AN EVALUATION OF TWO KNOWLEDGE SITUATIONS ON FARM RESOURCE USE ON A REPRESENTATIVE CENTRAL KANSAS FARM

by

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B. S., Kansas State University, 1969

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

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ACKNOWLEDGMENT

The author wishes to thank Dr. Orlan Buller for his assistance in the research and writing of this paper.

Also a thank you is extended to the other members of my graduate committee; Dr. Dale Knight and Dr. Frank Orazem. Thanks also to Dr. John McCoy who filled in for Dr. Orazem in his absence.

INTRODUCTION

Justification

Management

Literature[1] states that a manager performs the following six functions:

(1) Problem definition
(2) Observation
(3) Analysis
(4) Decision
(5) Action
(6) Acceptance of responsibility

Observation involves anything from merely visual observation to close examination of records. Analysis consists of the study of the facts to determine cause and effect relationships. Decision making involves making a choice of an alternative from many alternatives based upon the analysis of the data. After an alternative is chosen it must be put into operation and then the manager must be prepared to accept the responsibility of his actions, whether they be monetary or otherwise.

A manager must constantly carry out these functions due to continual change and uncertainty. Within a situation in which there is no change or uncertainty, management, as such, is not needed. Johnson states;

> "---Management is needed only in situations involving change and ignorance. It is because knowledge is imperfect or changes imperfectly foreseen that it is necessary to perform the six managerial functions. A large percentage of the problems created by change and ignorance and encountered in running a business are not repetitive in nature. Such problems occur but once, and the managerial tasks must be repeated for

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[1] Johnson, Glenn, "Managerial Concepts for Agriculturalists," (Kentucky Agricultural Experiment Station, University of Kentucky, Lexington, July 1943, Bulletin 619) p. 14.

each problem. Thus, the manager handling such problems repeats the managerial tasks over and over again without the acquisition of personal capacities or skills having repetitive value and it is said that he is managing the affairs of his own business."[2]

Continuing, there is a distinction between management and labor, or an acquired skill.

"When a hired man who does not know how to handle a grain-combine decides to acquire such ability, it is necessary for him to perform the six managerial functions discussed---. Thus, in managing his own affairs ---a hired man is performing managerial actions. Once, however, this ability is acquired he becomes a more skilled laborer. The return for his managerial activity is the skill which he acquires--he acquires a worthwhile asset (a new skill) as a result of his managerial action. When he sells the use of this asset to the farmer employing him, he is not selling managerial services--he is selling skilled labor. His wages are a return on this asset--net returns to his management. The skill itself was the return for his managerial actions."[3]

Having defined management and shown how it differs from labor, it is observed[4] that there are five problem areas which continually face management.

(1) Price structure and changes.
(2) Production methods and response (including weather effects).
(3) Prospective technological development.
(4) The behavior and capacities of people associated with farm businesses.
(5) The economic, political, and social situations in which a farm business operates.

Management, then operates without certainty and must formulate expectations based upon present knowledge to develop plans for future farm organizations.

E. O. Heady states that management can be broken down into two distinct activities; co-ordination and supervision.[5] The activity of supervision is fairly self explanatory. It is the activity of seeing that the plan which has

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[2]Ibid., p. 12

[3]Ibid., p. 13

[4]Ibid., p. 24

[5]Heady, E. O., "Economics of Agricultural Production and Resource Use," (Prentice-Hall, Inc., New York: 1952) p. 465.

has been formulated is carried out. This is usually considered a somewhat lesser activity than the coordination activity of management.

The need for coordination grows out of the inability to predict the future with certainty. The fundamental role of coordination accordingly breaks down into four parts. First, there is the formulation of expectations of conditions which will prevail in the future. This task must be done before investment is made, or production plans are ready to be put into action. Secondly, after expectations of the future have been established, a plan for production must be formulated which is logical and consistant with expectations. In other words, decisions must be made. Third, the production plans must be put into operation. Lastly, the manager must accept the responsibility of the economic consequence of the plan.

With perfect knowledge the management role would be reduced to the supervision role once the original plan was formulated. This is so because once a plan was laid out it would specify the manner in which resources should be combined at each point of time, for each variable in the production function, for each change in techniques, and each price change. After this plan was laid out, only supervision would be required to see that the plan was carried out.

Expectations

One purpose of this study is to evaluate a specific expectation model in planning farm organizations. When a manager formulates expectations about the coming year, there are many things that influence these expectations. Certain work done in the area of expectations relates to planning and provides guidelines for study such as this.

Based upon information of how farmers form their expectations several different types of planning models have been considered.

Although expectation models have been discussed in economic literature since the works of Alfred Marshall, the modern approach to the role of expectations in decision making process is generally attributed to Frank H. Knight in his 1921 publication, Risk, Uncertainty and Profit. Subsequently, two of his disciples, Hart and Hicks, made contributions. Hart wrote an article entitled, "Anticipation, Business Planning and the Cycle," in the Quarterly Journal of Economics, Volume 51, 1936-37. He also wrote another entitled, "Anticipations, Uncertainty, and Dynamic Planning" in the Studies in Business Administration, Volume 11, 1940. Hicks made his contribution in his 1939 publication, entitled Value and Capital.[6]

Some of these newer models to be developed are; supply models, supply-demand models, government action models, business activity models, and demand models.

Furthermore, the importance of expectation models is illustrated as follows:

> The capacity to formulate images of the future in decision making varies with farmers and may determine the success or failure of the farming operations. Still all farmers use some kind of framework to formulate expectations to guide them in gleaning all the information available and show them how the information is to be used. These frameworks may be called: "expectation models."[7]

This study is also concerned with how past events can be used to formulate decisions and plans. Managers use the knowledge of past years in formulating their expectations of future prices, yields, and other events. What is not known however, is how much influence each respective year of the past has upon these expectations.

Models Used In The Study

Two different models are used to study the role of expectations in decision making. One is a "perfect-knowledge" model in which prices, yields,

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[6]Partenheimer, Earl J. and Bell, Robert D., "Managerial Behavior of Farmers in Formulating Expectations of Future Events," A Study of Managerial Processes of Midwestern Farmers, p. 86.

[7]Ibid.

and technology are known for each of the years studied. This represents the most desirable situation and shows what could happen if prices and yields were known, and assembled into a plan. The other model used, was a year-by-year planning model in which prices and yields in year n + 1 are expected to be identical to those in year n[7].

Results of the two models were then compared with an actual case farm's organization to see how each model compared to the actual situation.

The year-to-year model is based upon much the same logic as the "cobweb theorm". This theorm is a projection of current yields and prices into the next production period. When a large number of farmers employ this model and base plans upon it, the result is cycles for hogs, cattle and other commodities. Commodity cycles in agriculture do not follow the regularity expressed in the "cobweb theorm" because production and supply functions also involve variability and uncertainty. "However presence of commodity cycles is proof that the majority of farmers do employ the extension model."[8] Thus, we see the importance of current events in formulating expectations, and the relevance of the second model.

Benefits

This study has several possible benefits. One benefit is information on the influence of knowledge of prices and yields on resource use and returns. Much work has been done in this area, and still relatively little is known about the impact of various expectations on organization and resource use on

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[7]Walker, Odell L. and Martin, James R., "Research Opportunities and Techniques," Journal of Farm Economics, Volume 48: p. 1922-1931, December 1966.

[8]Heady, Earl O., "Role of Management and Expectations in Resource Administration," Economics of Agricultural Production and Resource Use, p. 483.

farms. Secondly, by showing the value of perfect-knowledge, a manager may be stimulated to analyze conditions better that affect future events and thus improve the formulation of his plans. A farmer will probably never attain perfect knowledge of many future events but improved knowledge might increase the reliability of his expectations.

Present throughout the above discussion has been the idea of an "increased", or a "greater" degree of accuracy. A study of this type can do this by adding to the knowledge of the role of expectations and by showing the need to improve the formulation of expectations.

Objectives

The objectives of this study are:

(1) To estimate the influence of perfect knowledge upon the organization, resource use, and income of a plan.

(2) To evaluate a year-to-year expectation model on resource use, organization, and income.

(3) To compare results under these models with those from an actual farm.

DATA

Time Period

The data[9] used was for the years 1950 through 1956. This however, is part of a larger study including years 1950 through 1964. The reason this set of data was chosen was because a complete set of data was available beginning with 1950. To show the pay-off to good management, it is only necessary to pick a series of years to compare results among alternative models. The 1950's were, however, not a typical decade as far as cattle prices and weather conditions are concerned.

Case Farm

Organization and size of enterprises of a farm, that kept records under the Kansas Farm Management Association program, was used as a basis for the enterprises and resource restrictions for both the perfect-knowledge and year-to-year model. This farm is located in central Kansas and was representative in terms of size, ownership, and organization of many farms in the region. The farm is in an area where rainfall can be adequate in some years but lacking in others. This is in contrast to both western and eastern Kansas. In western Kansas, rainfall is usually scarce and managers plan accordingly. In eastern Kansas, rainfall is more dependable. In central Kansas, however, farmers must take into account larger variability in rainfall. As a matter of fact, crops

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[9] Data used was compiled from Kansas Farm Management records as compiled by Dr. Dale Knight.

in 1951 flooded out, but by the mid-1950's, the region was in drought. This, therefore, complicates the job of management somewhat over the two other areas of Kansas because of the various plans that can be made due to weather conditions alone. This area of Kansas represents a challenge to management because of the uncertainties which are present there.

Supplement Data

Information published by the Kansas State Board of Agriculture[10] about yields, prices, etc., were used when such data were not given in the Farm Management records.

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[10]Kansas Board of Agriculture, Farm Facts, 1950-1956 (Topeka, Kansas: State Printing Office, 1950-1956).

ANALYZING THE PROBLEM WITH LINEAR PROGRAMMING

Perfect Knowledge

Analytical Tools Used

Linear programming is used to analyze the problem. The perfect-knowledge model is a multiperiod linear programming model, Figure 1. In this model, the objective function is:

$$\text{MAX } Z = \sum {}^{n}C_{j}^{n}X_{j}^{n}$$

$$\text{subject to } \sum A_{ij}^{n}X_{i}^{n} \leq B_{i}^{n}$$

$$\text{and } X_{i} \geq 0 \text{ for all n}$$

Where C_{j}^{n} is gross income minus variable cost for "i"th enterprise in year n, A_{ij}^{n} is the "i"th resourse required for "j"th enterprise in the year n, X_{j}^{n} is the "j"th enterprise in year n and B_{i}^{n} is the "i"th resource available in year n.

An abbreviated matrix for the model is shown in Figure 2.

Explanation of the Matrix

Restrictions. The land is classified into owned and rented cropland, pasture, alfalfa, and wheat allotment. Cropland is divided into that available for spring or fall planted crops which is necessary to describe crop rotation over time. Land planted to wheat in one year cannot be planted to corn or grain sorghum the following year but is available the second year after the year in which wheat is planted.

Labor is classified into total labor for May, June, July, August,

$$\text{Max } Z = \sum_{i=1} C_j X_j^i$$

Subject to

$$\begin{array}{lll}
A_{11}X_1 + A_{12}X_2 + \text{---} + A_{1n}X_n & & \leq B_1 \\
A_{11}^1 X_1^1 + A_{12}^1 X_2^1 + \text{---} A_{1n}^1 X_n^1 & & \leq B_1^1 \\
 & A_{11}^n X_1^n + A_{12}^n X_2^n + \text{---} + A_{1n}^n X_n^n & \leq B_1^n \\
 & & \leq B_2 \\
A_{21}X_1 + A_{22}X_2 + \text{---} K A_{2n}X_n & & \leq B_2^1 \\
A_{21}X_1^1 + +7_{22}^1 X_2^1 + \text{---} + A_{2n}^1 X_n^1 & & \leq B_2^1 \\
 & A_{21}^n X_1^n + A_{22}^n X_2^n + \text{---} + A_{2n}^n X_n^n & \leq B_2^1 \\
 & & \leq B_n \\
A_{n1}X_1 + A_{n2}X_2 + \text{---} + A_{nn}X_n & & \leq B_n^1 \\
A_{n1}^1 X_1^1 + A_{n2}^1 X_2^1 + \text{---} + A_{nn}^1 X_n^1 & & \\
 & A_{n1}^n X_1^n + A_{n2}^n X_2^n + \text{---} + A_{nn}^n X_n^n & \leq B_n^n
\end{array}$$

Figure 1. Perfect knowledge model.

Resources	Producing Activities	Buy Land	Lot Development	Transfer Fixed Capital	Transfer to Capital Replacement	Save	Borrow Working Capital	Borrow Fixed Capital	Borrow Living Expense	Buy Machinery
Year 1										
	C_j	-T	-T			.04	- .04	- .04	- .04	T, D, I*
Land	a	-1								
Lot Development			-1							
Labor	a									
Working Capital	a									-a
Fixed Capital		a	a	1						
Fixed Cost Living Expense	+a	-a	-a		-1	-1				-a
Save						- .92	1	1	1	
Year n										
Land		-1								
Lot Development			-1							
Labor										
Working Capital							-1			
Fixed Capital		-a	-a	-1				-1		
Fixed Cost Living Expense		-a	-a						-1	-a
Unused Machinery		1							-1	
Capital Replacement					.92					-a

*Taxes, depreciation, interest

Figure 2. Perfect knowledge matrix.

September, and total labor for the year. Labor available on the representative farm is that of one full time person throughout the year with additional summer labor provided by other members of the family. Labor can be hired on a monthly basis for June, July, and August, on a seasonal basis of May through October and on a fulltime or yearly basis.

Fixed costs do not effect the selection of most profitable enterprises[11] but do influence the accumulation of capital for re-investment. Two equations for each period are used to describe the fixed cost requirements of the farm; those which must be met each year as family consumption, taxes, insurance, interest and mortgage repayment; and those which must be met sometime during the period, such as replacement of machinery and buildings.

Family consumption items are food, housing, clothing, household operation and miscellaneous expenses estimated to be $3,600 per year per family of four members.[12] Land taxes, debt repayment, insurance, and interest are estimated to be $3,000 per year for this representative farm. An estimated $8,400 is needed to meet the capital replacement of machinery and building during the 1950-57 period on this representative farm.

Capital resource is classified into long term and working capital. Long term capital is net assets in land and buildings; and working capital is net assets in livestock, machinery, supplies, and accounts receivable. Long term capital is required when land is purchased or when feed lot capacity is increased. Working capital is required for operating expenses; fuel, oil, repairs, seed, fertilizer, and pesticides of crop enterprises, and feed, supplement, veterinary and purchase of cattle in the livestock enterprises.

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[11]Henderson, James M. and Quandt, Richard E., "Microeconomic Theory a Mathematical Approach", (Mograw Hill Book Co. Inc., New York: 1958) p. 53.

[12]Correll, Mrs. Myrtle, "Farm Income and Living Costs 1946-50," Agriculture Experiment Station, Kansas State College, Manhattan, Kansas Bulletin 363, p. 32.

Three equations describe the nutritional requirements of livestock each year. These equations are for forage, grain, and protein requirements. Forage requirements are met by either alfalfa hay, sorghum silage or prairie hay which can be produced or purchased. Grain requirements are met by either grain sorghum or corn, which can be produced or purchased. All crops fed provide protein to meet livestock requirements, but a protein concentrate can also be purchased.

Enterprises

The "C_j" row represents total revenues minus variable cost for each enterprise for each year. In models used in the study, values in the objective functions are not discounted values and thus, the concept of the present values of the future earnings is not used. Discounting is not done because the plan made in the first year is not the same for all seven years. Instead, each year is a new decision making situation for the manager, and the model is used to evaluate the optimal organization for a sequence of years.

The producing activity in Figure 2 requires land, labor, and working capital and is representative of the many crops and livestock producing activities appearing in the model. Producing activities add an amount equal to net return to the living expense row which is used to meet fixed cost.

The producing activities in the model are wheat grown on owned and rented acres produced for sale, grain sorghum grown on owned and rented acres and produced for sale or feed, sorghum silage grown on owned and rented acres produced for feed, alfalfa grown on owned and rented acres produced for feed, and corn grown on owned and rented acres produced for sale and feed.

The value in the objective row for the land purchase activity is interest and taxes for each acre added, and one acre of land is added to land

owned in the year in which it is purchased and all succeeding years. The acre of land purchased requires long term capital to finance the purchase of it in the year in which it is purchased but in succeeding years annual land mortgage payments add to annual long term capital. In this way, total assets remain the same in the year of purchase and the capital used to buy the land in one year is not available as collateral to buy land again in following years unless repayment has occurred. The capital asset used to buy the land is converted into another asset with the value of total assets remaining constant. If land is purchased then, the fixed costs increase by the amount of annual mortgage repayment, interest and annual taxes. Land mortgage repayment is based on a 20-year loan and a 4 percent interest rate.

Lot development is set up similar to the land purchase activity except that the mortgage repayment is based on a 10-year loan.

Transfer activity transfers unused fixed capital from one year to the next, thus, fixed capital not used to purchase land in one year is transferred to the next and is available the following year.

An activity to transfer income in excess of living expense and fixed cost to a machinery depreciation equation is included to meet the depreciation of existing equipment. The model does not require that a fixed amount of machinery depreciation be paid every year, but that depreciation must be met some time during the period.

Income not used for production expenses, fixed costs, and living expenses in a given year is placed in savings for future use with an eight percent reduction in value. This reduction is based on the amount of income tax liability on each dollar of the objective function placed in savings. This estimate of eight percent is based on calculating the amount of income tax liability on net farm income minus personal exemptions minus the ten percent

standard deduction and then relating the tax liability to income as used in the objective function.

Funds not used to meet fixed costs are added to savings of that year and are available in the following years to meet living expense, fixed cost, working or fixed capital requirements. Savings if not used in following years earn four percent interest as the opportunity cost of non-farm use of income.

Three borrowing activities, take funds from savings of one year to meet working capital, long term capital, or fixed costs requirements of the following year. The cost of using savings is four percent, which is the opportunity cost of non-farm use.

An assumption was that machinery was available to farm eighty additional acres. If more than eighty acres of land is purchased, additional machinery must also be purchased. An "acre unit" is the machinery necessary to properly farm an acre of land. This is a mixture of machinery as opposed to one more specific piece of equipment. The cost to the net revenue row is the sum of taxes, depreciation and insurance of additional machinery purchased.

Year-to-Year Model

The model used for the year-to-year expectation model is shown in Figure 3. Each matrix includes two years such as 1950-51, 1951-52, ----1955-56. The first year in each matrix is always the current year's operation, and the second year in the matrix is the plan for the following year. For example, the optimal enterprises for year 1951 are selected in 1950-51 model based upon prices and yields expected to exist in 1951.

Max Z =

Subject to

$$A_{11} X_1 + A_{12} X_2 + \cdots + A_m X_n \qquad A^1_{11} X^1_1 + A^1_{12} X^1_2 + \cdots + A^1_{1n} X^1_n \qquad \leq B_1 \qquad \leq B^1_1$$

$$A_{21} X_1 + A_{22} X_2 + \cdots + A_{2n} X_n \qquad A^1_{21} X^1_1 + A^1_{22} X^1_2 + \cdots A^1_{2n} X^1_n \qquad \leq B_2 \qquad \leq B^1_2$$

$$A_{n1} X_1 + A_{n2} X_2 + \cdots + A_{nn} X_n \qquad A^1_{n1} X^1_1 + A^1_{n2} X^1_2 + \cdots + A^1_{nn} X^1_n \qquad \leq B_n \qquad \leq B^1_n$$

Figure 3. Year-to-year model.

Explanation of the Matrix

Crop and livestock producing activities are the same as those listed for the perfect-knowledge model, as are the resource quantities, with the following exceptions: when land is purchased, the increase in land owned is added to successive years by increasing the acreage of owned land. This same principle holds for lot development.

The capital replacement equation is not included in this model because each matrix consisted of too few years to require capital replacement to be included in the program.

Funds not used to meet variable costs, fixed costs, or living expenses are added to savings of that year. These savings earn four percent as the opportunity costs of non-farm use of income. Funds in savings are available for use in following years, i.e., suppose that a certain sum of money is saved in 1950, in the 1950-1951 model. This amount is then available to the organization for 1951 in the 1951-1952 model. Savings from 1950 are included in the resource restrictions in the 1951-1952 model.

The three borrowing activities take funds from the savings of the previous year to meet working capital, fixed capital, or living expense and fixed cost requirements of the current year. The cost of using savings is 4 percent, which is the opportunity cost of non-farm capital use.

In this model, the assumption is also made that machinery capacity is available to farm eighty additional acres as was discussed previously. If more than eighty acres of land was purchased, more machinery would be required.

Living expense in this model is estimated the same way as it is in the perfect-knowledge model.

Case Farm

The enterprises used in the case farm are wheat, corn, sorghum silage, grain sorghum, alfalfa, pasture land, and crop land. Livestock enterprises are not studied because data were not available. The acreages of crop enterprises are compared with the organizations formulated by the models.

RESULTS

Tables 1 and 2 give the actual prices and yields for crop and livestock enterprises for the case farm. These prices and yields are used in the perfect-knowledge model and year-to-year planning model.

Table 3 shows optimal organization from the perfect-knowledge model, Table 4 shows the optimum organization from the year-to-year model, and Table 5 shows the data used for the case farm. There are a limited number of enterprises listed in Table 5 because this was the only data available.

Perfect-Knowledge Model

Farm Organization

Wheat did not enter the organization until 1952 in the perfect-knowledge model, because this model reflects the flood of 1951. Wheat is planted in 1952, increases in acreage through 1954, and acreage then declines because of dry weather.

Grain sorghum does not become part of the organization because of low yields as hybrid grain sorghum varieties were not generally available until after the mid-1950's.

Corn is planted in 1950 and 1951 to take advantage of the soil moisture available resulting in higher corn than grain sorghum yields.

Grain sorghum is purchased to provide feed for cattle when the corn enterprise is discontinued as a part of the optimum organization.

Size of the cattle enterprise varies in numbers because of price changes and feed available, but in 1952 returns to both grass fed calves and

Table 1. Prices and yields of crops by year as given in records available for the representative farm.

Year	Wheat		Grain Sorghum		Sorghum Silage		Alfalfa		Corn	
	Price (bu)	Yield (bu/ac)	Price (bu)	Yield (bu/ac)	Price (ton)	Yield (ton/ac)	Price (ton)	Yield (ton/ac)	Price (bu)	Yield (bu/ac)
1950	2.02	6	1.07	38	7.6	18	18.2	2.3	1.43	40
1951	2.13	11.4	1.32	23.1	10.0	8.7	23.0	1.3	1.73	45
1952	2.14	1.45	13.3	13.3	19.0	4.0	31.4	2.4	1.53	10
1953	2.11	16.4	1.27	17.1	12.0	8	25.6	0.6	1.48	15
1954	2.18	1.25	9.4	11.0	2.0	2.0	23.0	2.5	1.48	9.9
1955	2.06	10.8	1.0	7.2	12.0	2.0	20.3	1.0	1.39	9.0
1956	2.00	12.3	1.22	7.5	16.0	2.2	25.5	0.5	1.35	6.5

Source: Kansas Farm Management Program records and information published by the Kansas Board of Agriculture.

Table 2. Prices received for classes of livestock by year.

Year	Deferred Steers ($/100)	Grass Fed Calves ($/100)	Deferred Yearlings ($/100)
1950	32.92	32.92	30.98
1951	34.78	34.78	31.73
1952	30.65	30.65	25.54
1953	23.00	23.00	18.80
1954	24.77	24.77	21.00
1955	20.23	20.23	17.61
1956	22.54	22.54	18.99

Source: Monthly prices per 100 pounds Kansas City 1946-65 as obtained from USDA Marketing Service, Kansas City, Missouri.

Table 3. Size of enterprises, capital requirements, and incomes by year given as most profitable by the perfect-knowledge model.

Enterprises	Units	1950	1951	1952	1953	1954	1955	1956
Wheat	Acres			96.0	204.2	216.2	184.2	199.0
Grain Sorghum	Acres				165.4			
Sorghum Silage	Acres	25.8		230.8	54.4	177.8	127.2	224.8
Alfalfa	Acres			30.0		30.0	30.0	
Corn	Acres	470.1	424.0					
Prairie Hay Purchased	1,000 lbs.					497.0		
Grain Sorghum Purchased	1,000 lbs.			539.8	50.7	940.2	190.4	209.2
Deferred Steers	No. of Head	107.6	411.0		111.4	411.0	94.0	
Grass Fed Calves	No. of Head			290.4				120.2
Long Term Capital		$ 2103	$ 540	0	88	250	0	250
Working Capital		6986	32326	27615.75	7138	30200	6986	8745
Living Expense		6400	6800	6200	6100	6100	6100	6100
Net Income		31778	56792	16554	6154	27277	-1157	4764

deferred steers are equal. However, deferred steers require more labor than grass-fed calves; therefore, grass-fed calves replace deferred steers in the optimum organization for 1952.

The changes in size of the cattle enterprises points out a very interesting aspect to optimal planning. Optimum size of enterprise can vary greatly as in 1951 and 1954 the beef enterprise is largest with 411 head but smallest in 1955 with 94 head. It is more than just a matter of reaching an "optimum size" or having constant growth in size, but to have optimal combinations and sizes of enterprises to achieve maximum profit. The optimum size of the enterprise is not necessarily the largest possible with the available feedlot facilities. This illustrates the importance of the managerial function in determining the most profitable size each year.

Long term capital used in this model declines from 1950 through 1952. Long term capital is used for purchasing land and increasing feedlot capacity. After the flood in 1951, 1952 is not a good time to buy land, and because of dry weather and low cattle prices, profits in 1955 were low so purchasing land is not profitable either.

Variation in working capital use is due to the fluctuation in the number of cattle fed each year in the optimum organization. A large proportion of the working capital used in the organization is for the cattle enterprise, and enterprises furnishing feed for the cattle enterprises.

Expenses remain constant except for the increase in mortgage payments, taxes, and interest from buying land and feed lot development.

Net income in Table 3 is the value of the objective function for each year minus property taxes, insurance, interest, machinery depreciation, and mortgage repayment from land purchases and feedlot development. Subtracting these values from the objective function, a figure is derived which is

comparable to net income reported by the case farm. Annually, an estimated $2800 is needed for the taxes, insurance, and interest, $1200 for machinery depreciation, and to this amount is added mortgage repayment, interest and taxes of land and machinery purchase.

Because of good moisture and prices, especially for cattle, income is high in 1950 and 1952. Dry weather caused net revenue to decline after 1952, but higher cattle prices in 1954 caused income to increase but decrease in 1955 because of dry weather and a decline in cattle price. In 1956, cattle prices increased again causing net revenue to increase also.

Year-to-Year Model

Table 4 gives results of the year-to-year model. In 1950, 264 acres of wheat are planted, but in 1951 no wheat is planted because the expected yield in 1951 is zero as the 1950 crop was destroyed by flood. Since expected yield of wheat in 1951 is zero, it was more profitable to plant corn in 1951, thus, wheat can not be planted until 1952. After 1953 wheat and grain sorghum replace corn as weather conditions made them profitable. Only a small acreage of grain sorghum, however, is planted in 1950 and 1954 because in the early 1950's high-yielding hybrid varieties are not available.

Grain sorghum is purchased for the cattle enterprise after corn became less profitable to raise than wheat.

Size of the cattle enterprise in this model is largest in 1952 (240 Head) and smallest in 1954 (42 Head). This decline is caused by the expectation that drought would continue, causing a decline in feed production and expected decline in cattle prices.

Use of fixed capital declines in 1951 but rose in 1952 because the expected return to land is high and thus land investments appeared profitable.

Table 4. Size of enterprise, capital use and income by year for the year-to-year planning model.

Enterprises	Units	1950	1951	1952	1953	1954	1955
Wheat	Acres	264.0			62.0	135.0	164.5
Grain Sorghum	Acres	50.0				13.0	
Sorghum Silage	Acres	21.5	25.5		74.1		150.3
Alfalfa	Acres		22.0	30.0	27.8	30.0	30.0
Corn	Acres	44.4	199.0	371.0	190.6	223.0	
Prairie Hay Purchased	1,000 lbs.	129.0	271.4	800.0		1.33	35.5
Grain Sorghum Purchased	1,000 lbs.	35.3	0.3		115.8	104.5	209.1
Deferred Steers	No. of Head		224.0	240.0		42.0	84.0
Grass Fed Calves	No. of Head				118.0		
Deferred Yearlings	No. of Head	104.0					
Fixed Capital		$ 2103	$ 540	$ 2976			
Working Capital		10551	14452	31611	$10518	$ 458	$ 699
Living Expense		6400	8377	6763	11273	17869	14995
Net Income		9497	38227	-2770	-1677	5205	-1305

Total Net Income $47,157

In this model income is inadequate to permit expansion of feedlot facilities or buy land after 1952.

Errors in expectations cause investments in land, feed lot and livestock which are very unprofitable in some years. Thus, for years after 1952, net income is often inadequate to meet living expenses, fixed costs and mortgage repayments. For such years, it is necessary to provide additional capital--over and above the amount available from net income from enterprises and capital available to the representative farm. This problem approximates a situation of insolvency which was not uncommon to many farms during the mid-1950's.

Working capital use increases from 1950 through 1952 because of expansion in size of the cattle enterprises and purchase of feed. Also, in 1952, 371 acres of corn are planted which require a large amount of working capital.

Expenses remain fairly constant until 1953 when they increase because of mortgage payments on land purchases and feed lot development.

Net revenue is high in the early 1950's because of high prices for crops and livestock sold and favorable weather conditions. In 1952, net revenue is negative because of dry weather causing low yields and it is low in 1953 because of low cattle prices. Because plans for a given year are based on previous years prices and yields, adjustments in the organization are in error causing a decline in net revenue. Net revenue increase in 1954 due to increasing cattle prices and production of wheat, but decline sharply to a negative amount in 1955 due to expectations for 1955 being different from the actual situations.

Case Farm

Table 5 shows actual land use on the case farm. The largest acreage of wheat is planted in 1950 but decreases in 1951 and 1952. Wheat acreage is large again in 1953 and then decreases again because of either drought or a decrease in wheat allotments. Low wheat yields and prices are the cause of adjustments in wheat acreage in the two linear programming models but the decrease in wheat acreage on the case farm could also have been because of a decrease in allotments, but this information is not available.

Corn is not planted on the case farm after 1952 because of dry weather. Grain sorghum is not included in the organization because of relatively low productivity of the varieties available.

Alfalfa acreage remains at a fairly constant level, in contrast to the acreage under the linear programming models because it is not practical to plant and destroy alfalfa each year.

Sorghum silage replaces corn grain produced on available crop land as part of the ration for beef.

Table 5. Size of enterprise and net income by year actual, for the case farm.

Enterprises	Units	1950	1951	1952	1953	1954	1955	1956
Wheat	Acres	264.0	156.0	166.0	257.0	189.0	157.0	172.0
Corn	Acres	50.0	60.0	75.0				
Sorghum Silage	Acres	35.0			42.0	20.0	116.0	65.0
Grain Sorghum	Acres	115.0						
Alfalfa	Acres	22.0	16.0	30.0	40.0	30.0	30.0	30.0
Pasture	Acres	340.0	340.0	358.0	416.0	416.0	414.0	400.0
Crop Land	Acres	474.0	476.0	373.0	385.0	386.0	388.0	403.0
Net Income	Dollars	11833	5583	1436	2264	10276	-4247	3050

Source: Kansas Farm Management Program records.

Comparison of Results

Changes in Organization

Comparing Tables 3 and 4 there are 17 changes between enterprises in the optimum farm organization for the year-to-year model and 16 changes for the perfect-knowledge model. Table 5 shows that the case farm changed from one enterprise to another only four times but information about changes in the livestock enterprise is not available.

Apparently, the farm studied is using an expectation model different from the year-to-year planning model. Instead of just using the present years knowledge to form expectations, possibly an average of the previous three, four or five years is used in formulating his expectations. However, the corn and sorghum silage enterprises are discontinued on the case farm before the discontinuance is suggested under the year-to-year model. Wheat is in the case farm organization every year and varies in acreage from 264 acres in 1950 to 156 acres in 1951. Under the perfect-knowledge model, wheat is first produced in 1952 (96 acres) and increased to 204 acres in 1953. With the year-to-year model there are 264 acres of wheat in 1950, none in 1951, and 1952, and only 62 acres in 1953. The case farm produces sorghum silage in 1950 and from 1953 through 1956, varying in acreage from 20 acres in 1954 to 116 acres in 1955. Under the perfect-knowledge model sorghum silage is produced every year except 1951, but the acreages vary from 26 in 1950 to 231 acres in 1952. Under the year-to-year model sorghum silage is produced in 1950, 1951, 1953, and 1955, with acreages ranging from 22 in 1950 to 150 in 1952. While the year-to-year planning model suggests changes and the case farm makes some changes, they are usually made a year after they are in the perfect-knowledge model, and then the magnitude of change under the year-to-year model and on the case farm are usually

less than the changes suggested under the perfect-knowledge model as illustrated by changes in the size of corn and wheat enterprises.

It was wet in the early 1950's and corn grew well, but after 1951 there was less rainfall and it became more difficult to raise corn, and then wheat was more profitable. The perfect-knowledge model suggests a discontinuation of the corn enterprise for 1952 and a switch to wheat for cash grain, sorghum silage and the purchase of grain sorghum for feed for its cattle enterprise. The farmer did not discontinue the corn enterprise until 1953, one year after the perfect-knowledge model indication. In 1953, the farmer increased his wheat acreage and began planting silage. In the year-to-year model, corn is not suggested for years after 1954. It suggests the planting of less silage and the purchasing of less grain sorghum than does the perfect-knowledge model, because the year-to-year model indicates fewer cattle and produces corn for more years in the study than does the perfect-knowledge model.

Information is not available to make accurate comparisons between cattle systems in the models with the actual farm. A comparison of the two models for early years with respect to cattle enterprises shows the perfect-knowledge model indicates deferred steers while for the year-to-year model it is deferred yearlings, but the size of the livestock enterprise is the same for both models in 1950. The year-to-year model indicates a switch to a deferred steers enterprise in 1951. Under the perfect-knowledge model the size of the deferred steers enterprise increases in 1951. In 1952, the perfect-knowledge model suggests a switch to grass fed calves, while the year-to-year model suggests a continuation of deferred steers on the expectation that deferred steers would do well again, but suggests a change to a grass-fed calf enterprise in 1953. The perfect-knowledge model suggests deferred steers again for 1953 as well as for 1954 and 1955.

Changes in Size of Optimal Enterprises

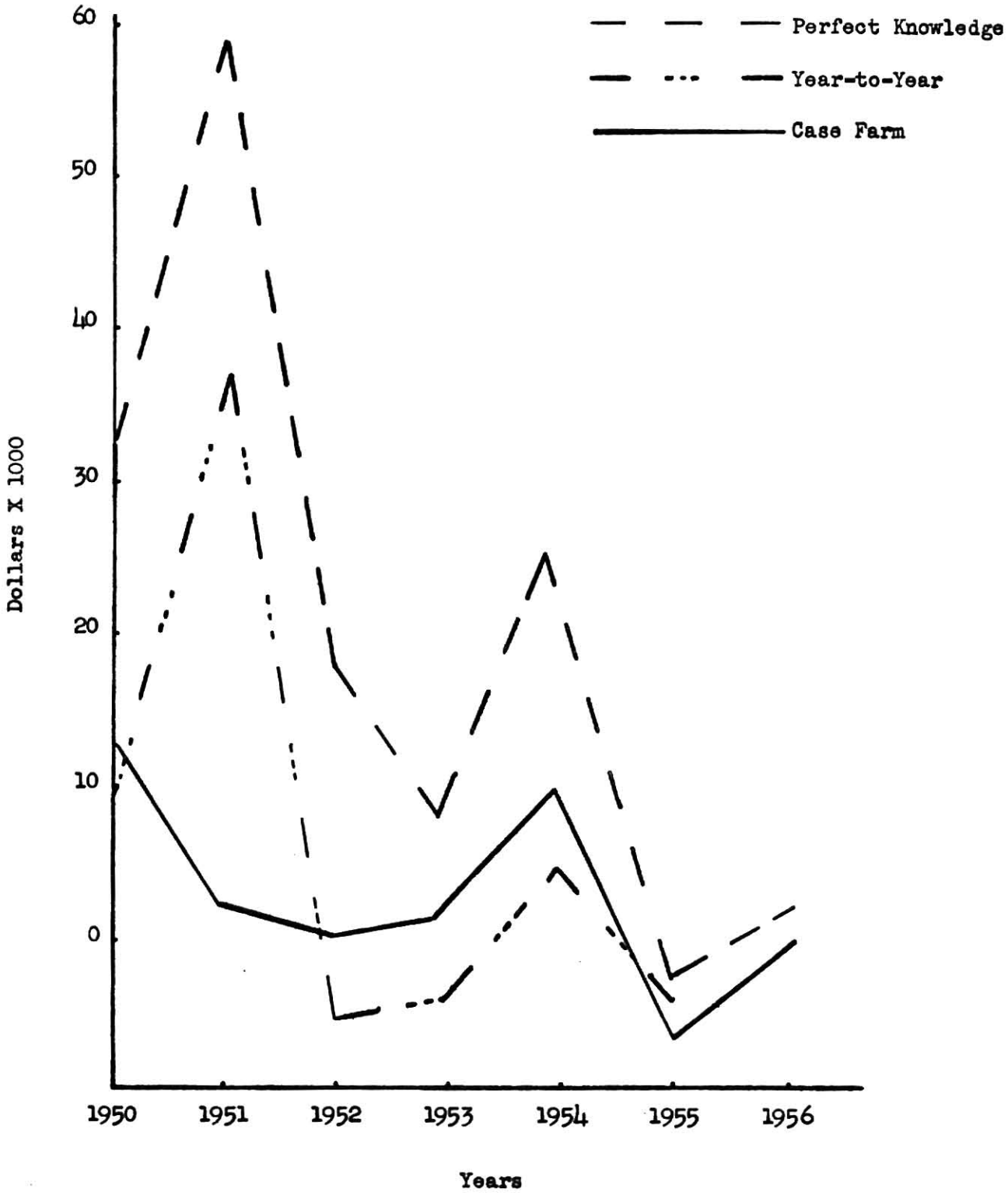
Suggested changes in the size of its crop enterprises are greater for the year-to-year model than for the perfect-knowledge model. Four hundred eleven head of cattle are suggested for 1954, but only 94 head in 1955. The year-to-year model suggests 240 head for 1952 and only 42 head for 1954.

Long term capital used under both models is the same in 1950 and 1951. In 1950 $2,103 is used and $540 in 1951 to buy land and increase lot capacity. In 1952 the year-to-year model suggests $2976 to buy land while the perfect-knowledge model indicates none. Under the year-to-year model neither additional land nor increased lot capacity are possible after 1952 because of limited income to meet mortgage payments and limiting fixed capital. The perfect-knowledge model suggests $88 in 1953, $250 in 1954, and $250 in 1956 to buy land and increase lot capacity.

Working capital use varies under both models but more is suggested in years with either favorable or expected favorable net returns. The perfect-knowledge model indicates a relatively large amount of working capital in 1951 while for the year-to-year model the amount is large for 1952.

Expenses increase under the year-to-year model because of increased indebtedness resulting from errors in planning optimum enterprises. Living expenses and fixed cost remain constant under the perfect-knowledge model.

Net revenue varies to a great extent for both linear programming models, Figure 4. Income for the perfect-knowledge model varies from a high of $45,972 in 1951 to a -$1157 in 1955. Income for the year-to-year model varies from $38,227 in 1951 to a -$2770 in 1952. Total net revenue for the period in the year-to-year model is $47,157; for perfect-knowledge model, $142,162; and for the case farm, $38,689. Net revenue for the case farm varies also, but while net revenue increases for both models in 1952, it decreases for the case


Perfect Knowledge
Year-to-Year
Case Farm
60
50
40
30
20
10
0
Dollars X 1000
1950
1951
1952
1953
1954
1955
1956
Years

farm. In 1953 net revenue for the case farm and the year-to-year model increase, while the net revenue for the perfect-knowledge model decreases. All three vary in the same way for later years. These are negative amounts in 1952, 1953, and 1955, for the year-to-year model while the perfect-knowledge model and the case farm have amounts which are negative amounts for 1955 only.

There is difficulty in comparing capital use under these models because capital is added under the year-to-year model from 1952 on, while income earned under the perfect-knowledge model is adequate to meet all requirements. For the perfect-knowledge model money is made each year and long term capital is used to buy land and increase lot capacity in 1953, 1954, and 1956, whereas under the year-to-year model this can not be done because of lack of income.

OBSERVATIONS

The results of the study point out the importance of forming accurate expectations about the future. While the farm, under the year-to-year model was in financial trouble in the later part of the study, under the perfect-knowledge model the farm increased in farm land size and in size of beef enterprise. Thus, growth of a farm buisness depends upon accurate estimation of the future prices and yields.

As agriculture becomes more complex it will become necessary for managers to develop systems to collect, work with, analyze, and use information in the operation of their farms. If a stable period with very few changes in prices and yields were to exist, the year-to-year planning model would approximate a plan much the same as the perfect-knowledge model. This may never be the case, because of the inability to control weather conditions and changes in demand for farm produce.

It is not unreasonable to hypothesize that the role of farm manager of the future may only be to survey and supervise. While a farmer will never achieve perfect knowledge, the returns to accurate expectations are large. It will become necessary to distinguish between the importance of "straightness of the row" and the "contents of the row". In other words, it will become the function of the labor to make "straight rows", and the function of management to determine "row width, plant population, fertilizer applications, etc." If a farmer operates the farm himself it will become increasingly important to separate the management function from the labor function and give each their proper importance.

SUMMARY

The objectives were: (1) to estimate the influence of perfect knowledge upon the organization, resources use, and income of a plan; (2) to evaluate a year-to-year expectation model regarding organization, resource use, and income; (3) to compare results under these models with those from an actual case farm.

Two linear programming models were used to analyze the problem. The first was a perfect-knowledge model covering years 1950-1957 with the objective function being:

$$\text{MAX } Z = \sum {}^{n}C_{j}^{n} X_{n}^{n}$$

$$\text{subject to } A_{ij}^{n} X_{k}^{n} \leq B_{i}^{n}$$

$$\text{and } X_{i} \text{ for all } t_{n} \geq 0$$

Where C_{n}^{j} is gross income minus variable cost for the "i"th the enterprise in year n, A_{ij}^{n} is the "i"th resource required for the "j"th enterprise in year n, and B_{i}^{n} is the "i"th resource available in year n.

The second model used was a year-to-year expectation model. This model was similar to the perfect-knowledge model except that this year-to-year model involved only two years in each matrix, such as 1950-1951, 1951-1952,---1955, 1956. The first year was always the current year's operation and the second year in a model was the year being planned for.

Perfect-Knowledge Model

Under the perfect-knowledge model, corn was planted in 1950 and 1957 to take advantage of good moisture conditions, but as conditions became dryer, wheat replaced corn. Cattle enterprise numbers varied from 411 head in 1954 to 94 in 1955 under the model illustrating the importance of considering not only optimal enterprises, but also optimal size of enterprises.

Fixed capital use declined from 1950 to 1952. Some fixed capital was used in 1953, 1954, and 1956. Working capital use varied with cattle numbers and feed enterprises, being high in 1951 and 1954. Expenses remained fairly constant for all years because fixed costs and mortgage payments remained relatively stable. Net income was high in 1950-1952 and 1954.

Year-to-Year Model

Under the year-to-year model, crop enterprises in the optimal organization varied, as did their size while cattle numbers were largest in 1952 with 240 head and smallest in 1954 with 42 head.

Fixed capital was used in large quantities in 1950 and 1952, but inadequate capital limited farm size increases after 1952. Working capital use varied with cattle numbers and feed enterprises under this model, which were largest in 1952 and 1954. Expenses remained fairly constant until 1953 when money was borrowed to meet mortgage payments. Net revenue was high in the early 1950's but declined in the following years, showing an increase for 1954.

The optimal farm organizations derived under the year-to-year model showed two more changes in crop and livestock enterprises than were derived under the perfect-knowledge model. Large changes in size of the cattle enterprises were made under the perfect-knowledge model, with 411 head in 1951 and 1954 and 94 head in 1955. The case farm did very little changing in either enterprises or size of enterprises.

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AN EVALUATION OF TWO KNOWLEDGE SITUATIONS ON FARM RESOURCE USE ON A REPRESENTATIVE CENTRAL KANSAS FARM

by

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B. S., Kansas State University, 1969

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

Planning the organization and operation of a farm business occurs in a setting of risk and uncertainty. To study the influence of various degrees of knowledge about future prices and yields, two knowledge situations are simulated in two linear programming models of a case farm situation representative of many central Kansas farms. The years 1950 through 1957 are included in the study.

Two multi-period programming models are used to analyze the importance of knowledge. One is a "perfect-knowledge" model in which each year is a sub-matrix of the 1950-57 matrix and actual prices and yields are used for each of the years. The analysis of the optimum farm organization for each year of the 1950-57 period is based on knowing in advance the prices and yields that occur each year.

The second model is a recursive, multi-period, linear programming model. Each matrix represents two years; the first year is the current year's organization and the second year represents the planning year. The organization of the current year is that specified as optimal using expected yield and prices. For example, in the two year matrix 1950-51, the 1950 sub-matrix used 1950 prices and yields, and the 1951 sub-matrix uses prices and yields expected for 1951. The optimal organization for 1951 is specified from the analysis of the 1950-51 model based on expected 1951 prices and yields and the organization for 1951 is then used as the current year in the 1951-1952 matrix. However, for the year 1951 in the 1951-52 model, actual, not expected, prices and yields are used. This second model is referred to as the year-to-year planning model.

Data from a central Kansas farm keeping records for the Kansas State Farm Management Association was used as a basis for the enterprises and restrictions for both models.

Results from the study are summarized below. Optimum organization of

enterprises for 1950-57 reported in the year-to-year model and the perfect-knowledge model made more changes among enterprises than the case farm did for the seven year period.

The year-to-year model changes size of its crop enterprises more than the perfect-knowledge model, but changes in size of the cattle enterprises are less than the perfect-knowledge model and less feed is purchased in the year-to-year model than the perfect knowledge model, although both models make large changes.

Perfect-knowledge model used long term capital to buy land in 1950 and 1951 whereas the year-to-year model purchased land only in 1952. The case farm did not buy land during the 1950-57 period.

Working capital use varied much from year to year in both models because of changes in actual or expected net returns.

Living expense and fixed cost, increased after 1953 through 1956 in the year-to-year model because of increased indebtedness resulting from errors in planning optimum organization. Living expenses and fixed cost remained constant after 1951 for the perfect knowledge program.

Although net revenue varied for both linear programming models, there was less variation in net revenue in the perfect-knowledge model than the year-to-year model. Total net revenue for the 1950-57 period in the year-to-year model was less than the perfect-knowledge model. Net revenue of the case farm varied also but while net revenue increased for both models in 1952, it decreased for the case farm. In 1953 net revenue for the case farm increased while it decreased in the two models. Net income for the three situations varied in the same way from 1953 through 1957.

While the year-to-year model was in financial trouble after 1953 the perfect-knowledge model increased firm size without financial problems. Thus, growth and survival of the firm depends upon accurate estimation of the future prices and yields.