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EC66-831 Linear Programming Applied to an Eastern Nebraska Farm

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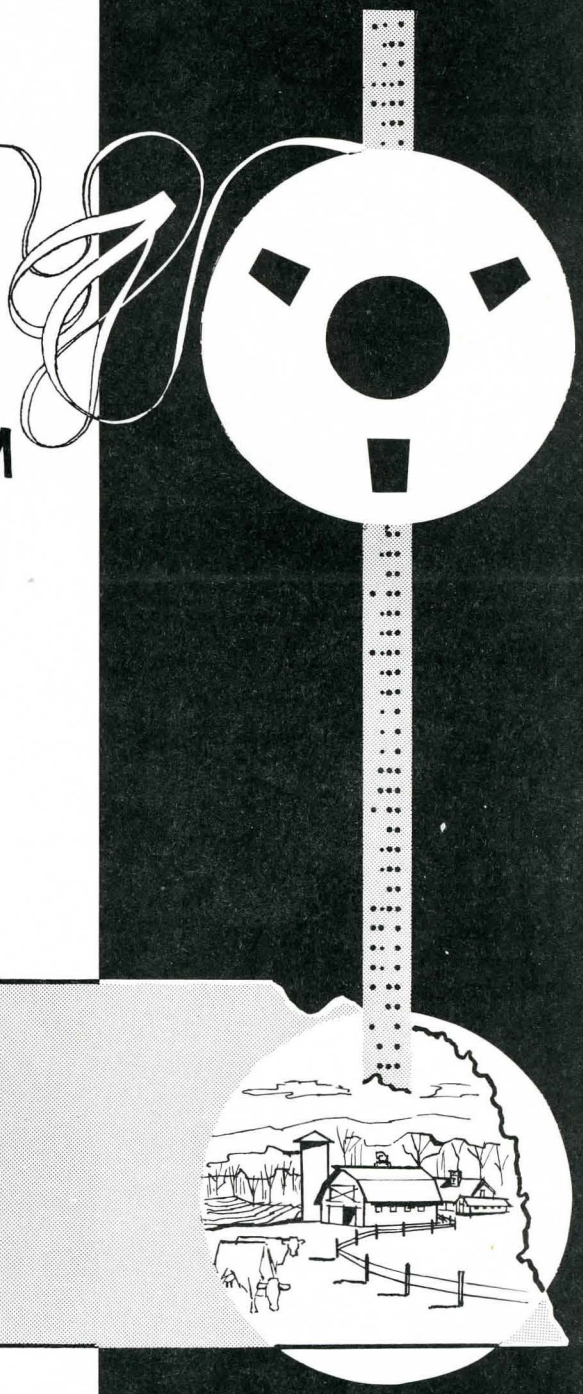
LINEAR PROGRAMING

applied to an EASTERN NEBRASKA FARM



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LINEAR PROGRAMING APPLIED TO AN EASTERN NEBRASKA FARM

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The application of linear programing to farm planning is a relatively new development. Agribusiness managers, farmers, ranchers and others are interested in using linear programing. Relatively few, however, know what linear programing is, or how they might effectively apply linear programing to their problems. Thus, this circular is to explain briefly what linear programing is and to demonstrate how it may help in developing a farm plan.

This discussion is not intended as a detailed linear programing instruction manual. It illustrates only the major steps involved in the development and use of a linear programed farm plan and answers the following questions:

1. What is linear programing?
2. What information is needed to linear program a farm plan?
3. How is this information used?
4. What results are obtained?
5. How can management use the results?

Previous knowledge of linear programing or advanced mathematics is not necessary for the reader to understand the application of linear programing to farm planning as presented in this circular.

What is Linear Programing?

Linear programing is a decision-making technique. The "answer" from a linear programing problem is only as accurate as the information available. Linear programing considers the resources available (land, labor, etc.) restrictions present (acreage allotments feedlots space, etc.) enterprises that are to be considered (corn, hogs, etc.). It then derives the combination of enterprises which will yield the highest possible return to the resources given.

When linear programing a farm plan, the goal is to make profits as high as possible. Linear programing has also been used extensively by industry as a tool for reducing costs. Many things farmers buy have been mixed according to a formula prescribed by linear programing. Feed, fertilizer, coffee, and sausage are examples. In a cost reducing problem, the costs and characteristics of all possible ingredients are determined and the requirements of the final product are set (minimum protein, maximum fat, etc, in the case of a feed mix). Linear programing selects the combination and amounts of ingredients which will meet the requirements at the lowest possible cost.

What Information is Needed to Linear Program a Farm Plan?

Information should be outlined as follows:

1. RESOURCES--Amount available and restrictions such as:
   a. Amount of land by land use cability.
   b. Labor, especially at peak labor periods.
   c. Capital--operating capital and borrowing limits
   d. Crop allotments, livestock space, storage space and other restrictions
   e. Management restrictions
2. ACTIVITY BUDGETS
   a. List enterprises that are feasible and fit the business
   b. List activities necessary to answer specific questions such as "Add Feedlot Capacity", "Buy Hay", "Sell Milo", "Hire Labor", etc.
   c. Develop activity budgets showing the returns, costs, and the resource requirements for each activity.

Linear programing forces the manager to consider thoroughly all aspect of the business and the questions to be answered. Thus, it forces him to: 1. organize relevant information and perhaps improve his methods of getting information, 2. clearly state his objective, 3. define the resources available, 4. define "restrictions" such as acreage allotments or feedlot space, and 5. "Think through" all realistic alternative crop and livestock enterprises and other activities.

How is this information used for Linear Programing?

The resources and activities are assembled in matrix form. A matrix is a table of rows and columns. The matrix is coded and the linear programing is solved by an electronic computer.

What Results are Obtained?

Linear programing results are important guides for better management decisions. A farm is obtained which yields the highest possible income to the resources given.

In addition to the highest profit plan, the electronic computer gives 1. the price ranges over which the highest profit plan will remain unchanged, 2. the amount income would be increased by adding an additional unit of a resource (1 acre of land), and 3. the amount income would be reduced if an enterprise which was not included in the highest profit plan were "forced" into the farm plan. This information gives the manager valuable information when he is considering expansion of the business or deviations from the plan.

How Can Management use the Results?

Risk, capital position, the family-farm life cycle, family demands and other factors affect the effective use of farm plans. The manager should keep such factors in mind as information is prepared for programing and the results are interpreted. A linear programing analysis will be profitable only if the manager can and is willing to put the results of the analysis to work. Thus, the manager must make the decisions which will lead to change.

Linear Programing a Case Farm

The Farm

The farm selected for this case example is on gently rolling upland in Eastern Nebraska. It is a crop-livestock farm with much of the feed produced being fed to hogs and cattle.

Based on personal observation and past records, the operator would be classed as "above average". He is in his late 30's and has a family, two members of which are boys. The oldest son is a junior in high school, and the younger son is nearing high school age. Both help on the farm during the school year and furnish a substantial portion of the farm labor during the summer.

The operator's planning objective is generally to make net income as high as possible, but there are some reservations. Year-to-year stability of income is desirable since farm real-estate mortgage payments and family expenses must be met. Thus, the operator is willing to engage in high risk enterprises on only a limited basis. An indication of this is his limit of 75 head of heavy feeder cattle. A further limitation is his unwillingness to hire labor.

The operator imposes no "internal" credit rationing. He is willing to borrow to the limit on a sound enterprise.

The operator is willing to build additional facilities, but the possibility of buying additional land was not considered.

This farm is now organized as shown in Table 1. The row crop land is planted to corn, 207 acres, and 100 acres to grain sorghum. Twenty acres of corn are used as silage for 190 head of feeder cattle. The hog operation on the farm now includes 18 sows. Additional facilities are needed for hog enterprise expansion. The income to fixed resources under the present plan is $27,087.

Fixed resources referred to include 1. land, 2. operator and family labor, 3. buildings, equipment, and machinery on the farm now and 4. general overhead expenses such as telephone, repairs, electricity, and taxes. The cost of fixed resources, such as machinery depreciation, must be met in the long

run, but this cost is considered fixed in the planning period we are considering. Thus, machinery is one of the fixed resources to which we are attempting to obtain returns which are as high as possible.

The Resources

Land - Seventy acres of land on this farm can be continuously row cropped. An additional 237 acres of row crops are rotated with alfalfa or small grain. The total land available for row crops each year is 307 acres. By virtue of the rotation, the plan includes a mandatory 40 acres of alfalfa and 20 acres of oats.

Labor - The operator does not care to hire labor, thus all labor is supplied by himself and his two sons. In Table 2, all months of labor are not shown. Only months in which labor is likely to be a limiting factor are used in the problem.

Capital - The operator's capital is currently "tied-up" in fixed assets--land, improvements, and machinery. Additional long-term capital can be borrowed for 6 per cent interest up to a limit of $15,000. All operating capital is borrowed at 7 per cent interest up to a limit of $40,000.

Feed - Three feed categories are listed. The quantity of each is zero. They may be thought of as "piles". The crop production activities add to the "pile" and the livestock activities consume from the "pile". For example, alfalfa production adds to the hay "pile" while various cattle feeding enterprises consume hay. If production is not enough, hay can be purchased for $20 per ton. Excesses can be sold for $18 per ton.

Table 1. Activities considered and the present farm organization

Activities	Present organization
Crop activities	
Grow corn for silage	20 Acres
Grow corn for grain	187 Acres
Grow grain sorghum	100 Acres
Grow alfalfa	40 Acres
Grow oats	20 Acres
Grow and sell soybeans	---
Cattle activities	
Str. calf-high roughage-Sept. Purch	60 Head
Str. calf-high roughage-Nov. Purch	---
Hfr. calf-high grain-Sept. Purch	40 Head
Hfr. calf-high grain-Nov. Purch	---
Yearling str.-high grain-April Purch	50 Head
Yearling str.-high roughage-Oct. Purch	40 Head
Swine activities	
Sow-Farrow in Dec. and June	9 Sows
Sow-Farrow in Jan. and July	9 Sows
Sow-Farrow in March and Sept.	---
Feeder pigs-Oct. Purch	---
Feeder pigs-Feb. Purch	---
Buy and sell activities	
Buy corn equivalents	---
Sell corn equivalents	8,192 Bu.
Buy hay	---
Sell hay	27 Ton
Borrow short-term capital	$38,943
Borrow long-term capital	---
Expansion activities	
Build feedlot	---
Build farrowing house	---
Build finishing house (1 unit = 15 head)	---
Income to fixed resources	$27,087

Table 2. Resources available on the case farm

Resources	Amount
Row crop land	307 Acres
Alfalfa land	40 Acres
Small grain land	20 Acres
April labor	376 Hours
May labor	376 Hours
June labor	580 Hours
July labor	580 Hours
Aug-Sept labor	956 Hours
October labor	376 Hours
Annual short-term capital[a]	$0
Short-term borrowing limit	$40,000
Long-term capital[a]	$0
Long-term borrowing limit	$15,000
Corn equivalents[a]	0 Bu.
Hay[a]	0 Ton
Silage[a]	0 Ton
Feed lot capacity	300 Head
Heavy cattle limit	75 Head
Farrowing house capacity	12 Sows
Finishing house capacity:	
(1 Unit = 15 pigs)	
Jan-Feb	10 Units
Mar-Apr.	10 Units
May-June	10 Units
July-Aug	10 Units
Sept-Oct	10 Units
Nov-Dec	10 Units

a/ These categories provide for the transfer of borrowed capital to individual enterprises, and the transfer of feed from crop enterprises to livestock enterprises or to feed selling activities.

Corn is handled in the same way. The selling price is $1.05/bu. and the purchase price is $1.15/bu.

Silage is not bought or sold. Only enough is produced to meet livestock needs.

Buildings and Lots - There is feedlot capacity for 300 head of feeder cattle.

An old farrowing house has space for 12 sows.

Hog finishing facilities are adequate for 150 head. For planning purposes, finishing hogs have been grouped in units of 15 head, thus, a capacity of 10 units.

Machinery - With the exception of a combine, the operator's present machinery is adequate for the crop and livestock activities considered. Custom combining was assumed as a part of the cash costs in the grain sorghum, oat, and soybean activity budgets.

Activities Considered

The next step was to consider all possible relevant enterprise activities which the operator might undertake. As a starting point, his present plan was reviewed. Table 1 shows the activities and the amounts of each included in the present plan.

One new crop activity was added: grow and sell soybeans.

Two beef feeding activities were added: steer calves on a high roughage ration purchased in November, and heifer calves on a high grain ration purchased in November.

Three swine activities were added: sows farrowing in March and September, feeder pigs purchased in October, and feeder pigs purchased in February.

Activities providing for the purchase and sale of hay and corn, borrowing short and long term capital, feedlot expansion, farrowing house expansion, and finishing house expansion were also included.

Raising sheep, poultry, castor beans, etc. were not considered relevant--given the likes and dislikes of the operator. He is interested in combining the enterprises listed in Table 1 with the resources listed in Table 2 in a way which will yield the most profit.

Develop Activity Budgets

Activity budgets were developed for each activity to be considered. Fertilizer and chemical costs for each crop were estimated from his past records. These records provided a general basis for estimating machine and power costs per acre or per animal. As shown in the sample activity budgets in Table 3, the labor requirements were needed by months. Only detailed enterprise accounts will yield this data.

Set Up a Matrix

Resources were listed in a column down the left side of the page and the activities were listed across the top of the page. Twenty-seven resources and 26 activities were listed.

Table 4 demonstrates how the requirements of an activity are listed on the lines corresponding to the resources used.

"Work" the Problem

This problem, run on a relatively small computer, required nine minutes of computer time.

Results

Results of the linear programed farm plan are shown in the second column of Table 5, entitled "Optimum Plan". The optimum, or most profitable, plan, indicates that all feed grain production would be grain sorghum. This is understandable as dryland sorghum has been outyielding corn by about 13 bushels per acre on this farm. Also, the additional cost of corn rootworm control adds to the cost of producing corn. As indicated earlier, the sorghum is custom combined. This uses less of the operator's October labor than does corn which he harvests himself. It will be shown later that October labor is a restrictive resource on this farm.

The mandatory 40 acres of alfalfa and 20 acres of oats are included in the plan.

Hog production is expanded in the most profitable plan to 26 sows farrowing in December and June, and January and July.

Slightly more cattle are fed in the most profitable plan as compared to the present plan. The most profitable plan favors feeding calves.

Fewer corn equivalents are sold under the most profitable plan. This is due mainly to expanded hog production. No hay is sold.

The highest profit plan expands hog facilities by building 14 units of farrowing house and 16 units (240 head) of hog finishing house.

The most profitable plan uses the $40,000 limit of operating capital. Expansion of hog facilities used the $15,000 of long term capital available.

The highest profit plan results in an income to fixed resources of $37,073 compared to $27,087 for the present plan.

Other Information

Other useful management information is also calculated by the computer. For example, the amount income would be increased if one additional unit of a limiting resource were added is given by the computer. As indicated in Table 6, an additional hour of October labor would increase income $30.98. Thus, the farmer would profit by putting in some "overtime" or by hiring some labor during this period. Labor in April and June also proved to be limiting, but would not merit the hiring of additional labor.

An additional acre of row crop land would add $28.73 to annual income. With land values at $275 per acre in the vicinity of this farm, the addition should be profitable. The computer also indicates that this level of added return will hold true through the addition of 11.0 acres. Addition beyond this point would result in less added income than for the first addition. By using other programing techniques, the point at which it would no longer be profitable to add land can be determined.

Table 3. Sample crop and livestock activity budgets

700# Yearling steer Liberal roughage ration October purchase		
Feed requirements:		
Corn equivalents		36 bu.
Silage		3.8 Ton
Cash costs:		
Animal	$170.03	
Protein, salt etc.	14.15	
Vet. & Med.	.80	
Machine & Equip. operation expense	3.75	
Misc. expense	7.25	
Total cash expense	$195.98	
Sale of finished steer 1130# @25.79	291.43	
Less death loss	2.91	
Gross receipts	$288.52	
Income over cash costs	92.54	
Days on farm	195	
Labor requirements:		
January		.7 hr.
February		.7 hr.
March		.7 hr.
April		.4 hr.
May		
June		
July		
August		
September		
October		.5 hr.
November		.5 hr.
December		.7 hr.

Grow corn for grain		
Corn equivalents		70 bu.
Cash costs:		
Machinery Operating costs & custom work	$8.10	
Seed	1.50	
Insecticide & herbicide	4.05	
Fertilizer	8.52	
Total cash costs	$22.17	
Labor requirements:		
		.3 hr.
		.6 hr.
		.6 hr.
		.7 hr.
		.3 hr.
		1.6 hr.

Table 4. Portion of the matrix showing resources available and five of the 26 activities considered.

RESOURCES AVAILABLE	Return over cash costs	Grow corn for Silage	Steer calf Sept. purch	Borrow S-T capital	Sow-farrow Dec. & June	Build farrowing house
		$-25.50	$111.96	$0.07	$418.12	$-50.00
Row crop land	307 Acres	1.0				
Alfalfa land	40 Acres					
Small grain land	20 Acres					
April labor	376 Hours	0.6	0.7		1.3	
May labor	376 Hours	0.6	0.7		1.3	
June labor	580 Hours	0.7	0.7		4.6	
July labor	580 Hours	0.3	0.7		4.6	
Aug-Sept. labor	956 Hours	0.2	0.5		2.2	
October labor	376 Hours		0.5		1.3	
Annual short-term capital	$0	25.50	132.05	-1.0	123.00	
Short-term borrowing limit	$40,000			1.0		350.00
Long-term capital	$0					
Long-term borrowing limit	$15,000					
Corn equivalents	0 bu.		40.0		201.0	
Hay	0 Ton		0.7			
Silage	0 Ton	-15.0	2.5			
Feedlot capacity'	300 Head		1.0			
Heavy cattle limit	75 Head					
Farrowing house capacity	12 Sows				1.0	-1.0
Finishing house capacity:						
January-February	10 Units (15 pigs)				0.5	
March-April	10 Units				0.5	
May-June	10 Units				0.25	
July-August	10 Units				0.5	
September-October	10 Units				0.5	
November-December	10 Units				0.25	

Table 5. Activities considered, the present plan, and the optimum plan

Activities	Present Plan	Optimum Plan
CROP ACTIVITIES		
Grow corn for silage	20 Acres	21.2 Acres
Grow corn for grain	187 Acres	-----
Grow grain sorghum	100 Acres	261.7 Acres
Grow alfalfa	40 Acres	40.0 Acres
Grow oats	20 Acres	20.0 Acres
Grow and sell soybeans	---	24.1 Acres
CATTLE ACTIVITIES		
Str calf-high roughage-Sept. Purch	60 Head	-----
Str Calf-high roughage-Nov. Purch	---	127 Head
Hfr calf-high grain-Sept. Purch	40 Head	80 Head
Hfr Calf-high Grain-Nov. Purch	---	6 Head
Yearling Str-high Grain-April Purch	50 Head	
Yearling Str-high Roughage-Oct. Purch	40 Head	
SWINE ACTIVITIES		
Sow-farrow in Dec. and June	9 Sows	26 Sows
Sow-farrow in Jan. and July	9 Sows	26 Sows
BUY AND SELL ACTIVITIES		
Sell corn equivalents	8,192 Bu.	1,922 Bu.
Buy hay	---	---
Sell hay	27 Ton	---
Borrow Short-term Capital	$38,943	$40,000
Borrow Long-term Capital	---	$15,000
EXPANSION ACTIVITIES		
Build farrowing house	---	14 Spaces
Build finishing house (1 unit = 15 head)	---	16 Units
INCOME TO RESOURCES	$27,087	$37,073
Fixed costs:		
Land taxes and interest	$ 7,770	
Labor-operator & family	7,000	
Bldgs. & equip. (Depr. Int. & Tax)	4,050	
Misc. farm expenses	1,500	
Total	$20,320	
NET RETURNS TO MANAGEMENT	$ 6,767	$16,753

Table 6. The rate at which the first additional unit of a limiting resource would raise income to fixed resources.

Limiting Resource	Activity Unit	Amount which the first additional unit would raise income
Row crop land	Acre	$ 28.73
Alfalfa land	Acre	82.21
April labor	Hour	.01
June labor	Hour	.09
October labor	Hour	30.98
Short-term borrowing capacity	Dollar	.22
Long-term borrowing capacity	Dollar	.08
Dec. & June farrowing space	Space	37.10
Jan. & July farrowing space	Space	62.28
Sept. - Oct. finishing space	Unit	100.00
Corn equivalents	Bushel	1.05
Silage	Ton	4.11
Hay	Ton	25.87

Table 7. The amount which income would be reduced by the introduction of an activity which was not selected in the optimum plan.

Activity	Activity Unit	Amount which the first unit would reduce income
Grow corn for grain	Acre	$ 33.54
Finish feeder pigs Oct. Purch	Unit	199.96
Finish feeder pigs Feb. Purch	Unit	98.30
Sow-March & Sept. farrowing	Sow	16.42
Str. calf Sept. purchase	Animal	12.76
Yearling str. April Purch	Animal	56.27
Yearling str. Oct. Purch	Animal	33.93
Build feedlot	Space	12.20

Table 7 indicates the change in income which would result from "forcing in" a unit of an activity which was not selected in the most profitable plan.

The first unit of a sow farrowing in March and September added to the plan would reduce income by $16.42. The first acre of corn grown for grain would reduce income by $33.54. The heavy demand for labor in October possibly affects the profitability of both of these enterprises.

Other Answers

After reviewing the limiting resources on this farm (Table 6), one might question the affects of additional resources on organization and income. To answer such questions, four alternative plans were run. The results are shown in Table 8. A discussion of each alternative plan follows.

Table 8. Four alternative plans

Activities	Alternatives			
	#1[a]	#2[b]	#3[c]	#4[d]
Crop activities				
Grow corn for silage	15.1 Acres	21.3 Acres	23.8 Acres	17.2 Acres
Grow corn for grain	---	---	---	---
Grow grain sorghum	290.5 Acres	227.0 Acres	256.4 Acres	251.3 Acres
Grow alfalfa	40.0 Acres	60.0 Acres	40.0 Acres	60.0 Acres
Grow oats	20.0 Acres	---	20.0 Acres	---
Grow and sell soybeans	1.4 Acres	58.7 Acres	---	---
Cattle activities				
Str. calf-high roughage-Sept.-Purch.	---	---	---	---
Str. calf-high roughage-Nov. Purch.	91 Head	127 Head	143 Head	103 Head
Hfr. calf-high grain-Sept. Purch.	127 Head	110 Head	103 Head	197 Head
Hfr. calf-high grain-Nov. Purch.	---	---	---	---
Yearling Str.-high grain-April Purch.	---	---	---	---
Yearling Str.-high roughage-Oct. Purch.	---	---	---	---
Swine activities				
Sow-farrow in Dec. and June	26 Sows	20 Sows	26 Sows	18 Sows
Sow-farrow in Jan. and July	26 Sows	20 Sows	26 Sows	18 Sows
Buy and sell activities				
Sell corn equivalents	3,820 Bu.	---	---	---
Buy hay	---	---	21.9 Tons	---
Sell hay	---	54.4 Tons	---	19.7 Tons
Borrow short-term capital	$40,000	$40,000	$44,130	$46,308
Borrow long-term capital	$15,000	9,418	15,000	6,942
Expansion activities				
Build farrowing house	14 spaces	8 spaces	14 spaces	6 spaces
Build finishing house (1 unit = 15 head)	16 units	10 units	16 units	8 units
Income to fixed resources	$38,620	$38,064	$37,244	$39,818

a/ Alternative No. 1--50 additional hours of October labor.

b/ Alternative No. 2--20 acres of small grain land transferred to alfalfa land.

c/ Alternative No. 3--no capital limitation.

d/ Alternative No. 4--no capital restriction, 50 additional hours of October labor, and 20 acres of small grain land transferred to alfalfa land.

Alternative 1 -- October labor was a limiting resource in the most profitable plan. Table 6 showed that one additional increment of October labor would increase income at the rate of $30.98 per hour. How much would income increase if 50 hours of October labor were added?

Under this plan, soybean acreage was reduced to practically zero and grain sorghum acreage was increased. About the same total number of cattle were fed. The swine enterprise remained the same as under the original most profitable plan. The sale of corn equivalents increased by 1898 bushels.

Alternative 2 -- Since the additional income possible from adding one acre of alfalfa land was substantial (Table 6), 20 acres of small grain land were made available for alfalfa. This change increased returns to fixed resources by $991 over that of the most profitable plan.

Soybean acreage was increased and grain sorghum acreage was reduced. As a result of the increased alfalfa acreage, 54.4 tons of hay were sold.

The cattle feeding enterprise was expanded slightly and the swine enterprise was reduced by six sows per farrowing period. The short-term capital borrowing limit was reached in this alternative, but only $9,418, of a possible $15,000 of long term capital was borrowed.

Alternative 3 -- Limited capital is often mentioned by farm managers as a restriction on the kind or size of enterprises. In the most profitable plan for this farm, the borrowing limits of both short and long term capital were reached. Thus, an alternative plan was run with the assumption of unlimited capital. As a result, 4,130 dollars of additional short term capital was borrowed. No additional long term capital was borrowed. Income to fixed resources was increased by only $207.

This alternative left 26.8 acres of land idle. Apparently, it was slightly more profitable to use limited October labor in cattle feeding enterprises than for producing soybeans or corn equivalents for sale. Thus, the cattle feeding enterprises were expanded by about 20 head. The swine enterprise remained at two groups of 26 sows.

Alternative 4 -- This alternative is a combination of the first three alternatives. Unlimited capital, additional October labor, and the transfer of small grain land to alfalfa land were all included. Compared to the original plan income to fixed resources was increased by $2,745.

In this plan 38.5 acres of land were left idle. The cattle feeding enterprise was expanded to the present feedlot capacity of 300 head. The swine enterprise was reduced to 18 sows per farrowing.

The amount of short-term capital borrowed was $46,308, which is $6,308 above that borrowed in the original most profitable plan. Only $6,942 of long term capital was borrowed as compared to $15,000 in the original most profitable plan.

Summary of Plans -- Table 9 summarizes the present and five linear programed organizations for the case farm.

Given this farmer's labor supply, he is presently operating very near the desirable limit of his capital borrowing capacity. When given additional capital, income is increased very little. Before he can expand his operations, he must deal with the problem of limited seasonal labor. Since it is difficult for him to hire labor, he may want to consider the costs and returns of highly mechanized crop and livestock systems. But he still may find that he must hire some labor if he is to profitably expand his farming operation. The value of additional October labor was demonstrated by Alternative 1 (Tables 8 and 9).

Such results provide management with confidence in decisions made in the past and guide future decision making. The answers to specific questions concerning labor, capital, expansion, and other changes in crops or livestock are especially useful.

Table 9. Comparison of selected activities for the present, optimum, and four alternative plans.

Activities	Present Plan	Optimum Plan	Alternatives			
			#1[a]	#2[b]	#3[c]	#4[d]
Feed grains	327.0	302.9	325.6	248.3	300.2	268.5
Hay	40.0	40.0	40.0	60.0	40.0	60.0
Soybeans	-----	24.1	1.4	58.7	-----	-----
Idle	-----	-----	-----	-----	26.8	38.5
Feeder cattle	190	213	218	237	246	300
Litters of pigs	36	104	104	80	104	72
Income to fixed resources	$27,087	$37,073	$38,620	$38,064	$37,244	$39,818
Net return to management[e]	6,767	$16,753	18,300	17,744	16,924	19,498

a/ 50 additional hours of October labor.

b/ 20 acres small grain land transferred to alfalfa land.

c/ Unlimited capital.

d/ Combination of (a), (b), and (c).

e/ Fixed Costs estimated to be $20,320 (See page 15).

Summary

Linear programing was used to develop a highest profit farm plan and four alternative plans for this eastern Nebraska farm. The operator had several basic questions concerning changes in the organization and size of his farm business. He also had a given stock of resources, and certain personal characteristics which were fixed. Linear programing provide a way to determine a farm organization which would return highest income to these fixed resources. Other information found in the linear programing process provided information useful in applying the most profitable plan.

Income to fixed resources, ranged from a low of $27,087 under the present plan, to $37,073 under the most profitable plan. Adjustments of available resources allowed further increases to $39,818.

Linear programing is a useful tool for the farm manager. In addition to providing a most profitable farm plan, it aids in studying the effects of possible management decisions. Examples are: 1. it indicates the income increase which would result if an additional unit of a limiting resource were added, 2. indicates the income decrease which would result if a "non-selected" enterprise were forced into the farm plan, 3. it indicates the effect on farm organization and resulting income associated with a change in available resources, and 4. it indicates the amount of cost or price changes necessary to change the most profitable farm plan.

Linear programing is a tool of the manager; it is not his successor. The most profitable farm plan may seldom be adopted as is, but it and the other resulting information may guide the manager's farm organization decisions.

Linear programing requires detailed information about a farm. Examples are: the number of hours of labor required per acre of corn, cash costs per acre of corn, and capital required per sow and litter.

Consequently, it serves as a guide for determining the data needed for planning. The manager must set out his objectives and recognize his limitations. Gathering the required data, and organizing it in the form of a matrix is in itself helpful to managers.

Commercial linear programing services are not available to the extent that there is an established price for the service. The University of Nebraska teaches and is using this method in research. It has not offered it as a service.

Commercial firms and universities show increased interest in developing the mechanics necessary to offer managers this service. The amount of professional consultation required will greatly affect the cost.

An investment in linear programing is long run. Costs should be prorated over several years. Also, when significant price or resource changes occur, the basic matrix may be revised and rerun at a relatively low cost.