Labor	Hour	---	114.0	259.0
Total Labor Utilized	Hour	885.0	1437.0	1914.0
Operating Capital: ¹				
Total Operating Capital	Dol.	4225.00	8450.00	16527.00
Annual Operating Capital	Dol.	2435.00	4956.00	9622.00
Returns Over ² Variable Cash Costs				
	Dol.	8398.00	16619.00	23176.00
Cash Overhead Costs:				
Machinery Ownership	Dol.	3561.00	3561.00	3706.00
Real Estate Taxes	Dol.	480.00	960.00	960.00
Total Cash Overhead	Dol.	4041.00	4521.00	4666.00
				5012.00
				4052.00
				960.00
				5012.00

Returns Over Cash Costs ³	Dol.	4357.00	12098.00	18510.00	24721.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	3120.00	6240.00	6240.00	6240.00
Operator Labor	Dol.	1328.00	1985.00	2483.00	2804.00
Total Noncash Overhead	Dol.	4448.00	8225.00	8723.00	9044.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	-91.00	3873.00	9787.00	15677.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

the 320 acre farm size in the amount of 114 hours per year with total utilization equal to 1,437 hours. The 640 acre farm utilizes 2,343 hours of labor annually, of which 474 hours are hired labor.

Operating capital used on the smallest farm size is \$4,225 of total operating capital or \$2,435 of annual operating capital. Whereas, the largest size farm was \$24,604 of total operating capital or \$14,287 of annual operating capital.

Combination Ownership and Custom Harvesting Farming System

This farming system is one in which the owner-operator has full equity in land and machinery but custom hires the harvesting operation. The custom hiring charges for harvesting include charges for the machine operator's time. The operator provides the labor supply for operations other than harvesting. Any additional labor needed is hired as the operator's labor is exhausted. As in the previously mentioned farming systems, operating capital is borrowed at the first of the production period and repaid at the end of harvest at an annual rate of 7 percent. Opportunity costs of 6-1/2 percent are charged on the land investment and \$1.50 per hour for operator labor.

The optimal organizations for the various study sizes for the combination ownership and custom harvesting farming system are presented in Table 7.

Table 7

Optimal Organizations and Associated Potential Incomes for an
Ownership Plus Custom Harvesting Farming System

Item	Unit	160	Farm Size (Acres)		
			320	480	640
Enterprise Organization:					
Corn	Acre	62.0	124.0	186.0	248.0
Wheat	Acre	26.0	52.0	79.0	105.0
Soybeans	Acre	72.0	144.0	215.0	287.0
Labor Utilized:					
Total Operator Labor	Hour	617.0	888.0	1071.0	1166.0
Total Hired Labor	Hour	---	114.0	259.0	465.0
Total Labor Utilized	Hour	617.0	1002.0	1330.0	1631.0
Operating Capital: ¹					
Total Operating Capital	Dol.	5102.00	10375.00	15697.00	21106.00
Annual Operating Capital	Dol.	2937.00	5960.00	9021.00	12112.00
Returns Over ₂ Variable					
Cash Costs	Dol.	7486.00	14795.00	22047.00	29215.00
Cash Overhead Costs:					
Machinery Ownership	Dol.	2178.00	2178.00	2232.00	2318.00
Real Estate Taxes	Dol.	480.00	960.00	1440.00	1920.00
Total Cash Overhead	Dol.	2658.00	3138.00	3672.00	4238.00

Returns Over Cash Costs ³	Dol.	4828.00	11657.00	18375.00	24977.00
Noncash Overhead Costs:					
Interest on Land Investment	Dol.	3120.00	6240.00	9360.00	12480.00
Operator Labor	Dol.	923.00	1332.00	1607.00	1749.00
Total Noncash Overhead	Dol.	4043.00	7572.00	10967.00	14229.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	785.00	4085.00	7408.00	10748.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

The returns over variable cash costs range from \$7,486 associated with the 160 acre farm size to \$29,215 associated with the 640 acre size farm for a \$21,729 spread. The returns to risk, management, and unallocated capital for the 160 acre size is \$785 and rises to \$10,748 at the 640 acre farm size level resulting in a \$9,663 spread. Returns over cash costs range upward from \$4,828 for the smallest farm size to \$24,977 for the largest farm size.

The optimal organization for the 160 acre farm size is 62 acres corn, 26 acres wheat, and 72 acres soybeans. This same proportion holds through the various study sizes. At the 640 acre farm size the crop acreages are 248 acres corn, 105 acres wheat, and 287 acres soybeans. Only operator labor was utilized in the 160 acre farm size, 617 hours. Starting with the 320 acre farm size, hired labor is utilized. At this size level, 888 hours of operator labor is used plus 114 hours of hired labor to give a total of 1,002 hours. At the 640 acre size level, a total of 1,631 hours of labor is utilized of which 465 hours are utilized.

The operating capital borrowed for the smallest farm size is \$5,102 of total operating capital or \$2,937 annual operating capital. In comparison, the largest farm size uses \$21,106 of total operating capital or \$12,112 annual operating capital.

Cash Rent-In Farming System

The owner-operator has full equity in his machinery complement and through cash rent-in acquires land services. The operator is the major source of labor with any additional labor being hired as the operator's labor supply is exhausted. Capital sufficient to cover variable cash costs and interest is borrowed at an annual rate of 7 percent at the beginning of the production period and repaid at harvest. Opportunity cost is considered for operator labor at \$1.50 per hour.

Table 8 presents the optimal organization and associated potential incomes for the cash rent-in farming system.

The farm size with the largest returns to risk, management, and unallocated capital is 383 acres with a return of \$7,075. The optimal organization associated with this income is 186 acres corn, 79 acres wheat, and 118 acres soybeans. To produce this income, 1,577 hours of labor, of which 144 are hired, are utilized. Total operating capital requirements are \$17,633 or \$10,672 annual operating capital. The returns over variable cash costs are \$12,931.

The farm size that produces the second largest returns to risk, management, and unallocated capital (\$6,760) is 367 acres. The optimal organization of 248 acres corn, 105 acres wheat, and 14 acres soybeans also produces a return over variable cash costs of \$12,875. One thousand four hundred eighty five hours of labor, of

Table 8
Optimal Organizations and Associated Potential Incomes for a
Cash Rent-In Farming System

Item	Unit	Farm Size (Acres)		
		160	320	480
				640
Enterprise Organization:				
Corn	Acre	62.0	124.0	186.0
Wheat	Acre	26.0	52.0	79.0
Soybeans	Acre	72.0	144.0	118.0
				248.0
				105.0
				14.0
Labor Utilized:				
Total Operator Labor	Hour	885.0	1323.0	1433.0
Total Hired Labor	Hour	---	114.0	144.0
Total Labor Utilized	Hour	885.0	1437.0	1577.0
				1375.0
				110.0
				1485.0
Operating Capital: ¹				
Total Operating Capital	Dol.	7105.00	14381.00	17633.00
Annual Operating Capital	Dol.	4085.00	8254.00	10672.00
				11635.00
Returns Over Variable				
Cash Costs ²	Dol.	5403.00	10628.00	12931.00
				12875.00
Cash Overhead Costs:				
Machinery Ownership	Dol.	3561.00	3561.00	3706.00
Real Estate Taxes	Dol.	---	---	---
Total Cash Overhead	Dol.	3561.00	3561.00	3706.00
				4052.00

				4052.00

Returns Over Cash Costs ³	Dol.	1842.00	7067.00	9225.00	8823.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	---	---	---	---
Operator Labor	Dol.	1328.00	1985.00	2150.00	2063.00
Total Noncash Overhead	Dol.	1328.00	1985.00	2150.00	2063.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	514.00	5082.00	7075.00	6760.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

which 110 hours are hired, are utilized by this size farm. Capital requirements are \$17,633 total operating capital or \$11,635 annual operating capital.

The smallest return to risk, management, and unallocated capital is \$514 which is associated with the 160 acre farm size composed of 62 acres corn, 26 acres wheat, and 72 acres soybeans. Only operator labor is utilized, 885 hours. Annual operating capital amounts to \$4,085 or \$7,105 total operating capital.

The smallest returns over cash costs is \$1,842 associated with the smaller farm size and ranges to \$9,225 associated with the largest farm size.

Crop-Share Rent-In Farming System

With the crop-share rent-in farming system, the operator has full equity in machinery and no equity in land. The operator receives two-thirds of the harvest and pays two-thirds of the seed, fertilizer, and herbicide costs plus all other variable expenses. The landlord receives one-third of the harvest as rent and pays one-third of the seed, fertilizer, and herbicide costs. The operator is the major source of labor with extra labor being hired as necessary. Operating capital is borrowed at the beginning of the production period and is repaid at the end of harvest at a 7 percent annual rate of interest. Opportunity cost charges are made on operator labor at the rate of \$1.50 per hour.

Table 9 presents the optimal organization and associated potential incomes for the crop-share rent-in farming system.

The returns to risk, management, and unallocated capital range from \$365 for the smallest farm size, 160 acres, up to \$13,417 for the largest farm size, 640 acres. Also, the smallest return over variable cash costs (\$5,254) is associated with the smallest farm size and the largest return over variable cash costs (\$20,273) is associated with the largest farm size. The returns over cash costs range from \$1,693 associated with the 160 acre farm size to \$16,221 associated with the 640 acre farm size.

The proportion of the various crops to farm size is constant for this farming system. The smallest farm size is organized into 38.75 percent corn, 62 acres; 16.25 percent wheat, 26 acres; and 45 percent soybeans, 72 acres. The largest farm size is organized into corn 248 acres, wheat 105 acres, and soybeans 286 acres which represents 38.75 percent, 16.25 percent, and 45 percent respectively.

The 160 acre farm size utilizes 885 hours of operator labor. Starting with the 320 acre farm size, hired labor is required. Total labor used at this level is 1,437 hours, of which 114 hours are hired. The largest farm size uses the most labor: operator labor--1,869 hours, and hired labor--474 hours.

Table 9
Optimal Organizations and Associated Potential Incomes for a
Crop-Share Rent-In Farming System

Item	Unit	Farm Sizes (Acres)			640
		160	320	480	
Enterprise Organization:					
Corn	Acre	62.0	124.0	186.0	248.0
Wheat	Acre	26.0	52.0	79.0	106.0
Soybeans	Acre	72.0	144.0	215.0	286.0
Labor Utilized:					
Total Operator Labor	Hour	885.0	1323.0	1655.0	1869.0
Total Hired Labor	Hour	---	114.0	259.0	474.0
Total Labor Utilized	Hour	885.0	1437.0	1914.0	2343.0
Operating Capital: ¹					
Total Operating Capital	Dol.	3149.00	6469.00	9838.00	13130.00
Annual Operating Capital	Dol.	1815.00	3714.00	5647.00	7623.00
Returns Over ₂ Variable					
Cash Costs	Dol.	5254.00	10330.00	15353.00	20273.00
Cash Overhead Costs:					
Machinery Ownership	Dol.	3561.00	3561.00	3706.00	4052.00
Real Estate Taxes	Dol.	---	---	---	---
Total Cash Overhead	Dol.	3561.00	3561.00	3706.00	4052.00

Returns Over Cash Costs ³	Dol.	1693.00	6769.00	11647.00	16221.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	---	---	---	---
Operator Labor	Dol.	1328.00	1985.00	2483.00	2804.00
Total Noncash Overhead	Dol.	1328.00	1985.00	2483.00	2804.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	365.00	4784.00	9164.00	13417.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

Operating capital is used in the smallest amounts, \$3,149 total operating capital or \$1,815 annual operating capital, by the smallest farm size, 160 acres. The largest farm size, 640 acres, uses the most total operating capital, \$13,130 or annual operating capital \$7,623.

Complete Custom Hiring Farming System

The operator utilizing a complete custom hiring has full equity in land but none in machinery. All operations are custom hired. The hiring of the machinery services include labor services to operate the machinery. Operating capital is borrowed at an annual rate of 7 percent at the beginning of the production period and repaid at the end of harvest. Opportunity costs are charged for the land investment at a rate of 6-1/2 percent.

The optimal organizations and the associated potential incomes for this system are presented in Table 10.

The returns over risk, management, and unallocated capital range from \$2,290 for the 160 acre farm size to \$9,475 for the 640 acre farm size for a spread of \$7,185. The spread of the returns over variable cash costs is larger than that of the returns to risk, management, and unallocated capital. The smallest return (\$5,890), is associated with the smallest farm size and the largest return (\$23,875) with the largest farm size for a spread of \$17,985. Returns over cash costs range from \$5,410 associated with the 160

Table 10

Item	Unit	Farm Size (Acres)			
		160	320	480	640
Enterprise Organization:					
Corn	Acres	62.0	124.0	186.0	248.0
Wheat	Acres	26.0	52.0	79.0	105.0
Soybeans	Acres	72.0	144.0	215.0	287.0
Labor Utilized:					
Total Operator Labor	Hour	---	---	---	---
Total Hired Labor	Hour	---	---	---	---
Total Labor Utilized	Hour	---	---	---	---
Operating Capital: ¹					
Total Operating Capital	Dol.	6637.00	13273.00	19911.00	26548.00
Annual Operating Capital	Dol.	3810.00	7621.00	11450.00	15261.00
Returns Over ₂ Variable					
Cash Costs	Dol.	5890.00	11781.00	17663.00	23875.00
Cash Overhead Costs:					
Machinery Ownership	Dol.	---	---	---	---
Real Estate Taxes	Dol.	480.00	960.00	1440.00	1920.00
Total Cash Overhead	Dol.	480.00	960.00	1440.00	1920.00

Returns Over Cash Costs ³	Dol.	5410.00	10821.00	16223.00	21955.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	3120.00	6240.00	9360.00	12480.00
Operator Labor	Dol.	---	---	---	---
Total Noncash Overhead	Dol.	3120.00	6240.00	9360.00	12480.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	2290.00	4581.00	6863.00	9475.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

acre farm size to \$21,955 associated with the 640 acre farm size.

The optimal organization of the crop enterprise is the same proportion for each farm size. The 160 acre farm size has 62 acres corn, 26 acres wheat, and 72 acres soybeans, or 38.75 percent, 16.25 percent, and 45 percent respectively. The 640 acre size farm is optimally organized with 248 acres corn, 105 acres wheat, and 287 acres soybeans or the same 38.75 percent corn, 16.25 percent wheat, and 45 percent soybeans as the 160 acre farm.

Total operating capital ranges upward from \$6,637 for the smallest farm size to \$26,548 for the largest farm size for a spread of \$19,911. Annual operating capital has a spread of \$11,451 from \$3,810 for the smallest farm size to \$15,261 for the largest farm size.

Cash Rent-Out Farming System

This farming system consists of the farm land being rented-out for \$18 per acre annually. The landlord pays none of the expenses incurred by the producer in the production of his crops. The tenant is free to produce whatever crop he so desires. The landlord's only expenses are the real estate taxes, \$3 per acre per annum, and opportunity costs on the land investment in which he has full equity. The opportunity cost is 6-1/2 percent, which comes to \$19.50 per acre per year. After the deduction for real estate

taxes, the landlord is not meeting his opportunity costs by \$4.50 per acre per year. For each acreage, the landlord is receiving \$15 net cash per acre.

For the 160 acre farm size, the gross rental income is \$2,880 and returns to risk, management, and unallocated capital are -\$720.

For the 320 acre farm size, gross rental income equals \$5,760. After deductions for real estate taxes and opportunity costs, a return to risk, management, and unallocated capital of -\$1,440 results.

The same trend holds for the 480 acre and 640 acre farm sizes. The 480 acre farm size has a gross rental income of \$8,640 which after real estate taxes and opportunity costs results in a returns to risk, management, and unallocated capital of -\$2,160. For the 640 acre farm size, gross rental income is \$11,520, and after overhead costs results in a returns to risk, management, and unallocated capital of -\$2,880.

These returns over cash costs range from \$2,400 upwards to \$9,600.

Table 11 presents the expense and income information for the cash rent-out farming system.

Crop-Share Rent-Out Farming System

This system is one in which the landlord receives one-third of the harvest as rent and pays one-third of the

Table 11
Potential Income from a Cash Rent-Out Farming System

Item	Unit	Farm Size (Acres)		
		160	320	480
Gross Income ¹	Dol.	2880.00	5760.00	8640.00
Cash Overhead Costs:				
Machinery Ownership	Dol.	---	---	---
Real Estate Taxes	Dol.	480.00	960.00	1440.00
Total Cash Overhead	Dol.	480.00	960.00	1440.00
Returns Over Cash Costs ²	Dol.	2400.00	4800.00	7200.00
Noncash Overhead Costs				
Interest on Land Investment	Dol.	3120.00	6240.00	9360.00
Operator Labor	Dol.	---	---	---
Total Noncash Overhead	Dol.	3120.00	6240.00	9360.00
Returns to Risk, Management, and Unallocated Capital ³	Dol.	-720.00	-1440.00	-2160.00
				-2880.00

¹Gross rental income.

²Returns over cash costs available for growth, consumption, and general farm overhead.

³Returns over cash costs after specified overhead costs. No consideration of general farm overhead is made.

costs of seed, fertilizer, and herbicide. The renter pays all other variable costs. The landlord pays overhead costs accrued to land ownership. The landlord provides no labor or managerial assistance. The landlord's operating capital is borrowed at 7 percent interest at the beginning of the production period and repaid at harvest. Opportunity charges are made on the land investment at the rate of 6-1/2 percent.

The returns to risk, management, and unallocated capital range downward from -\$456 for the smallest farm size (160 acres) to -\$1,825 for the largest farm size (640 acres). This is due to the inability of the returns over variable cash costs to cover the overhead costs of taxes and opportunity charges. Returns over variable cash costs range from \$3,144 for the 160 acre farm size to \$12,575 for the 640 acre farm size. The returns over cash costs range upward from \$2,664 to \$10,655 for the 160 acre and 640 acre farm sizes, respectively.

The operating capital requirements for the smallest farm size are \$1,076 total operating capital or \$621 annual operating capital while the largest farm size uses the services of \$4,303 total operating capital or \$2,486 annual operating capital.

The optimal organization associated with the smallest farm size is 62 acres corn, 26 acres wheat, and 72 acres soybeans. The optimal organization for the largest farm

size has the same proportions with corn 248 acres, wheat 105 acres, and soybeans 287 acres.

Table 12 presents the optimal organizations and associated potential incomes for the crop-share rent-out farming system.

Summary

The purpose of this chapter was to present the results of the analysis. As farm size increases, with the exception of the cash rent-in farming system, returns over cash costs increase. The capital limitation of the cash rent-in farming system restricted the income earning ability of this system at the 480 acre and 640 acre farm sizes.

The largest income producer for the 160 acre farm size was the complete custom hire system while at the 320 acre and larger farm sizes, the complete ownership system was the largest.

The complete custom hire system was the largest returns to risk, management, and unallocated capital producer for the 160 acre farm size. At the 480 acre and 640 acre farm sizes, the ownership plus cash rent-in system was associated with the largest returns.

The optimal organization, for the most part, is composed of 38.75 percent corn, 16.25 percent wheat, and 45.00 percent soybeans for all farm sizes. The exceptions are the ownership plus cash rent-in and ownership plus

Table 12

Optimal Organizations and Associated Potential Incomes for a
Crop-Share Rent-Out Farming System

Item	Unit	Farm Size (Acres)			640
		160	320	480	
Enterprise Organization:					
Corn	Acre	62.0	124.0	186.0	248.0
Wheat	Acre	26.0	52.0	79.0	105.0
Soybeans	Acre	72.0	144.0	215.0	287.0
Labor Utilized:					
Total Operator Labor	Hour	---	---	---	---
Total Hired Labor	Hour	---	---	---	---
Total Labor	Hour	---	---	---	---
Operating Capital: ¹					
Total Operating Capital	Dol.	1076.00	2151.00	3228.00	4303.00
Annual Operating Capital	Dol.	621.00	1241.00	1865.00	2486.00
Returns Over ₂ Variable					
Cash Costs	Dol.	3144.00	6289.00	9431.00	12575.00
Cash Overhead Costs:					
Machinery Ownership	Dol.	---	---	---	---
Real Estate Taxes	Dol.	480.00	960.00	1440.00	1920.00
Total Cash Overhead	Dol.	480.00	960.00	1440.00	1920.00

Returns Over Cash Costs ³	Dol.	2664.00	5329.00	7991.00	10655.00
Noncash Overhead Costs					
Interest on Land Investment	Dol.	3120.00	6240.00	9360.00	12480.00
Operator Labor	Dol.	---	---	---	---
Total Noncash Overhead	Dol.	3120.00	6240.00	9360.00	12480.00
Returns to Risk, Management, and Unallocated Capital ⁴	Dol.	-456.00	-911.00	-1369.00	-1825.00

¹Total operating capital refers to the total amount required for the year. Annual operating capital refers to the annual equivalent on which interest is paid.

²Programmed returns. Does not include any charges for operator labor, land costs, machinery overhead, or real estate taxes.

³Returns available for consumption, growth, and general farm overhead.

⁴Returns over cash costs after specified overhead costs. General farm overhead is not considered.

crop-share rent-in systems. The rented in acreage is all corn, resulting in 59.17 percent corn, 10.83 percent wheat, and 30.00 percent soybeans at the 480 acre farm size level and 69.37 percent corn, 8.13 percent wheat, and 22.50 percent soybeans at the 640 acre level. The other exception is the cash rent-in system. At the 480 acre and 640 acre farm sizes, the credit restraint limits farm size and therefore has effected the optimal organization.

In general, as farm size increased, total labor utilized increased. More operator than hired labor was utilized. Those farming systems, excluding the cash rent-in system, where no machinery services are custom hired have the largest utilization of operator, hired, and total labor. The rent-out systems and the complete custom hire system use the least labor.

The type of farming system exerts some influence on the amount of operating capital borrowed. Those systems with large cash expenditures have large borrowings.

Footnotes

¹Larry J. Connor, Costs and Returns for Major Cash Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University, 1967, pp. 5-6.

CHAPTER IV

COMPARISON OF ALTERNATIVES AND IMPLICATIONS OF THE STUDY

This chapter contains a comparison of the respective farming systems, based on the results of the analysis presented in Chapter III, and the implications drawn from the comparisons.

Comparison of Alternatives

Farm operators are faced with a continuing problem of selecting the manner in which to acquire resource services in order to maximize income. Depending on the manner in which resource services are acquired, incomes vary. This presentation is directed toward comparing the alternative cash-grain farming systems in terms of returns over cash costs (returns available for growth, consumption, and general farm overhead); returns to risk, management, and unallocated capital; operating capital; labor utilization; and optimal enterprise organization.

Returns Over Cash Costs

The potential returns over cash costs for the alternative cash-grain farming systems for all farm sizes are

presented in Table 13. The table contains two comparisons: (1) A comparison between those farming systems where all operator labor is for the use of the farming system, if it can be utilized. These farming systems are termed "pure" farming systems. (2) In addition, a comparison is made between those farming systems where some operator labor is sold off-farm and the "pure" farming systems. The farming systems where operator labor is sold off-farm to supplement the farm income are termed "combined" farming systems, i.e., farm income is combined with off-farm income.

There are three "combined" farming systems. The unused labor of these farming systems is sold at the average manufacturing rate and added to the farming system's returns over cash costs, in order to explore the income earning potential of cash-grain farming plus off-farm work. The unused labor of the cash rent-out and crop-share rent-out farming systems is sold at the average manufacturing wage rate of \$7,289 per year. In addition, 80 percent of the unused labor of the complete custom hire farming system is sold at the average manufacturing wage. The remaining 20 percent is utilized in management activities for the custom hiring operations.

These three farming systems were used as the systems from which operator labor was employed off-farm because they had the largest amount of time available. The critical labor requirements during certain time periods of the year

Table 13
A Comparison of Potential Returns Over Cash Costs
for Alternative Cash-Grain Farming Systems

Farming System	Farm Size (Acres)			(Dollars)
	160	320	480	
Complete Ownership	4,357.00 31 52	12,098.00 1 3	19,638.00 1 2	26,876.00 1 2
Ownership + Crop-Share Rent-In	4,357.00 3 5	12,098.00 1 3	17,847.00 4 5	23,386.00 4 5
Ownership + Cash Rent-In	4,357.00 3 5	12,098.00 1 3	18,510.00 2 3	24,721.00 3 4
Ownership + Custom Harvest	4,828.00 2 4	11,657.00 4 7	18,375.00 3 4	24,977.00 2 3
Cash Rent-In	1,842.00 8 11	7,067.00 6 9	9,225.00 7 10	8,823.00 9 12
Crop-Share Rent-In	1,693.00 9 12	6,769.00 7 10	11,647.00 6 9	16,221.00 6 9
Complete Custom Hire	5,410.00 1 8	10,821.00 5 8	16,223.00 5 6	21,955.00 5 6

Cash Rent-Out	2,400.00 7	4,800.00 9	7,200.00 9	9,600.00 8
Crop-Share Rent-Out	10 2,664.00 6	12 5,329.00 8	12 7,991.00 8	11 10,655.00 7
Complete Custom Hire+ Off-Farm Work	9 11,241.00 --	11 16,652.00 --	11 22,054.00 --	10 27,786.00 --
Cash Rent-Out + Off-Farm Work	1 9,689.00 --	1 12,089.00 --	1 14,489.00 --	1 16,889.00 --
Crop-Share Rent-Out + Off-Farm Work	3 9,953.00 --	6 12,618.00 --	8 15,280.00 --	8 17,944.00 --
	2	2	7	7

¹Ranking from highest to lowest in terms of return over cash costs for "pure" farming systems. "Pure" farming systems are those where operator labor is utilized on-farm only.

²Ranking from highest to lowest in terms of returns over cash costs for the "combined" and "pure" farming systems. "Combined" systems are those farming systems where operator labor is employed off-farm.

for the other systems was cause for them to not be considered in a combination of farm and off-farm incomes. It was assumed that any amount of labor could be employed off-farm, but only the two previously mentioned levels were considered in the analysis.

The combinations undertaken by this study are directed toward exploring some of the possible consequences and is not intended to be exhaustive in its scope. There are problems concerning the "combined" systems because of the unemployment factor of industrial workers in terms of hours worked, the cost of travel to and from work, the fringe benefits of industrial employment, and other differences. Important as these considerations are, the results of the combination still may give useful insights into the income earning ability of these systems without including them in the analysis.

Comparison of "Pure" Cash-Grain Farming Systems.

As farm size increases, with the exception of the cash rent-in farming system, returns over cash costs increase. The capital limitation of the cash rent-in system restricted the income earning ability of the system at the 480 acre and 640 acre farm size.

For the 160 acre farm size, the returns over cash costs for the rent-in farming systems (\$1,842 for cash rent-in and \$1,693 for crop-share rent-in) are lowest because of under-utilization of the available machinery

services and rent expense for land services. The rent-out farming systems have low incomes (\$2,400 and \$2,664 for the cash rent-out and crop-share rent-out farming systems, respectively) because of the low cash rental rate for the cash rent-out farming system. The cash rent after cash expenses is less than returns over cash costs for the other farming systems. Likewise, the crop-share rent-out system's returns are low due to the small revenue received as rent compared to the other systems. The returns for the complete custom hire system are highest (\$5,410) because the system utilizes only the machinery services that it needs, i.e., the system has no idle machinery and subsequent un-utilized machinery services, and no cash expenses for acquiring land services. The spread between the lowest income earner, the crop-share rent-in farming system, and the highest income producer, the complete custom hire system, is \$3,717.

For the 160 acre and 320 acre farm sizes, the complete ownership, the ownership plus cash rent-in, and the ownership plus crop-share rent-in systems have the same returns over cash costs, and returns to risk, management, and unallocated capital figures. This is due to the ownership plus cash rent-in and the ownership plus crop-share rent-in systems being the same as the complete ownership system until the 320 acre farm size. After the 320 acre farm size, the additional 160 acre and 320 acre of land services are acquired via the rent-in schemes which changes the earning abilities of the farming systems.

As the farm size increases to 320 acres, the complete ownership system becomes the largest returns over cash costs producer (\$12,098) and retains this ranking for the 480 acre and 640 acre farm sizes (incomes of \$19,638 and \$26,876, respectively) also. This is because of the more efficient utilization of the machinery services and the earnings of land services accruing to the system.

The cash rent-out and crop-share rent-out systems rank lowest relative to the other systems for the 320 acre (returns of \$4,800 and \$5,329) and 480 acre (returns of \$7,200 and \$7,991 respectively) farm sizes because the rent earned is lower than returns over cash costs for the other systems. Even though the other systems have more expenses, the income earned more than offset the additional expense. For the 640 acre farm size, the rent-out systems moved up in ranking because of the cash rent-in system meeting its credit restraint, which curtailed its earning potential, and caused it to drop to the lowest income earning position.

The complete land service rent-in systems usually rank higher than the rent-out systems for the 320 acre, 480 acre, and 640 acre farm sizes due to the larger income earning ability of these systems.

The complete custom hire system ranks above the rent-in systems because this system does not have cash rental expenses for land services. Even though the custom hiring expenses are larger than machinery ownership costs,

the difference is not great enough to offset the lower costs resulting from no rental expenses for land services.

Comparison of "Combined" Cash-Grain Farming Systems. Off-farm work is not uncommon among Michigan farmers. By combining off-farm work income with the farm income of those farming systems which require no labor of the operator for operation of the farm, a comparison between "pure" and "combined" farming systems may be made. The "combined" systems are: complete custom hire plus off-farm work system, cash rent-out plus off-farm work system, and crop-share rent-out plus off-farm work system.

Considering both "pure" and "combined" systems, the complete custom hire plus off-farm work is the largest income producer for all farm sizes. The crop-share rent-out plus off-farm work system and the cash rent-out plus off-farm work system, rank second and third, respectively, for the 160 acre farm size. The 160 acre farm size for the "pure" systems is insufficient to produce an income equal to off-farm wages. Therefore, if off-farm income is added to that income which is produced by the farming sector of the farming system, the resulting combination is larger than any of the "pure" farming systems. Although, only 80 percent of the off-farm income of the crop-share rent-out system and the cash rent-out system is added to the complete custom hire system, the difference between the returns produced by farming are great enough to overcome the 20

percent differential in wage income to make the complete custom hire plus off-farm work the largest income producer.

For the 320 acre farm size, the "combined" systems are ranked as follows: first--complete custom hire plus off-farm work; second--crop-share rent-out plus off-farm work; and sixth--cash rent-out plus off-farm work. The cash rent-out plus off-farm work system is separated from the higher ranked complete ownership system by only \$9.00. As explained for the 160 acre farm size, the first and second ranked "combined" systems are superior in earning ability to the "pure" systems due to the off-farm earned income being more than enough to overcome the earning ability of the various "pure" farming systems.

For the 480 acre and 640 acre farm sizes the complete custom hire plus off-farm work is again the largest income producing system.

Returns to Risk, Management, and Unallocated Capital

Table 14 presents the returns to risk, management, and unallocated capital associated with alternative farming systems for all farm sizes.

The rent-out systems for all farm sizes have negative returns to risk and management values due to inability of the system to produce enough income to cover the opportunity costs on land investment. The complete ownership system of the 160 acre farm size also is negative due to a

Table 14

A Comparison of the Returns to Risk, Management, and Unallocated Capital for Alternative Farming Systems

Farming Systems	160	Farm Size (Acres)		640
		320	480	
		(Dollars)		
Complete Ownership	-91.00 (5) ₁ 8 ₂	3,873.00 (5) ₈	7,795.00 (4) ₅	11,592.00 (4) ₅
Ownership + Crop-Share Rent-In	-91.00 (5) ₈	3,873.00 (5) ₈	9,124.00 (3) ₄	14,352.00 (2) ₃
Ownership + Cash Rent-In	-91.00 (5) ₈	3,873.00 (5) ₈	9,787.00 (1) ₂	15,677.00 (1) ₂
Ownership + Custom Harvest	785.00 (2) ₅	4,085.00 (4) ₇	7,048.00 (6) ₇	10,748.00 (5) ₆
Cash Rent-In	514.00 (3) ₆	5,082.00 (1) ₄	7,075.00 (5) ₆	6,760.00 (7) ₈
Crop-Share Rent-In	365.00 (4) ₇	4,784.00 (2) ₅	9,164.00 (2) ₃	13,417.00 (3) ₄
Complete Custom Hire	2,290.00 (1) ₄	4,581.00 (3) ₆	6,863.00 (7) ₈	9,475.00 (6) ₇

Cash Rent-Out	-720.00 (9) 12	-1,440.00 (9) 12	-2,160.00 (9) 12	-2,880.00 (9) 12
Crop-Share Rent-Out	-456.00 (8) 11	-911.00 (8) 11	-1,369.00 (8) 11	-1,825.00 (8) 11
Complete Custom Hire + Off-Farm Work	8,361.00 ---	10,892.00 ---	13,414.00 ---	17,266.00 ---
Cash Rent-Out + Off-Farm Work	6,809.00 ---	6,329.00 ---	5,849.00 ---	5,369.00 ---
Crop-Share Rent-Out + Off-Farm Work	7,073.00 ---	6,858.00 ---	6,640.00 ---	6,424.00 ---
	2	2	9	9

¹Ranking from highest to lowest in terms of returns over cash costs for "pure" farming systems. "Pure" farming systems are those where operator labor is utilized on-farm only.

²Ranking from highest to lowest in terms of returns over cash costs for the "combined" and "pure" farming systems. "Combined" systems are those farming systems where un-utilized operator labor is employed off-farm.

lack of returns able to cover opportunity costs on operator and family labor and land investment. This lack of returns is due to high machinery costs for the assumed machinery complement for the farm size.

All other systems for all other farm sizes have positive returns to risk and management.

The highest returns to risk and management for the "pure" systems changed from the complete custom hire system for the 160 acre farm size to the cash rent-in system for the 320 acre farm size, thence to the ownership plus cash rent-in system for the 480 acre and 640 acre farm sizes. The lowest positive returns to risk, management, and unallocated capital accrue to the crop-share rent-in system for the 160 acre farm size, the ownership plus custom harvest system for the 320 acre farm size, the complete custom hire system for the 480 acre farm size, and the cash rent-in system for the 480 acre farm size.

If the farming systems are unable to cover their opportunity costs, the owner-operator might want to examine alternative enterprises where the returns to risk, management, and unallocated capital is not negative. However, the criteria for selecting a system should not be the magnitude of the returns to risk, management, and unallocated capital alone as this may not necessarily indicate the largest amount of funds available for consumption, growth, and general overhead expenses.

Optimal Enterprise Organization

The optimal enterprise organization for each farming system for each farm size is presented in Table 15.

The optimal organizations for the complete ownership, ownership plus custom harvest, crop-share rent-in, complete custom hire, and crop-share rent-out farming systems for all farm study sizes have the same proportions for each crop. The proportions for these farming systems are: corn, 38.75 percent, wheat, 16.25 percent, and soybeans, 45 percent.

The Cash Rent-Out system has no enterprise organization shown due to the landlord having little control over the management of the cropping operations of the tenant.

The Ownership plus Crop-Share Rent-In and the Ownership plus Cash Rent-In systems have identical enterprise organizations for all farm sizes. The two systems' enterprise organizations differ from the above mentioned systems in that the rented acreages are all allocated to the corn enterprise. The 160 acre and 320 acre farm size enterprises' proportions are the same as that of the Complete Ownership farming system: corn, 38.75 percent, wheat, 16.25 percent, and soybeans, 45 percent. The 480 acre farm size has 284 acres of corn, 52 acres of wheat, and 144 acres of soybeans. For the 640 acre farm size, the wheat and soybean acreages stay the same as those for the 480 acre farm size but the corn acreage jumps to 444 acres.

Table 15
A Comparison of Optimal Enterprise Organizations Associated with Alternative
Cash-Grain Farming Systems

Farming Systems		Farm Size (Acres)								
		160			320			480		
		Acres	Percent		Acres	Percent		Acres	Percent	
Complete Ownership	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
Ownership + Crop-Share Rent-In	Corn	62	38.75		124	38.75		284	59.17	
	Wheat	26	16.25		52	16.25		52	10.83	
	Soybeans	72	45.00		144	45.00		144	30.00	
Ownership + Cash Rent	Corn	62	38.75		124	38.75		284	59.17	
	Wheat	26	16.25		52	16.25		52	10.83	
	Soybeans	72	45.00		144	45.00		144	30.00	
Ownership + Custom Harvest	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
Cash Rent-In	Corn	62	38.75		124	38.75		186	48.56	
	Wheat	26	16.25		52	16.25		79	20.63	
	Soybeans	72	45.00		144	45.00		118	30.81	
Crop-Share Rent-In	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
Complete Custom Hire	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
Cash Rent-Out ¹	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
Crop-Share Rent-Out	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	
	Corn	62	38.75		124	38.75		186	38.75	
	Wheat	26	16.25		52	16.25		79	16.25	
	Soybeans	72	45.00		144	45.00		215	45.00	

¹The cash rent-out system has no enterprise organization shown because the landlord has little control over the management of the cropping operations of the tenant.

The Cash Rent-In systems differ from the proportions to the various enterprises for the 480 acre and 640 acre farm sizes due to the capital restraint limiting the total cropped acres. The optimal enterprise organization for the 480 acre farm size is corn, 186 acres, wheat, 79 acres, and soybeans, 118 acres. For the 640 acre farm size, the enterprise organization is 248 acres of corn, 105 acres of wheat, and 14 acres of soybeans. The minimal soybean acreage is due to the program forcing a minimum level of wheat acreage, and a maximum level of corn acreage.

Comparison of Labor Utilization

A comparison of operator and hired labor utilized by farming systems and farm size is presented in Table 16.

The cash rent-out and crop-share rent-out systems used no operator or hired labor. This is due to the operator of the system not participating in the actual cropping activities, except in the case of the crop-share rent-out where participation is limited to partially financing the crop. The complete custom hire system receives its labor as a part of the custom services which it hires and therefore the operator does not provide labor to the system directly.

The ownership plus custom harvesting system uses the next smallest amount of labor for all farm sizes. Again, this is due to labor services for harvesting being acquired through the custom hiring of the harvesting operation.

Table 16

A Comparison of Labor Utilization for the Various
Cash-Grain Farming Systems

Farming Systems	Unit	160	Farm Size (Acres)	
			320	480
				640
(Hours)				
Complete Ownership	hour	885.0 ¹	1,323.0	1,655.0
	hour	---	114.0	259.0
	hour	885.0 ³	1,437.0	1,914.0
Ownership + Crop-Share Rent-In	hour	885.0	1,323.0	1,655.0
	hour	---	114.0	259.0
	hour	885.0	1,437.0	1,914.0
Ownership + Cash Rent-In	hour	885.0	1,323.0	1,655.0
	hour	---	114.0	259.0
	hour	885.0	1,437.0	1,914.0
Ownership + Custom Harvest	hour	617.0	888.0	1,071.0
	hour	---	114.0	259.0
	hour	617.0	1,002.0	1,330.0

Cash Rent-In	hour	885.0	1,323.0	1,433.0	1,375.0
	hour	---	114.0	144.0	110.0
	hour	885.0	1,437.0	1,577.0	1,485.0
Crop-Share Rent-In	hour	885.0	1,323.0	1,655.0	1,869.0
	hour	---	114.0	259.0	474.0
	hour	885.0	1,437.0	1,914.0	2,343.0
Complete Custom Hire	hour	---	---	---	---
	hour	---	---	---	---
	hour	---	---	---	---
Cash Rent-Out	hour	---	---	---	---
	hour	---	---	---	---
	hour	---	---	---	---
Crop-Share Rent-Out	hour	---	---	---	---
	hour	---	---	---	---
	hour	---	---	---	---

¹Operator labor.²Hired labor.³Total labor.

The operator and hired labor utilized by the remaining systems for the 160 acre and 320 acre farm sizes is the same. The reason for this is that the method of acquiring machinery services and corresponding labor service requirements does not change although the method of acquiring land services does change. At the 320 acre and 640 acre farm size level, the operating capital constraint stops the expansion of farm size for the cash rent-in system and therefore limits the labor utilization.

The labor utilization for the complete ownership, ownership plus cash rent-in, ownership plus crop-share rent-in, and the crop-share rent-in systems for the 480 acre and 640 acre farm sizes is the same, and the largest amount of labor utilized for all farming systems.

In all cases, as farm size increased, operator labor services and hired labor service utilization increased. Operator labor utilization was greater for all farm sizes and systems than hired labor utilization due to labor services being hired only when the demands exceeded the supply of operator labor services in that time period. The operator labor service supply was sufficient to meet all labor service demands for the 160 acre farm size. Starting with the 320 acre farm size, the operator labor service supply was not adequate for the demands on some time periods and labor services were hired.

Comparison of Operating Capital

A comparison of total operating capital and annual operating capital for all farm sizes and farming systems is presented in Table 17. Annual operating capital is the total amount of capital borrowed adjusted to a yearly figure based on the length of time for which the money was borrowed. All operating capital is borrowed at the beginning of the production period and repaid at harvest. Operating capital consists of all variable cash expenses.

The largest amount of total operating capital and the corresponding annual operating capital for the 160 acre and 320 acre farm sizes is borrowed by the cash rent-in system. This is due to the larger operating requirements of cash rent; machinery operating expenses; seed, fertilizer, and herbicide costs, and other variable cash expenses. The second largest operating capital using system for the 160 acre and 320 acre farm size, and the largest user for the 480 acre and 640 acre farm size is the complete custom hire system. The large capital requirements for this system are due to the cash expenditures to pay for the custom operations in addition to the seed, fertilizer, and herbicide costs. The third largest operating capital using system for the 160 acre and 320 acre farm size is the ownership plus custom harvesting system.

The largest operating capital using system for the 480 acre farm size is the complete custom hire system

Table 17

A Comparison of Total Operating Capital and Annual Operating
Capital by Farming System and Farm Size

Farming System	Farm Size (Acres)		
	160	320	480
			640
(Dollars)			
<u>TOTAL OPERATING CAPITAL</u>			
Complete Ownership	\$4,225.00	\$ 8,450.00	\$12,677.00
Ownership + Crop-Share Rent-In	4,225.00	8,450.00	12,372.00
Ownership + Cash Rent-In	4,225.00	8,450.00	16,527.00
Ownership + Custom Harvest	5,102.00	10,375.00	15,697.00
Cash Rent-In	7,105.00	14,381.00	17,633.00
Crop-Share Rent-In	3,149.00	6,469.00	9,838.00
Complete Custom Hire	6,637.00	13,273.00	19,911.00
Cash Rent-Out	---	---	---
Crop-Share Rent-Out	1,076.00	2,151.00	3,228.00
			4,303.00

ANNUAL OPERATING CAPITAL

Complete Ownership	\$2,435.00	\$ 4,956.00	\$ 7,513.00	\$10,110.00
Ownership + Crop-Share Rent-In	2,435.00	4,956.00	7,222.00	9,487.00
Ownership + Cash Rent-In	2,435.00	4,956.00	9,622.00	14,287.00
Ownership + Custom Harvest	2,937.00	5,960.00	9,021.00	12,112.00
Cash Rent-In	4,085.00	8,254.00	10,672.00	11,635.00
Crop-Share Rent-In	1,815.00	3,714.00	5,647.00	7,623.00
Complete Custom Hire	3,310.00	7,621.00	11,450.00	15,261.00
Cash Rent-Out	---	---	---	---
Crop-Share Rent-Out	621.00	1,241.00	1,865.00	2,486.00

followed by the cash rent-in system. In third place is the ownership plus cash rent-in system. The cash rent-in system dropped from the largest user of operating capital position due to the operating capital constraint stopping acreage expansion and hence operating capital usage at the 480 acre farm size. The complete custom hire system is large due to amounts of capital required to pay for the custom charges in addition to the other variable cash expenses.

For the 640 acre farm size, the complete custom hire system is the largest operating capital utilizer due to the previously mentioned reasons. The second largest operating capital user is the ownership plus cash rent-in system.

The cash rent-out system uses no operating capital and therefore ranks as the smallest user of operating capital. The second smallest user is the crop-share rent-out system because the system provides only 1/3 of the costs of the seed, herbicide, and fertilizer.

Farm Sizes Necessary to Produce Incomes Equal to Average Manufacturing Wages

The farm sizes for the alternative farming systems necessary to produce an income equivalent to that of an industrial worker in Michigan are presented in Table 18.

The income level selected was that of an industrial worker in the manufacturing classification. This classification is broad enough so that it is representative of a

Table 18
A Comparison of Farm Sizes Necessary to Provide an Income¹ Comparable
to that of an Industrial Worker²

Item	Unit	Complete Ownership System	Ownership plus Crop- Share Rent- In System	Ownership plus cash Rent-In System	Ownership plus Custom Harvesting System
Farm Size	Acres	459.0	424.0	412.0	490.0
Labor Utilized:					
Operator Labor	Hours	1,613.0	1,490.0	1,483.0	1,081.0
Hired Labor	Hours	241.0	240.0	231.0	269.0
Total Labor	Hours	1,854.0	1,730.0	1,714.0	1,350.0
Operating Capital:					
Total Operating Capital	Dollars	12,121.00	10,999.00	13,094.00	15,625.00
Annual Operating Capital	Dollars	6,987.00	6,343.00	7,554.00	8,995.00
Returns over Variable Cash Costs	Dollars	23,730.00	20,267.00	20,220.00	22,522.00
Cash Overhead Costs:					
Machinery Ownership	Dollars	3,586.00	3,561.00	3,561.00	2,232.00
Real Estate Taxes	Dollars	1,377.00	960.00	960.00	1,470.00
Total Cash Overhead	Dollars	4,963.00	4,521.00	4,521.00	3,702.00

Returns over Cash Costs	Dollars	18,767.00	15,746.00	15,698.00	18,820.00
Non-Cash Overhead Costs:					
Interest on Land					
Investment	Dollars	8,951.00	6,240.00	6,240.00	9,550.00
Operator Labor	Dollars	2,420.00	2,236.00	2,225.00	1,622.00
Total Non-Cash Overhead	Dollars	11,371.00	8,476.00	8,465.00	11,172.00
Returns to Risk, Management and Unallocated Capital	Dollars	7,396.00	7,270.00	7,233.00	7,648.00
Invested Capital	Dollars	162,890.00	121,190.00	121,190.00	158,045.00

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¹The income is the residual that remains to returns over cash costs after consideration of the interest on land investment, and an opportunity charge on operator labor.

²The assumed level of income is that of an industrial worker in the manufacturing industries.

Table 18, continued.

Item	Unit	Cash Rent-In System ³	Crop-Share Rent-In System	Complete Custom Hire System	Cash Rent-Out System ³	Crop-Share Rent-Out System ³
Farm Size	Acres	---	410.0	502.0	---	---
Labor Utilized:						
Operator Labor	Hours	---	1,477.0	---	---	---
Hired Labor	Hours	---	229.0	---	---	---
Total Labor	Hours	---	1,706.0	---	---	---
Operating Capital:						
Total Operating Capital	Dollars	---	8,070.00	20,687.00	---	---
Annual Operating Capital	Dollars	---	4,650.00	11,955.00	---	---
Returns over Variable Cash Costs	Dollars	---	13,119.00	18,481.00	---	---
Cash Overhead Costs:						
Machinery Ownership	Dollars	---	3,561.00	---	---	---
Real Estate Taxes	Dollars	---	---	1,506.00	---	---
Total Cash Overhead	Dollars	---	3,561.00	1,506.00	---	---

Returns over Cash Costs	Dollars	---	9,558.00	16,975.00	---	---
Non-Cash Overhead Costs:						
Interest on Land						
Investment	Dollars	---	---	9,789.00	---	---
Operator Labor	Dollars	---	2,216.00	---	---	---
Total Non-Cash						
Overhead	Dollars	---	2,216.00	9,789.00	---	---
Returns to Risk, Management						
and Unallocated Capital	Dollars	---	7,342.00	7,186.00	---	---
Invested Capital	Dollars	---	148,190.00	150,600.00	---	---

³These systems are unable to produce an income equivalent to that of an industrial worker under the assumption of this study.

large portion of the job market and could be assumed to be representative of the wage rate that a farm operator could expect to receive if he were to work off-farm. This comparison is useful in that it may provide some guideline for the farm operator to gauge his level of income relative to the off-farm worker and help him to make a decision as to the desirability, in terms of income, of staying in agriculture or moving off-farm, depending on his particular situation.

Using the returns to risk, management, and unallocated capital as the income criteria with which to equate the industrial worker, the smallest farm size necessary to produce an income equivalent to an average manufacturing wage in Michigan is 410 acres associated with the crop-share rent-in system. This is followed by 412 acres as the second smallest farm size producing the manufacturing wage equivalent. The farming system associated with this farm size is the ownership plus cash rent-in system.

The farming system associated with the largest farm size, 502 acres, is the complete custom hire system. The ownership plus custom harvesting system has the second largest acreage, 490 acres, necessary to produce an income equivalent to that of an industrial worker.

The system which used the largest amount of operating capital to produce an equivalent income is the complete custom hire system, followed by the ownership plus custom

harvesting system. The crop-share rent-in system used the least operating capital.

The complete ownership system used the most labor, both operator and hired, in producing the income equivalent. The complete custom hire system used the least labor.

The farming systems with the least invested capital are the ownership plus cash rent-in system and the ownership plus crop-share rent-in system. The second smallest amount of invested capital necessary to provide an income equivalent to that of an industrial worker's wages is associated with the crop-share rent-in system. The largest amount of invested capital is associated with the complete ownership system.

The cash rent-in system, the cash rent-out system, and the crop-share rent-out system were not analyzed because these systems did not produce a level of returns to risk, management, and unallocated capital sufficient to equal the level of income of an industrial worker.

Implications of the Study

Based on the assumption that farm operators wish to maximize income that is available for growth, consumption, and general farm overhead, a number of implications arise from the results of the study. Some of these implications are: (1) It appears that the larger farm sizes with the operator employed full-time on the farm are relatively

profitable which may result in larger and fewer farms in the future. (2) At the smaller farm sizes, based on the larger associated incomes, the operator will tend to custom hire part or all of the required machinery services, which may result in an increased demand for custom services. (3) The smaller operators (less than 320 acres) will tend to enlarge their operations or to take off-farm jobs in order that they might maintain or raise their incomes. (4) Pure tenancy will tend to decrease because of low returns to these operations relative to other farming systems and its low capital generating ability. (5) Corn and soybeans with a minimum acreage of wheat allowable to maintain the allotment will become the dominant crops provided the government programs assumed for this study do not change. (6) Based on the relatively low returns over cash costs, it appears that the smaller rent-in and rent-out farming systems will have little chance for growth unless off-farm work is undertaken to raise the income of these systems. (7) Finally, the more resource services the operator can acquire, the better opportunity, it appears there is for a higher income.

The implication that there will be larger and fewer cash-grain farms is based on increased income as farm size increases, and the increased pressure to enlarge the farm

to provide more employment to the operator or to rent-out or custom hire operations and work off-farm on the small farms to compensate for low returns.

The implication that the smaller farm size operators will custom hire part or all of their machinery services is based on the higher income earning potential of these farming systems as compared to the other farming systems.

For the 320 acre and less farm sizes, the larger returns accrue to the "combined" farming systems. This is strikingly shown by the 160 acre farm size. The larger returns of the "combined" systems is cause to expect movement to off-farm work plus some arrangement concerning the farm operation itself.

The "tenant" or rent-in farming systems are consistently low or lowest in terms of income potential. If possible, the operator may desire to change to another farming system, increase the size of his operation, or leave farming altogether in order to raise his income.

The optimal organizations for the alternative farming systems in Southern Michigan are composed of corn and soybeans, with a minimum of wheat, provided the government programs assumed for this study do not change. This is cause to believe a shift to corn, soybeans, and wheat might occur.

Limitations of the Study

In general, the study was limited by the single value expectations assumed for the study. More information could be gathered if prices paid and received, yields, soil group, and machinery complement size were varied. By varying prices paid and received, an indication of the sensitivity of the various farming systems to price changes could be determined. The technical input-output coefficients were fixed at a given level. By varying these coefficients and analyzing the resulting changes, valuable information about the responsiveness of the systems could be gained. The study was restricted to the loams-clay loam soil management group which is representative of only a part of Southern Michigan, resulting in limited geographic coverage. Four-row equipment and power units were assumed to be representative of the farms in Southern Michigan. By varying the equipment complement and power units, comparative information on machinery size and its effects on farm income could be gained.

An average factory wage was assumed to be the income earning ability of farm operators. This may or may not be the case and therefore limits the creditability of the comparison of the farming systems with off-farm work and those without off-farm work. Also, the wage rate paid to hire labor for the farming systems were not varied, thereby limiting the study.

Also, a harvest sale was assumed. Not all cash-grain farmers sell at harvest. Consideration of storage, on or off-farm, would extend the applicability of the study.

A single managerial level was assumed. Where the managerial level varied, implications could be drawn about the importance of management in relation with the farming system. Another limitation and area for further study is that this study only tried to specify the major farming systems under a single proprietorship. More research needs to be done in the area of what farming systems are actually in use and why, plus potential farming systems and their potential income earning abilities. The study was limited in that the number of farms of the various systems that could be supported in Southern Michigan was not analyzed, as were not the problems of entry, exit, and growth.

Suggestions for Further Study

Many important areas for further study were mentioned under the Limitations of the Study section. In addition to these, interesting tangents to the main stream of the study would arise as it was made. Some of these are as follows: What jobs are available to those persons which have farm skills? Further, to insure off-farm jobs, what skills should farmers possess? What should be the objectives of rural schools? To prepare the students to stay in rural areas or to move to urban areas?

Another interesting topic would be to determine exactly what farming systems farmers are using? Also, how should these systems be adjusted in order to increase their profitability and attain the goals of the operators. It is difficult to make recommendations about what to do unless the present situation is known.

More study should be done on the custom hiring of services. Who provides these services? Farmers with excess machinery capacity? Companies offering custom services to expand the sales of other products? Or, full-time custom service providers? What are the possibilities for the future of this field?

Of interest, also, is the effects on income of the various alternative actions under government programs. Should individual farmers take part in government programs? If so, to what extent, and under what circumstances?

Another need for further study lies within the management process itself. What is management is a question that yet has to be satisfactorily answered though much research has been accomplished in this area. Further study needs to be done in the conceptualization of farm systems and their interrelation and interaction.

Better management techniques are needed in order to help the farm operators cope with the flood of new equipment and technology that is occurring. On what basis does a farm operator decide to change machinery systems which cost

thousands of dollars? How does an operator decide to quit farming and work off-farm? How does a farmer gather information to make these decisions?

As change takes place in agriculture, each of the above points may provide interesting research topics.

CHAPTER V

SUMMARY

The major purpose of this study was to provide information to farmers, agricultural workers, and policy-makers about potential incomes associated with alternative farming systems on cash-grain farms in Southern Michigan. The specific objectives of the study were to: (1) describe major farming systems on Southern Michigan cash-grain farms; (2) determine the optimum farm organization associated with each farming system and varying farm sizes; (3) compare the potential incomes associated with these farming systems over varying farm size levels; and (4) appraise the adjustment implications for cash-grain farmers.

Nine farming systems were studied, each differentiated from the other by the manner in which land, labor, machinery, or capital were acquired. These farming systems were: complete ownership, ownership plus crop-share rent-in, ownership plus cash rent-in, ownership plus custom hire, crop-share rent-in, cash rent-in, complete custom harvest, cash rent-out, and crop-share rent-out.

The "synthetic firm" approach, with linear programming and partial budgeting, was used to estimate potential

income and the optimal organization associated with the alternative farming systems. Four farm sizes were assumed for each farming system: 160 acres, 320 acres, 480 acres, and 640 acres. A comparative analysis of the various farming systems was based on the returns over cash costs; returns to risk, management, and unallocated capital; operating capital; labor utilized; optimal enterprise organization; and the farm size necessary to provide an income equal to that of an average Michigan durable goods manufacturing worker in 1967. Enterprises included in the analysis were corn, wheat, oats, soybeans, and alfalfa.

The farming systems were analyzed with and without off-farm work assumed for some of the farming systems. When off-farm work was assumed, it was considered for only three systems: crop-share rent-out farming system, cash rent-out farming system, and complete custom hire farming system. The average annual wage rate for a durable goods industry worker (\$7,289) was assumed to be the income obtained from off-farm work for the cash rent-out and the crop-share rent-out farming systems. Eighty percent of the average annual wage rate for a durable goods industry worker was assumed to be the off-farm income earned by the complete custom hire farming system. The remaining 20 percent was assumed to be used in the management of the custom hiring operations.

As farm size increased, the farming system (no labor sold off-farm) which produced the largest returns over cash costs changed also. For the 160 acre farm size, the complete custom hire system is the largest income producer because of lower total machinery costs. In second place was the ownership plus custom harvesting system. The custom hiring of harvesting operations kept the machinery investment down and returns up compared to the other farming systems at this level. As the farm size increased to 320 acres, the complete ownership farming system became the largest income producer with a range of \$441 between this system and the next system; ownership plus custom harvesting. The complete custom hire system ranked third. Apparently the economies of size of the machinery complement lowered the ownership costs below the custom charges, thereby pushing the complete ownership system into first place. For the 480 acre and 640 acre farm sizes, the complete ownership system was the largest income producer with wider margins over the second largest income producer as acreage increased.

The introduction of off-farm work resulted in a re-arrangement of the standings of the various systems, based on income earning potential. For all farm sizes, the complete custom hire plus off-farm work system was the largest income producing system, although from the 320 acre farm size, the range between first and second positions shrunk. As farm size increased, the cash rent-out plus

off-farm work system and the crop-share rent-out plus off-farm work system lost in ranking of importance and the complete ownership system increased.

The optimal organization for the complete ownership, ownership plus custom harvesting, crop-share rent-in, complete custom hire, and crop-share rent-out systems for all farm study sizes had the same proportions for each crop. The proportions for these farming systems are: corn, 38.75 percent; wheat, 16.25 percent; and soybeans, 45.00 percent.

The enterprise organization of the cash rent-out system was not under the control of the operator of this farm system, and therefore was not considered. The ownership plus crop-share rent-in and ownership plus cash rent-in systems had identical enterprise organizations which differed from the other systems in that they had a larger percentage of corn and a smaller percentage of wheat and soybeans. The cash rent-in enterprise organization for the 480 acre and 640 acre farm sizes differed from the above mentioned organizations because of the credit restraint limiting the farm operation.

As would be expected, those farming systems with the largest expenditures hired more services relative to the other farming systems and also used the most operating capital. As the use of total capital services increased, so did income.

There appeared to be little relationship between potential incomes associated with the alternative farming systems of various sizes and wages of industrial workers. However, as might be expected, those farming systems which had lower productivity required more acreage to provide the income level desired.

Based on the returns over cash costs, it appears that the larger farm sizes with the operator employed full-time on the farm are relatively profitable which may result in larger and fewer farms in the future. At the smaller farm sizes, based on the larger associated incomes, the operator will tend to custom hire part or all of the required machinery services, which may result in an increased demand for custom services. The smaller operators (less than 320 acres) will tend to enlarge their operations or to take off-farm jobs in order that they might maintain or raise their incomes. Pure tenancy will tend to decrease because of low returns to these operations relative to other farming systems and its low capital generating ability. Corn and soybeans with a minimum acreage of wheat allowable to maintain the allotment will become the dominant crops provided the government programs assumed for this study do not change. Based on the relatively low returns over cash costs, it appears that

the smaller rent-in and rent-out farming systems will have little chance for growth unless off-farm work is undertaken to raise the income of these systems. Finally, the more resources services the operator can acquire, the better opportunity it appears there is for a higher income.

In general, the study was limited by the single value expectations assumed for the study. More information could be gathered if prices paid and received, yields, soil group, and machinery complement size were varied. Also, a single managerial level was assumed. Where the managerial level varied, implications could be drawn about the importance of management in relation with the farming system. Another limitation and area for further study is that this study only tried to specify the major farming systems under a single proprietorship. More research needs to be done in the area of what farming systems are actually in use and why, plus potential farming systems and their potential income earning abilities. The study was limited in that the number of farms of the various systems that could be supported in Southern Michigan was not analyzed, as were not problems of entry, exit, and growth.

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APPENDIX

APPENDIX TABLE 1

Assumed Prices Paid and Received¹

Item	Unit	Price
<u>PRICES PAID:</u>		
<u>Seed:</u>		
Corn for grain	bu.	13.50
Wheat	bu.	3.25
Oats	bu.	1.75
Soybeans	bu.	4.50
Alfalfa	lb.	.62
<u>Fuel and Lubricants:</u>		
Gasoline	gal.	.174
Diesel	gal.	.154
Motor Oil	gal.	.90
Lubricant	lb.	.22
<u>Fertilizer:</u>		
Amonium Nitrate (33 1/3-0-0)		
Bulk	ton	70.00
Bag	ton	75.50
Anhydrone Ammonia		
With equipment	ton	120.00
Without equipment	ton	110.00
Phosphate (0-46-0)		
Bulk	ton	80.00
Bag	ton	84.50
Potash (0-0-60)		
Bulk	ton	51.00
Bag	ton	55.50
<u>Chemicals:</u>		
Atrazine	lb.	2.90
Z1 4-D (amine)	lb.	.82
Amiben	lb.	5.00
<u>Hauling:</u>		
Corn and Soybeans	bu.	.06
Wheat and Oats	bu.	.05
Alfalfa (hauling and storing)	bale	.10
<u>Land:</u> ²		
Cash Rent	acre	300.00
	acre	18.00
<u>Labor:</u>		
	hr.	1.50

APPENDIX TABLE 1 (Continued)

Item	Unit	Price
<u>PRICES RECEIVED:</u> ³		
Corn	bu.	1.10
Wheat	bu.	1.50
Oats	bu.	.67
Soybeans	bu.	2.60
Alfalfa	ton	22.50
Land (Cash Rent)	acre	18.00

¹These price assumptions are not to be interpreted as predictions or prospective prices. Assumed machinery prices are shown in Appendix Table 10.

²Real estate taxes are assumed to be one percent of the land price per acre.

³Approximate 1967-68 season average prices.

Source: Larry J. Connor, Cost and Returns for Major Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

APPENDIX TABLE 2

Crop Yields, Fertilizer and Herbicide Requirements, and Machinery Operations for Selected Cash-Grain Crops

Crop ¹	Maximum Assumed Yield (acre)	Seed Requirements (acre)	Fertilizer Requirements ² N-P ₂ O ₅ -K ₂ O
Corn	85 bu.	.21 bu.	80-0-0 10-50-25
Wheat	45 bu.	1.75 bu.	45-75-25
Oats	65 bu.	2.25 bu.	45-50-15
Soybeans	28 bu.	.83 bu.	30-50-15
Alfalfa	3.2 ton	2 lb.	0-50-15

¹Corn was planted in 38-inch rows; soybeans in 28-inch rows.

²Quantities shown refer to actual pounds of nitrogen, phosphate, and potash, respectively.

Source: Larry J. Connor, Cost and Returns for Major Cash Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

Herbicide Requirements (lbs/acre)	Machinery Operation	Times Over
2 (atrazine)	bulk spread fertilizer plow plant and fertilize spray cultivate harvest	1 1 1 1 1 1 1
---	plow disc harrow drill and fertilize harvest	1 1 1 1 1
.25 (2,4-D)	plow disc harrow drill and fertilize spray harvest	1 1 1 1 1 1
1 (amiben)	plow harrow plant, fertilize, and spray cultivate harvest	1 1 1 1 1 1
---	plant and fertilize fertilizer (top-dress) mow-condition windrow bale 2nd harvest 3rd harvest	1 1 1 1 1 1 1

APPENDIX TABLE 3

Variable Cash Costs per Acre for Selected Cash-Grain Crops for Alternative Cash-Grain Farms

Item	Farming Systems							
	Complete Ownership	Ownership Plus Custom Hire	Cash Rent-In	Crop-Share Rent-In	Complete Custom Hire	Cash Rent-Out	Crop-Share Rent-Out	
(Dollars)								
CORN:								
Seed	2.84	2.84	2.84	1.89	2.84	--	.95	
Fertilizer	15.28	15.28	15.28	10.19	15.28	--	5.09	
Herbicide	5.80	5.80	5.80	3.87	5.80	--	1.93	
Hauling	5.10	5.10	5.10	5.10	5.10	--	--	
Power and Machinery	3.46	9.67	3.46	3.46	19.55	--	--	
Rent	--	--	18.00	--	--	--	--	
Total	32.48	38.69	50.48	24.51	48.57	--	7.97	
WHEAT:								
Seed	5.69	5.69	5.69	3.79	5.69	--	1.90	
Fertilizer	13.14	13.14	13.14	8.76	13.14	--	4.38	
Herbicide	--	--	--	--	--	--	--	
Hauling	2.25	2.25	2.25	2.25	2.25	--	--	
Power and Machinery	2.55	7.76	2.55	2.55	17.00	--	--	
Rent	--	--	18.00	--	--	--	--	
Total	23.63	28.84	41.63	17.35	38.08	--	6.28	
OATS:								
Seed	3.94	3.94	3.94	2.63	3.94	--	1.31	
Fertilizer	10.38	10.38	10.38	6.92	10.38	--	3.46	
Herbicide	.21	.21	.21	.14	.21	--	.07	
Hauling	3.25	3.25	3.25	3.25	3.25	--	--	
Power and Machinery	2.83	7.99	2.83	2.83	18.50	--	--	
Rent	--	--	18.00	--	--	--	--	
Total	20.61	25.77	38.61	15.77	36.28	--	4.84	

APPENDIX TABLE 3

Item	Farming Systems						
	Complete Ownership	Ownership Custom Hire	Cash Rent-In	Crop-Share Rent-In	Complete Custom Hire	Cash Rent-Out	Crop-Share Rent-Out
(Dollars)							
SOYBEANS:							
Seed	3.74	3.74	3.74	2.49	3.74	--	1.25
Fertilizer	8.68	8.68	8.68	5.79	8.68	--	2.89
Herbicide	5.00	5.00	5.00	3.33	5.00	--	1.67
Hauling	1.68	1.68	1.68	1.68	1.68	--	--
Power and Machinery	3.08	8.03	3.08	3.08	17.50	--	--
Rent	--	--	18.00	--	--	--	--
Total	22.18	27.13	40.18	16.37	36.60	--	5.81
ALFALFA:							
Seed	1.24	1.24	1.24	.83	1.24	--	.41
Fertilizer	5.00	5.00	5.00	3.33	5.00	--	1.67
Herbicide	--	--	--	--	--	--	--
Hauling	9.60	9.60	9.60	9.60	9.60	--	--
Power and Machinery	5.36	21.70	5.36	5.36	22.60	--	--
Rent	--	--	18.00	--	--	--	--
Total	21.20	37.54	39.20	19.12	38.44	--	2.08

APPENDIX TABLE 4

Total Labor Requirements Per Acre For Selected
Cash-Grain Crops¹

Crop	Acres	Hours Per Acre ²
Corn	160	6.495
	320	5.473
	480	4.951
	640	4.612
Oats	160	4.524
	320	3.564
	480	3.101
	640	2.808
Alfalfa	160	10.841
	320	9.891
	480	9.374
	640	9.023
Wheat	160	4.411
	320	3.521
	480	3.086
	640	2.811
Soybeans	160	5.100
	320	4.008
	480	3.481
	640	3.150

¹Based on unpublished research by David Armstrong, Department of Agricultural Economics, Michigan State University.

²The hour per acre is based on a Cobb-Douglas function, $\log Y = a - b \log X$ where Y = hour per acre and X = acres. The A and B values are:

Crop	A	B
Corn	1.3570	0.2470
Wheat	1.3613	0.3252
Oats	1.4135	0.3439
Soybeans	1.4735	0.3475
Alfalfa	1.3269	0.1324

APPENDIX TABLE 5

Estimated Labor Requirement per Acre per Time Period for Specified Cash
Crops Using 4-Row Equipment, Southern Michigan

Time Period	Corn				Wheat			
	Percent of Total	Time (hr.)			Percent of Total	Time (hr.)		
		160a	320a	480a 640a		160a	320a	480a 640a
A. Operator Provides All Machinery Services ¹								
Nov.-March	.21951	1.43	1.20	1.09 1.01	-	-	-	-
April	.18536	1.20	1.01	.92 .86	-	-	-	-
May	.32195	2.09	1.76	1.59 1.48	-	-	-	-
June	.13658	.89	.75	.68 .63	-	-	-	-
July	-	-	-	-	.24444	1.08	.86	.75 .69
August	-	-	-	-	.36111	1.59	1.27	1.11 1.02
September	-	-	-	-	.39444	1.74	1.39	1.22 1.11
October	.13658	.89	.75	.68 .63	-	-	-	-
Total	1.00000	6.50	5.47	4.96 4.61	1.00000	4.41	3.52	3.08 2.82
B. Operator Provides All Machinery Services, Except Harvesting								
Nov.-March	.01463	.09	.08	.07 .07	-	-	-	-
April	.18536	1.20	1.01	.92 .85	-	-	-	-
May	.32195	2.09	1.76	1.59 1.49	-	-	-	-
June	.13658	.89	.75	.67 .63	-	-	-	-
July	-	-	-	-	-	-	-	-
August	-	-	-	-	.36111	1.59	1.27	1.11 1.01
September	-	-	-	-	.39444	1.74	1.39	1.22 1.11
October	-	-	-	-	-	-	-	-
Total	-	4.27	2.60	3.25 3.04	-	3.33	2.66	2.33 2.12

¹ Based on Larry J. Connor's, Cost and Returns for Major Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

APPENDIX TABLE 5 (Continued)

Time Period	Oats			Soybeans			Alfalfa								
	Percent of Total	Time (hr.)		Percent of Total	Time (hr.)		Percent of Total	Time (hr.)							
		160a	320a 480a 640a		160a	320a 480a 640a		160a	320a 480a 640a						
A. Operator Provides All Machinery Services ¹															
Nov.-March	.18367	.83	.66 .57 .52	-	-	-	-	-	-	-	-	-	-	-	-
April	.36224	1.64	1.29 1.12 1.02	.14414	.73	.58	.03296	.36	.33	-	-	-	-	-	-
May	-	-	-	.28828	1.47	1.15 1.00 .91	-	-	-	-	-	-	-	-	-
June	.08163	.37	.29 .25 .23	.13063	.67	.52 .46 .41	.32234	3.49	3.19	3.02	2.91	-	-	-	-
July	.15306	.69	.55 .48 .43	.16216	.83	.65 .56 .51	.32234	3.49	3.19	3.02	2.91	-	-	-	-
August	.07142	.32	.25 .22 .20	-	-	-	.10256	1.11	1.01	.96	.92	-	-	-	-
September	-	-	-	.13963	.71	.56 .49 .44	.21978	2.38	2.17	2.06	1.98	-	-	-	-
October	.14795	.67	.53 .46 .41	.13513	.69	.54 .47 .43	-	-	-	-	-	-	-	-	-
Total	1.00000	4.52	3.47 3.10 2.81	1.00000	5.10	4.00 3.48 3.15	1.00000	10.83	9.89	9.37	9.01	-	-	-	-
B. Operator Provides All Machinery Services, Except Harvesting.															
Nov.-March	.18367	.83	.66 .57 .51	-	-	-	-	-	-	-	-	-	-	-	-
April	.36224	1.64	1.29 1.12 1.02	.14414	.73	.58	.03296	.36	.33	-	-	-	-	-	-
May	-	-	-	.28828	1.47	1.15 1.00 .91	-	-	-	-	-	-	-	-	-
June	.08163	.37	.29 .25 .23	.13063	.66	.52 .46 .41	-	-	-	-	-	-	-	-	-
July	-	-	-	.16216	.83	.65 .56 .51	-	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
October	.14795	.67	.53 .46 .42	-	-	-	-	-	-	-	-	-	-	-	-
Total	3.51	2.77	2.40 2.18	-	3.69	2.90 2.52 2.28	-	.36	.33	-	.31	-	.30	-	.30

¹Based on Larry J. Connor's, Cost and Returns for Major Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

APPENDIX TABLE 6

Machinery and Power Operating Costs per Acre by Enterprise and Operation Using a 4-row Complement with Complete Ownership

Enterprise and Operation	Equipment Size	Operating Cost Per Hour	Per Acre	
			Machine Hour Requirements	Operating Costs
		(Dollars)	(Hours)	(Dollars)
CORN				
Spread fertilizer	10 ft.	.15	.21	.032
Plow	4-16"	.58	.46	.267
Plant and fertilize	4 row	.37	.29	.107
Spray	6 row	.19	.13	.025
Cultivate	4 row	.23	.26	.060
Combine	2 row	2.52	.63	1.588
Power	64 HP	1.12	.67	.750
Power	51 HP	.92	.68	.626
Total Machinery		Operating Cost Per Acre		3.455
WHEAT				
Plow	4-16"	.58	.46	.267
Disc	12 ft.	.30	.18	.054
Harrow	12 ft.	.12	.17	.020
Drill and fertilize	15-7"	.39	.44	.172
Combine	10 ft.	1.90	.40	.760
Power	64 HP	1.12	.62	.694
Power	51 HP	.92	.63	.580
Total Machinery		Operating Cost Per Acre		2.547
OATS				
Plow	4-16"	.58	.46	.273
Disc	12 ft.	.30	.18	.054
Harrow	12 ft.	.12	.17	.023
Drill and fertilize	15-7"	.39	.44	.203
Spray	6 row	.19	.13	.030
Combine	10 ft.	1.90	.40	.836
Power	64 HP	1.12	.69	.773
Power	51 HP	.92	.69	.635
Total Machinery		Operating Cost Per Acre		2.827

Enterprise and Operation	Equipment Size	Operating Cost Per Hour	Per Acre	
			Machine Hour Requirements	Operating Costs
		(Dollars)	(Hours)	(Dollars)
SOYBEANS				
Plow	4-16"	.58	.46	.267
Harrow	12 ft.	.12	.17	.020
Plant, fertilize and spray	4 row	.46	.45	.207
Cultivate	4 row	.23	.35	.080
Combine ¹	10 ft.	1.90	.55	1.045
Power ¹	64 HP	1.12	.71	.795
Power ¹	51 HP	.92	.72	.662
	Total Machinery	Operating Cost Per Acre ²		3.076
Plant and fertilize	15-7"	---	.44	---
Fertilize	30 ft.	.15	.07	.010
Mow-Condition	7 ft.	.61	.42	.256
Windrow	12 ft.	.34	.22	.075
Bale	168 inch.	.42	.20	.084
2nd Harvest		1.37	.84	1.151
3rd Harvest		1.37	.84	1.151
Power ¹	64 HP	1.12	1.29	1.445
Power ¹	51 HP	.92	1.30	1.196
	Total Machinery	Operating Costs Per Acre		5.368

¹Hourly power requirements per acre were divided evenly between the two tractors.

²Charged to oat enterprise.

Sources: Larry J. Connor, Costs and Returns for Major Cash Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

Gary Benjamin, An Economic Analysis of Alternative Means of Acquiring Farm Machinery Services for Southern Michigan Cash-Grain Farms, (unpublished M.S. thesis) Michigan State University.

APPENDIX TABLE 7

Machinery and Power Operating Costs Per Acre by Enterprise and Operation Using a 4-row Complement with Ownership Plus Custom Harvesting

Enterprise and Operation	Equipment Size	Operating Cost Per Hour	Per Acre	
			Machine Hour Requirements	Operating Costs
		(Dollars)	(Hours)	(Dollars)
CORN				
Spread fertilizer	10 ft.	.15	.21	.032
Plow	4-16"	.58	.46	.267
Plant and fertilize	4 row	.37	.29	.107
Spray	6 row	.19	.13	.025
Cultivate	4 row	.23	.26	.060
Custom combining ²	2 row	--	--	7.000
Powerl	64 HP	1.12	.67	.750
Powerl	51 HP	.92	.68	.626
Total Machinery Operating Cost Per Acre				8.867
WHEAT				
Plow	4-16"	.58	.46	.267
Disc	12 ft.	.30	.18	.054
Harrow	12 ft.	.12	.17	.020
Drill and fertilize	15-7"	.39	.44	.172
Custom combining ²	10 ft.	--	--	6.000
Powerl	64 HP	1.12	.62	.694
Powerl	51 HP	.92	.63	.580
Total Machinery Operating Cost Per Acre				7.757
OATS				
Plow	4-16"	.58	.46	.273
Disc	12 ft.	.30	.18	.054
Harrow	12 ft.	.12	.17	.023
Drill and fertilize	15-7"	.39	.44	.203
Spray	6 row	.19	.13	.030
Custom combining ²	10 ft.	--	--	6.000
Powerl	64 HP	1.12	.69	.773
Powerl	51 HP	.92	.69	.635
Total Machinery Operating Cost Per Acre				7.991

APPENDIX TABLE 7 (Continued)

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Enterprise and Operation	Equipment Size	Operating Cost Per Hour	Per Acre	
			Machine Hour Requirements	Operating Costs
		(Dollars)	(Hours)	(Dollars)
SOYBEANS				
Plow	4-16"	.58	.46	.267
Harrow	12 ft.	.12	.17	.020
Plant, fertilize and spray	4 row	.46	.45	.207
Cultivate	4 row	.23	.35	.080
Custom Combining ²	10 ft.	--	--	6.000
Power ¹	64 HP	1.12	.71	.795
Power ¹	51 HP	.92	.72	.662
	Total Machinery	Operating Cost Per Acre		8.031
Plant and fertilize	15-7"	--	.44	--
Fertilize	30 ft.	.15	.07	.100
Custom mow-condition ²	7 ft.	--	--	2.500
Custom windrow ²	12 ft.	--	--	1.500
Custom bale ²	--	--	--	3.200
2nd custom harvest ²	--	--	--	7.200
3rd custom harvest	--	--	--	7.200
Power ¹	--	--	--	--
Power ¹	--	--	--	--
	Total Machinery	Operating Cost Per Acre		21.700

¹Hourly power requirements per acre were divided evenly between the two tractors.

²See Appendix Table 8 for custom rates.

³Charged to oat enterprise.

Sources: Larry J. Connor, Costs and Returns for Major Cash Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

Gary Benjamin, An Economic Analysis of Alternative Means of Acquiring Farm Machinery Services for Southern Michigan Cash-Grain Farms, (unpublished M.S. thesis) Michigan State University.

APPENDIX TABLE 8

Custom Rates Per Acre by Enterprise and Operation

Enterprise and Operation	Custom Rates Per Acre (Dollars)
<u>CORN</u>	
Spread fertilizer	1.05
Plow	5.50
Plant and fertilize	2.30
Spray	1.50
Cultivate	2.00
Harvest	7.00
Total for Corn	19.55
<u>WHEAT</u>	
Plow	5.50
Disc	2.00
Harrow	1.50
Drill and fertilize	2.00
Harvest	6.00
Total for Wheat	17.00
<u>OATS</u>	
Plow	5.50
Disc	2.00
Harrow	1.50
Drill and fertilize	2.00
Spray	1.50
Harvest	6.00
Total for Oats	18.50
<u>SOYBEANS</u>	
Plow	5.50
Harrow	1.50
Plant, fertilize, and spray	2.50
Cultivate	2.00
Harvest	6.00
Total for Soybeans	17.50
<u>ALFALFA</u>	
Fertilize	1.00
Mow condition	2.50
Windrow	1.50
Bale	3.20
2nd harvest	7.20
3rd harvest	7.20
Total for Alfalfa	22.60

Sources: Gary Benjamin, An Economic Analysis of Alternative Means of Acquiring Farm Machinery Services for Southern Michigan Cash-Grain Farms, (unpublished M.S. thesis) Michigan State University.

Rates for Custom Work in Michigan, Extension Bulletin E-485. Cooperative Extension Service, Michigan State University.

APPENDIX TABLE 9

Available Operator Labor by Time Period

Time Period	Available Operator Labor ¹
	(Hours)
November-March	1,160
April	260
May	270
June	250
July	270
August	270
September	250
October	270
Total	3,000

¹Assumes operator works 60 hours per week for 50 weeks per year with two weeks vacation in the November-March time period.

Source: E. M. Hughes, Jr. and B. F. Stanton, Time Spent on Entrepreneurial and Related Activities, Agricultural Economics Report 187, Department of Agricultural Economics, Cornell University.

APPENDIX TABLE 10

Assumed Four-Row Machinery and Power Complement

Item	Description	New Cost
		(Dollars)
Tractor	Diesel, 51 HP (PTO)	5,185.00
Tractor	Diesel, 64 HP (PTO)	6,205.00
Combine	10 ft., SP, with grain platform	6,240.00
Corn head	Two-row	1,985.00
Bean head		900.00
Baler	Size 14 x 18, PTO, Twine Tie	1,830.00
Plow	4-16", semi-mounted	1,050.00
Planter	Four-row with fert. attach.	1,075.00
Drill	15-7", with fert. attach.	1,100.00
Cultivator	Four-row	875.00
Disc	12 ft.	1,000.00
Harrow	12 ft.	250.00
Windrower	12 ft. PTO	1,190.00
Mower-conditioner	7 ft.	2,000.00
Sprayer	6-row, pull-type with tank	575.00

Source: Larry J. Connor, Costs and Returns for Major Cash Crops in Southern Michigan, Agricultural Economics Report No. 87, Department of Agricultural Economics, Michigan State University.

APPENDIX TABLE 11

Cropland Renting Questionnaire

**Confidential:
For Research
Purposes Only**

Department of Agricultural Economics
Michigan State University
Questionnaire on Cropland Renting in Southern Michigan

1. Is cropland in your county typically rented on a cash lease _____ or crop share _____ basis?
 - 1a. What percentage of the total cropland is rented on a cash lease _____ and crop share _____ basis?

_____%

_____%
2. What is the current rate per acre for renting cropland on a cash lease basis? _____ (\$ per acre)
3. What are the typical shares under crop share lease for the following crops:

<u>Crop</u>	<u>Tenant's Share</u>
Corn	_____
Wheat	_____
Soybeans	_____
Field beans	_____
Oats	_____
Alfalfa	_____

- 3a. What proportion of the following cost items is the tenant responsible for?

Item	Proportion which Tenant is Responsible for
Seed	
Fertilizer	
Herbicides	
Power and Machinery	
Other	

Thank you.

APPENDIX TABLE 12

Results of Cropland Renting Survey

Question	Description	Response
1	Typical Renting Arrangement	
	Cash Lease	0
	Crop-Share Lease	6
	Both	5
	Total	11

1a Percentage Total Cropland Rented By:

(a) Cash Lease	(b) Crop-Share Lease
35%	65%
25%	75%
25%	75%
40%	60%
25%	75%
25%	75%
40%	60%
25%	75%
5-%	50%
15%	85%
50%	50%

2 Current Cash Rent Per Acre:

Range	Acreage When Given
\$8 to 20	
10 to 25	17
10 to 15	
12 to 15	
10 to 20	
10 to 30	18
5 to 25	12
10 to 15	
15	
10 to 25	
15	

APPENDIX TABLE 12 (Continued)

Question	Description				Response
3	Typical Tenant Share Under Crop-Share Lease:				
		50%	66-2/3%	Both	Do Not Grow
	Corn	4	3	4	
	Wheat	4	3	4	
	Soybeans	4	3	3	1
	Field Beans	3	3	1	4
	Oats	4	3	4	
	Alfalfa	6	1	4	
3a	Proportion Which Tenant is Responsible For: 50%				
		50%	66-2/3%	100%	50% to 66-2/3% 100% to 100%
	Seed	6	1	2	2
	Fertilize	6	1	2	2
	Herbicide	6	1	2	2
	Power and Machinery			13	

APPENDIX TABLE 13

An Example of a Linear Programming Tableau Used in This Study: Complete Ownership Farming System, 160 Acre Farm Size

Item	Unit	P ₀	P ₁ CØRN	P ₂ WHEAT	P ₃ ØATS	P ₄ SØYBN	P ₅ ALFAL	P ₆ SLCRN	P ₇ SLWHT	P ₈ SLSØY
1	PRØFIT		32.48	23.63	20.61	22.18	21.20	-1.10	-1.50	-2.60
2	LANDC	62.0	1.0							
3	LANDW	26.0		1.0						
4	LANDT	160.0	1.0	1.0	1.0	1.0	1.0			
5	LRØNM	1,160	1.43		.83	.73	.36			
6	LRØAP	260	1.20		1.64	1.47				
7	LRØMY	270	2.09			.67				
8	LRØJE	250	.89		.37	.67	3.49			
9	LRØJY	270		1.08	.69	.83	3.49			
10	LRØAT	270		1.59	.32	.71	1.11			
11	LRØSR	250	.89	1.74		.69	2.38			
12	LRØØR	270			.67	.69				
13	LRØTØ		-6.50	-4.41	-4.52	-5.10	-10.83			
14	LRHIR									
15	LRTØT		-6.50	-4.41	-4.52	-5.10	-10.83			
16	SLTRC		-85.0					1.0		
17	SLTRW			-45.0					1.0	
18	SLTRS									1.0
19	CPTLAN		18.76	21.99	15.39	-28.0	7.77			
20	CPTLTC	37,235	32.48	23.63	20.61	9.73	21.20			

APPENDIX TABLE 13 (Continued)

Item	Unit	P ₉ HLRNM	P ₁₀ HLRAP	P ₁₁ HLRMY	P ₁₂ HLRJE	P ₁₃ HLRJY	P ₁₄ HLRAT	P ₁₅ HLRSR	P ₁₆ HLRØR	P ₁₇ SLLR	P ₁₈ CPTBW
1 PRØFIT	dollar	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50		.07
2 LANDC	acre										
3 LANDW	acre										
4 LANDT	acre										
5 LRØNM	hour	-1.0									
6 LRØAP	hour		-1.0								
7 LRØMY	hour			-1.0							
8 LRØJE	hour				-1.0						
9 LRØJY	hour					-1.0					
10 LRØAT	hour						-1.0				
11 LRØSR	hour							-1.0			
12 LRØØR	hour								-1.0		
13 LRØTØ	hour										
14 LRHIR	hour	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0		
15 LRTØT	hour	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
16 SLTRC	bushel										
17 SLTRW	bushel										
18 SLTRS	bushel										
19 CPTLAN	dollar	.75	.75	.75	.75	.75	.75	.75	.75		-1.0
20 CPTLTC	dollar	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50		

¹Column P₁₇, entitled SLLR, was intended to be used as a labor selling activity at the time of the construction of the tableau. However, at a later date, a different manner of handling the employment of operator labor off-farm was arrived at which resulted in the labor selling activity being left in the tableau, but not used.

APPENDIX TABLE 14

Schedule of Annual Ownership Costs by Farm Size with a 4-row System of Complete Ownership¹

Machinery Items	Size	Years of Life to Obsoles- cence	Annual Cost to Obsoles- cence	Annual Ownership Costs With Excessive Machinery Use at:									
				440A.	480A.	520A.	560A.	600A.	640A.	680A.	720A.	760A.	800A.
(Years)				(Dollars)									
Tractor	50 HP	10	658										
Tractor	64 HP	10	787										
Plow	4-16"	10	133	145	158	175	175	198	198	198	230	230	230
Disc	12 ft.	12	112										
Harrow	12 ft.	15	24										
Planter	4 row	10	136	147	161	178	178	200	200	200	233	233	233
Drill	15-7"	12	123										
Cultivator	4 row	10	111								120	120	120
Sprayer (pull type)	6 row	10	73										
Sprayer attachment	4 row	10	21	23	25	25	28	28	32	32	37	37	37
Fertilizer													
spreader	10 ft.	10	51										
Combine													
grain plat- form	10 ft.	10	1,158										
corn head	2 row	10		1,249	1,363	1,363	1,509	1,509	1,705	1,705	1,705	1,705	1,979
bean attach- ment		10											
Bean puller	4 row	10	174										
Bean wind- rower	4 row	10	.										
TOTALS				3,561	3,586	3,706	3,837	3,857	4,026	4,052	4,248	4,280	4,327 4,601

See footnote and source at bottom of Appendix Table 15.

APPENDIX TABLE 15

Schedule of Annual Ownership Costs by Farm Size with a 4-row System Using a Combination of Ownership and Custom Harvesting¹

Machinery Items	Size	Years of Life to Obsoles- cence	Annual Ownership Cost to Obsoles- cence	Annual Ownership Costs With Excessive Machinery Use at:												
				440A.	480A.	520A.	560A.	600A.	640A.	680A.	720A.	760A.	800A.			
(Years)				(Dollars)	(Dollars)											
Plow Planter Sprayer Cultivator Harrow	4-16"	10	133	145	158	175	175	198	198	198	230	230	230	230		
	4-row	10	136	147	161	161	178	178	200	200	200	233	233	233		
	6-row	10	73													
	4-row	10	111													
	12 ft.	15	24													
Sprayer Attach. Disc Drill Tractor Tractor	4-row	10	21	23	25	25	28	28	32	32	32	37	37	37		
	12 ft.	12	112													
	15-7"	12	123													
	51 HP	10	658													
	64 HP	10	787													
Totals				2178	2203	2232	2249	2269	2292	2318	2318	2350	2397	2397		

¹Ownership costs include depreciation, interest, and insurance. In all cases, depreciation is based on the number of years until a machine becomes technologically obsolete, or until it becomes physically worn out; whichever is shorter. Figures in Column 4 represent annual ownership costs when farms are small enough to allow the machinery to reach obsolescence. Figures in Columns 5 and above represent annual ownership costs on farms so large that excessive use of the machine is required and it becomes worn out before becoming obsolete.

Source: Gary Benjamin, An Economic Analysis of Alternative Means of Acquiring Farm Machinery Services for Southern Michigan Cash-Grain Farms, (unpublished M.S. Thesis) Michigan State University.

APPENDIX TABLE 16

Operating Capital Requirements per Acre for Selected Farming Systems in Southern Michigan

Item	Complete Owner and Operator	Combination Owner and Custom Hiring	Complete Custom Hire	Rent-Out Crop-Share	Rent- Out Cash	Rent-In Crop- Share	Rent-In Cash
Corn-Annual Total	18.76 32.48	22.38 38.69	28.06 48.57	4.60 7.97	-- --	14.16 24.51	29.16 50.48
Wheat-Annual Total	21.99 23.63	26.84 28.84	35.44 38.08	5.84 6.28	-- --	16.14 17.35	38.74 41.63
Oats-Annual Total	15.39 20.61	19.33 25.77	27.21 36.28	3.62 4.84	-- --	11.78 15.77	28.85 38.61
Soybeans-Annual Total	9.73 22.18	11.83 27.13	15.96 36.60	2.55 5.81	-- --	7.18 16.37	17.63 40.18
Alfalfa-Annual Total	7.77 21.20	14.81 37.54	15.16 38.44	.76 2.08	-- --	7.01 19.12	14.37 39.20

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