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ECONOMICS OF CORN PRODUCTION ON DAIRY FARMS
AND AS A CASH CROP

by

Robert A. Milligan

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BACKGROUND

The analysis for and a discussion of this material was presented at the Annual Meeting of the Empire State Chapter of the Soil Conservation Society at Alexandria Bay, New York on October 1, 1977. The discussion was a part of a program entitled "Corn Production and Soil Conservation--Mutually Exclusive?" The discussion was presented again for the Farm Management Seminar on October 10, 1977.

Two purposes are intended for publishing the material. The first is to make the information on substitution for corn enterprises available. The second is to illustrate the useful material that can rather easily be generated using NEWPLAN programs.

Economics of Corn Production on
Dairy Farms and as a Cash Crop

by

Robert A. Milligan^{1/}

Introduction

The purpose of this discussion is to provide information concerning the role of corn silage and corn grain enterprises on New York dairy farms, with some comments on the role of corn grain as a cash crop. The emphasis of the discussion is to indicate the optimum use of corn enterprises and the cost associated with selecting alternative plans. Hopefully, this procedure will quantify the trade-off between corn and alternatives that are better suited to soil conservation. The discussion is focused on dairy farms with additional emphasis on corn silage.

Before proceeding with the analysis, a discussion of the general advantages and disadvantages of corn production is presented. The advantages include:

1. Both corn silage and corn grain are relatively high value crops.
2. There is no better source of the energy required by dairy cows.
3. In situations where corn silage and/or corn grain are not produced, these enterprises will provide diversification. Some dairy farms are already rather specialized in corn enterprises.
4. Corn enterprises have less yield and quality variability than most of their substitutes. This is particularly true with respect to quality of hay and corn silage. The exception to this statement may be on poorly drained soil where there is a significant probability of harvesting no corn silage crop.

The disadvantages of corn production include:

1. Both corn silage and corn grain are expensive crops to produce. Both require large quantities of seed, fertilizer, and herbicides and have large harvesting expenses.

^{1/}Robert A. Milligan is Assistant Professor in the Department of Agricultural Economics, Cornell University.

2. Introduction or expansion of corn silage and/or corn grain usually requires expensive machinery items and storage facilities.
3. Growing corn, particularly on sloping land, produces more soil conservation problems than does growing most of the substitutes for corn.

Production and Nutrient Content of Hay and Corn Silage

Acreage and production of corn silage and corn grain have increased rapidly in New York. Table 1 summarizes corn acreage and production for 1972-1976. During this time period corn grain acreage has increased much more rapidly than corn silage acreage; however, grain acreage is still much less than corn silage as Table 2 indicates the acreage of hay crops has remained relatively constant.

Yields of both corn silage and corn grain increased in every year except 1976. Hay crop yields showed less improvement. It is important to recognize that these are average yields and in general are not representative of comparable yields from the same soil. Much of the acreage of hay crops, particularly the acreage of other hay, is not capable of producing corn. In general the corn grain is produced on the most fertile soils.

Table 3 summarizes the nutrient composition per pound of dry matter and the production of nutrients using these compositions and 1976 yields. These figures illustrate the importance of corn grain and corn silage as energy sources. A good quality hay crop with a good yield is a much superior protein source than a corn crop; however, when the quality slips and yields are low, hay crops lose the advantage even as a protein source.

Cost of Production

To indicate comparative production costs for hay crops, corn silage, and corn grain, enterprise budgets are included for four yield levels of dry hay, corn silage, and corn grain. These budgets, taken from Knoblauch and Milligan^{2/}, were formulated using the synthetic firm approach with the fixed costs based on all new equipment prices (see the footnotes to the budgets for details). These budgets illustrate that corn enterprises, especially corn silage, have large production costs. The budgets also illustrate that all three enterprises can be produced profitably.

Corn Productions on Dairy Farms

Corn enterprises are both a roughage and a concentrate source for a dairy

^{2/}Knoblauch, Wayne A. and Robert A. Milligan, An Economic Analysis of New York Dairy Farm Enterprises, Cornell University, Department of Agricultural Economics, A.E. Res. 77-1, January 1977.

PRODUCTION AND NUTRIENT CONTENT OF CORN AND HAY

Table 1. Acreage and Yield of Corn Silage and Corn for Grain.

Year	Corn Silage		Corn for Grain		Total
	Acres harvested 1,000 acres	Yield per acre tons	Acres harvested 1,000 acres	Yield per acre tons	Acres Corn 1,000 acres
1972	599	10.5	270	70	869
1973	610	12.5	360	77	970
1974	627	13.0	440	80	1067
1975	633	13.5	466	85	1099
1976	631	12.0	492	77	1123

Source: New York Agricultural Statistics, 1976.

Table 2. Acreage and Yield for Hay Crops.

Year	Alfalfa Hay		Other Hay		All Hay	
	Acres harvested 1,000 acres	Yield per acre tons	Acres harvested 1,000 acres	Yield per acre tons	Acres harvested 1,000 acres	Yield per acre tons
1972	960	2.30	1,350	1.70	2,310	1.95
1973	945	2.65	1,350	2.00	2,295	2.27
1974	925	2.70	1,350	2.10	2,275	2.34
1975	930	2.70	1,370	1.90	2,300	2.22
1976	990	2.70	1,410	1.90	2,400	2.23

Source: New York Agricultural Statistics, 1976.

Table 3. Nutrient Content of Corn and Hay.

	Per Pound Dry Matter		Per acre, 1976 Yields	
	Energy MCal/lb.	Protein Percent	Energy MCal	Protein Pounds
Corn Grain	0.95	10.2	3482	440
Corn Silage	0.71	8.0	5112	576
Good Quality Alfalfa	0.50	17.0	2430	826
Average Quality Hay	0.47	12.0	1886	482

Enterprise	Dry Hay Fed		Dry Hay Fed		Dry Hay Fed		Dry Hay Fed	
Production Level	High		Above Average		Average		Low	
Enterprise Code Number	1		2		3		4	
INCOME:								
Yield Per Acre, T.	5.5		4.0		2.5		1.5	
Price, \$/T.	50.00		50.00		50.00		50.00	
Value of Production	<u>\$275.00</u>		<u>\$200.00</u>		<u>\$125.00</u>		<u>\$ 75.00</u>	
1 ^{a/} Gross Income (Off-Farm Sales)	<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>	
VARIABLE EXPENSES:								
Growing ^{b/}								
Seed, lb.	(12)	4.25	(12)	4.25	(12)	4.25	(12)	4.25
Fertilizer:								
Nitrogen, lb.	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00
Phosphorus, P ₂ O ₅ lb.	(75)	14.25	(50)	9.50	(25)	4.75	(25)	4.75
Potassium, K ₂ O lb.	(100)	10.00	(75)	7.50	(50)	5.00	(50)	5.00
Manure, Lime, Cover Crop	1.00		1.00		1.00		1.00	
Herbicide, Other Chemicals	2.00		2.00		2.00		2.00	
Power and Equipment:								
Fuel, Oil, Grease	2.60		2.60		2.40		2.00	
Repairs & Maintenance	1.30		1.30		1.10		0.90	
Other	2.00		2.00		1.80		1.60	
Total Growing Cost	<u>\$ 37.40</u>		<u>\$ 30.15</u>		<u>\$ 22.30</u>		<u>\$ 21.50</u>	
Harvesting								
Power & Equipment:								
Fuel, Oil, Grease	6.40		6.10		5.00		3.80	
Repairs & Maintenance	9.00		8.70		6.90		5.80	
Twine	7.00		5.00		3.50		1.75	
Other	2.00		2.00		1.60		1.20	
Total Harvesting Cost	<u>\$ 24.40</u>		<u>\$ 21.80</u>		<u>\$ 17.00</u>		<u>\$ 12.55</u>	
Selling ^{c/}								
Truck, Tractor & Equipment	0.00		0.00		0.00		0.00	
Drying & Marketing	0.00		0.00		0.00		0.00	
Other	0.00		0.00		0.00		0.00	
Total Selling Cost	<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>	
2 Total Selected Variable Expenses	<u>\$ 61.80</u>		<u>\$ 51.95</u>		<u>\$ 39.30</u>		<u>\$ 34.05</u>	
3 Interest on Operating Expenses ^{d/}	2.80		2.35		1.75		1.55	
4 Family & Hired Labor, Hours ^{e/}	(12.0)	42.00	(11.7)	40.95	(10.6)	37.10	(8)	28.00
Total Variable Expenses	<u>\$106.60</u>		<u>\$ 95.25</u>		<u>\$ 78.15</u>		<u>\$ 63.60</u>	
FIXED EXPENSES:								
Power and Equipment ^{f/}	27.20		27.20		27.20		27.20	
Truck ^{g/}	1.00		1.00		1.00		1.00	
Interest (Power, Equip., Truck) ^{h/}	9.20		9.20		9.20		9.20	
Building Use ^{i/}	2.00		2.00		2.00		2.00	
Land Charge, Value/Acre ^{j/}	(800)	56.00	(600)	42.00	(400)	28.00	(200)	14.00
Property Tax ^{k/}	13.60		10.20		6.80		3.40	
Insurance ^{l/}	2.90		2.90		2.90		2.90	
Total Fixed Expenses	<u>\$111.90</u>		<u>\$ 94.50</u>		<u>\$ 77.10</u>		<u>\$ 59.70</u>	
TOTAL VARIABLE & FIXED EXPENSES ^{n/}	<u>\$218.50</u>		<u>\$189.75</u>		<u>\$155.25</u>		<u>\$123.30</u>	
FEED EQUIVALENT PRODUCED:								
5 Corn Equivalent, bu.	0		0		0		0	
6 Hay Equivalent, T.	5.5		4.0		2.5		1.5	

The footnotes are on Page 16 following the budgets for forages. The power and equipment complement assumed is indicated in Table 2 Page 17.

Enterprise	Corn Silage Fed		Corn Silage Fed		Corn Silage Fed		Corn Silage Fed	
Production Level	High		Above Average		Average		Low	
Enterprise Code Number	17		18		19		20	
INCOME:								
Yield Per Acre, T.	20		16		13		10	
Price, \$/T.	17.00		17.00		17.00		17.00	
Value of Production	<u>\$340.00</u>		<u>\$272.00</u>		<u>\$221.00</u>		<u>\$170.00</u>	
1 ^a / Gross Income (Off-Farm Sales)	<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>	
VARIABLE EXPENSES:								
Growing								
Seed, bu.	(.30)	13.80	(.28)	12.60	(.26)	11.30	(.26)	11.30
Fertilizer:								
Nitrogen, lb.	(130)	23.40	(100)	18.00	(80)	14.40	(60)	10.80
Phosphorus, P ₂ O ₅ lb.	(60)	11.40	(50)	9.50	(30)	5.70	(20)	3.80
Potassium, K ₂ O lb.	(60)	6.00	(50)	5.00	(30)	3.00	(20)	2.00
Manure, Lime, Cover Crop		4.00		3.00		3.00		3.00
Herbicide, Other Chemicals		16.00		15.00		10.00		8.00
Power and Equipment:								
Fuel, Oil, Grease		5.00		5.00		4.50		4.50
Repairs & Maintenance		3.40		3.40		2.90		2.90
Other		2.00		2.00		1.50		1.50
Total Growing Cost		<u>\$ 85.00</u>		<u>\$ 73.50</u>		<u>\$ 56.30</u>		<u>\$ 47.80</u>
Harvesting								
Power and Equipment:								
Fuel, Oil, Grease		10.80		10.10		9.20		8.20
Repairs & Maintenance		14.40		13.70		12.90		11.90
Other		1.50		1.50		1.00		1.00
Total Harvesting Cost		<u>\$ 26.70</u>		<u>\$ 25.30</u>		<u>\$ 23.10</u>		<u>\$ 21.10</u>
Selling ^c /								
Truck, Tractor & Equipment		0.00		0.00		0.00		0.00
Drying & Marketing		0.00		0.00		0.00		0.00
Other		0.00		0.00		0.00		0.00
Total Selling Cost		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>
2 Total Selected Variable Expenses		<u>\$111.70</u>		<u>\$ 98.80</u>		<u>\$ 79.40</u>		<u>\$ 68.90</u>
3 Interest on Operating Expenses ^d /		5.00		4.45		3.60		3.10
4 Family & Hired Labor, Hours ^e /	(8.5)	29.75	(8.3)	29.05	(8.0)	28.00	(7.8)	27.30
Total Variable Expenses		<u>\$146.45</u>		<u>\$132.30</u>		<u>\$111.00</u>		<u>\$ 99.30</u>
FIXED EXPENSES:								
Power and Equipment ^f /								
Truck ^g /		27.95		27.95		27.95		27.95
Interest (Power, Equip., Truck) ^h /		1.00		1.00		1.00		1.00
Building Use ⁱ /		9.30		9.30		9.30		9.30
Land Charge, Value/Acre ^j /	(800)	2.00	(600)	2.00	(400)	2.00	(200)	2.00
Property Tax ^k /		56.00		42.00		28.00		14.00
Insurance ^l /		13.60		10.20		6.80		3.40
		3.00		3.00		3.00		3.00
Total Fixed Expenses		<u>\$112.85</u>		<u>\$ 95.45</u>		<u>\$ 78.05</u>		<u>\$ 60.65</u>
TOTAL VARIABLE & FIXED EXPENSES ⁿ /		<u>\$259.30</u>		<u>\$227.75</u>		<u>\$189.05</u>		<u>\$159.95</u>
FEED EQUIVALENT PRODUCED:								
5 Corn Equivalent, bu.		0		0		0		0
6 Hay Equivalent, T.		6.7		5.3		4.3		3.3

The footnotes are on Page 16 following the budgets for forages. The power and equipment complement assumed is indicated in Table 3, Page 18.

Enterprise	Corn Grain Fed		Corn Grain Fed		Corn Grain Fed		Corn Grain Fed	
Production Level	High		Above Average		Average		Low	
Enterprise Code Number	27		28		29		30	
INCOME:								
Yield Per Acre, bu.	120		100		80		60	
Price, \$/bu.	2.50		2.50		2.50		2.50	
Value of Production	<u>\$300.00</u>		<u>\$250.00</u>		<u>\$200.00</u>		<u>\$150.00</u>	
1 ^{a/} Gross Income (Off-Farm Sales)	<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>	
VARIABLE EXPENSES:								
Growing								
Seed, bu.	(.30)	13.80	(.28)	12.60	(.26)	11.30	(.26)	11.30
Fertilizer:								
Nitrogen, lb.	(130)	23.40	(100)	18.00	(80)	14.40	(60)	10.80
Phosphorus, P ₂ O ₅ lb.	(60)	11.40	(50)	9.50	(30)	5.70	(20)	3.80
Potassium, K ₂ O lb.	(60)	6.00	(50)	5.00	(30)	3.00	(20)	2.00
Manure, Lime, Cover Crop		4.00		3.00		3.00		3.00
Herbicide, Other Chemicals		16.00		15.00		10.00		8.00
Power and Equipment:								
Fuel, Oil, Grease		4.80		4.80		4.30		4.30
Repairs & Maintenance		3.30		3.30		2.80		2.80
Other		3.00		3.00		2.00		2.00
Total Growing Cost	<u>\$ 85.70</u>		<u>\$ 74.20</u>		<u>\$ 56.50</u>		<u>\$ 48.00</u>	
Harvesting								
Power and Equipment:								
Fuel, Oil, Grease		2.80		2.60		2.20		2.00
Repairs & Maintenance		3.50		3.20		2.70		2.50
Other		3.50		3.00		2.50		2.50
Total Harvesting Cost	<u>\$ 9.80</u>		<u>\$ 8.80</u>		<u>\$ 7.40</u>		<u>\$ 7.00</u>	
Selling ^{c/}								
Truck, Tractor & Equipment		0.00		0.00		0.00		0.00
Drying and Marketing		0.00		0.00		0.00		0.00
Other		0.00		0.00		0.00		0.00
Total Selling Cost	<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>		<u>\$ 0.00</u>	
2 Total Selected Variable Expenses	<u>\$ 95.50</u>		<u>\$ 83.00</u>		<u>\$ 63.90</u>		<u>\$ 55.00</u>	
3 Interest on Operating Expenses ^{d/}	4.30		3.75		2.90		2.40	
4 Family & Hired Labor, Hours ^{e/}	(6.0)	21.00	(5.9)	20.65	(5.6)	19.60	(5.4)	18.90
Total Variable Expenses	<u>\$120.80</u>		<u>\$107.40</u>		<u>\$ 86.40</u>		<u>\$ 76.30</u>	
FIXED EXPENSES:								
Power and Equipment ^{f/}								
Truck ^{g/}		27.90		27.90		27.90		27.90
Interest (Power, Equip., Truck) ^{h/}		1.00		1.00		1.00		1.00
Building Use ^{i/}		9.40		9.40		9.40		9.40
Land Charge, Value/Acre ^{j/}		2.00		2.00		2.00		2.00
Property Tax ^{k/}	(800)	56.00	(600)	42.00	(400)	28.00	(200)	14.00
Insurance ^{l/}		13.60		10.20		6.80		3.40
		3.00		3.00		3.00		3.00
Total Fixed Expenses	<u>\$112.90</u>		<u>\$ 95.50</u>		<u>\$ 78.10</u>		<u>\$ 60.70</u>	
TOTAL VARIABLE & FIXED EXPENSES ^{n/}	<u>\$233.70</u>		<u>\$202.90</u>		<u>\$164.50</u>		<u>\$137.00</u>	
FEED EQUIVALENT PRODUCED:								
5 Corn Equivalent, bu.	120		100		80		60	
6 Hay Equivalent, T.	0		0		0		0	

The footnotes are on Page 16 following the budgets for forages. The power and equipment complement assumed is indicated in Table 3, Page 18.

FOOTNOTES TO CROP BUDGETS

- a/ The numbers in the left hand margin are reference values stored for use with NEWPLAN Programs 65 and 36.
- b/ For dry hay, haylage, and improved pasture cash expenses of seed, seed bed preparation, etc., are prorated over the assumed four year life of the stand.
- c/ Storage expenses (repairs, depreciation and interest) for crops fed are charged to the dairy enterprise.
- d/ It is assumed the operating capital is tied up for 6 months at an interest rate of 9 percent.
- e/ The labor requirement estimates for the enterprise budgets are based on labor disappearance, not on machinery use time.
- f/ Assumes depreciation to be 14 percent of new cost.
 - For Dry Hay see Table 2, page 17.
 - For Haylage see Table 2, page 17.
 - For Corn Silage see Table 3, page 18.
 - For Wheat, Oats, Rye and Barley see Table 10, page 31.
 - For Corn Grain and Soybeans see Table 3, page 18.
 - For Red Kidney and Black Turtle Soup Beans see Table 12, page 40.
- g/ Assumes a \$4,000 pick-up truck with depreciation 12.5 percent of new cost.
- h/ Assumes a 9 percent interest rate on one half the new value.
- i/ Assumes depreciation and interest to be 10 percent of new cost.
- j/ Interest rate assumed is 7 percent.
- k/ Assumes property taxes to be \$1.70 per \$100 of market value.
- l/ Assumes insurance to be 1.5 percent of new cost.
- m/ Assumes a 75 bushel per hour continuous flow dryer with depreciation and interest 16 percent of new cost.
- n/ The total variable and fixed expense estimate is for a specific farm size, and technology, with all investments at 1976 price levels. This figure does not represent "the" cost of producing the crop in New York State.

Table 2. Power and Equipment Complements and 1976 Investment Costs for Dry Hay and Haylage^{a/}

	New Cost	Dry Hay		Haylage	
		Proportion Charged to Baled Hay	Propor- tional Cost	Proportion Charged to Haylage	Propor- tional Cost
Tractor (125 hp. with cab)	\$23,000	0.15	\$ 3,450	0.15	\$ 3,450
Tractor (60 hp.)	11,075	0.20	2,215	0.20	2,215
Plow 5-16" bottoms	3,175	0.06	190	0.06	190
Disc Harrow (14')	2,975	0.06	180	0.06	180
Spring Tooth Harrow (18')	1,150	0.06	70	0.06	70
Baler with Bale Thrower	5,500	1.00	5,500	- -	- - - -
Forage Harvester	6,100	- -	- - - -	0.50	3,050
Pick up Head	1,140	- -	- - - -	1.00	1,140
Mower-Conditioner Windrower (7')	4,300	1.00	4,300	1.00	4,300
Side Delivery Rake	1,550	1.00	1,550	1.00	1,550
Wagons 2 @ 1,000	2,000	1.00	2,000	- -	- - - -
Forage Wagons 2 @ 5,250	10,500	- -	- - - -	0.50	<u>5,250</u>
		Total	\$19,455		\$21,395
		Per Acre (100)	\$194.55		\$213.95

^{a/} Assumes 500 tillable acres with 100 acres each of hay crop, corn silage, corn grain for feed, a row cash crop, and a non-row cash crop.

Table 3. Power and Equipment Complements and 1976 Investment Costs for Corn Silage and for Corn Grain and Soybeans^{a/}

	New Cost	Corn Silage ^{b/}		Corn Grain & Soybeans	
		Proportion Charged to Corn Silage	Proportional Cost	Proportion Charged to Corn and Soybeans	Proportional Cost
Tractor (125 hp. with cab)	\$23,000	0.15	\$ 3,450	0.15	\$ 3,450
Tractor (60 hp.)	11,075	0.20	2,215	0.20	2,215
Plow 5-16" bottoms	3,175	0.235	750	0.235	750
Planter	4,400	0.33	1,450	0.33	1,450
Disc Harrow (14')	2,975	0.235	700	0.235	700
Spring Tooth Harrow	1,150	0.235	270	0.235	270
Cultivator, 4 Row	1,350	0.33	445	0.33	445
Forage Harvester	6,100	0.50 ^{c/}	3,050	- -	- - - -
2-Row Corn Head	2,175	1.00	2,175	- -	- - - -
Forage Wagons 2 @ 5,250	10,500	0.50 ^{c/}	5,250	- -	- - - -
Combine (gasoline, cab, 4 row corn head or 13' grain head)	30,000	- -	- - - -	0.33	9,900
Grain Wagons 2 @ 1,150	2,300	- -	- - - -	0.33	760
		Total	\$19,755		\$19,940
		Per Acre(100)	\$197.55		\$199.40

a/ Assumes 500 tillable acres with 100 acres each of hay crop, corn silage, corn grain for feed, a row cash crop, and a non-row cash crop.

b/ For corn silage plus NPN add \$500 to the total investment for metering equipment.

c/ Assumes hay is harvested as haylage; otherwise, proportion charged to corn silage would be 1.0.

farm. From a conservation viewpoint, the alternative to corn silage as a roughage source, a hay crop, is a very desirable enterprise. The alternatives to corn grain as a concentrate source are less desirable. In this discussion, consequently, alternative roughage sources are analyzed first by analyzing the roughage source question and then by studying the substitutability of hay for concentrate. This discussion is followed by an analysis of the economics of corn grain and oat enterprises.

Corn as a Roughage Source

This analysis is conducted in two stages. First, the importance of corn silage to a dairy farm is evaluated by determining the combination of enterprises that maximizes profitability using three corn silage enterprise situations. In the second stage the cost of substituting hay for concentrate is considered.

Profit Maximizing Roughage Combinations

The following three cropping situations are evaluated:

1. No restrictions on crop enterprise acreages.
2. Corn, both silage and grain, can be grown on no more than one half of the tillable acres.
3. No corn silage can be grown.

The three cropping situations are compared for two farm sizes, 150 tillable acres with 50 cows and 250 tillable acres with 100 cows and two production levels, 13,000 and 16,000 pounds per cow. These and other factors for the farm situations are contained in Table 4A. The crop yields are 3.5 tons of hay (90 percent dry matter), 12.0 tons corn silage, and 70 bushels of corn grain. The hay yield is higher relative to that of corn silage than is true for most farm situations.

The three cropping situations are compared for each size and production level by using a linear programming based computer program titled Profitable Organization of Dairy Farm Enterprises.^{3/} This program uses information from the enterprise budgets described earlier and additional input to select the combination of dairy livestock and crop enterprises and the roughage composition of the ration to maximize profit.

^{3/} This program (NEWPLAN program 65) was written by Dr. Sherrill Nott of Michigan State University and is further described in Nott, Sherrill B. and Stephen B. Harsh, User's Manual for TELPLAN Program 65, Dairy Farm Linear Programming, Michigan State University, September 15, 1976; and Milligan, Robert A. and Wayne A. Knoblauch, Profitable Organization of Dairy Farm Enterprises, Cornell University, Department of Agricultural Economics, A. E. Ext. 77-3, June 1977. For further information contact the authors.

The results for the three cropping situations for each of the synthetic firms are summarized in Tables 4B and 4C. The seeming unprofitability of these firms results from the use of management income as the income measure. Management income is the return to management after all factors of production, including family and operator labor and equity capital, have been "paid." Negative management incomes are not uncommon. The cropping pattern for the unrestricted situation contains more than half corn silage and corn grain in all situations. The appearance of corn grain in situations where corn silage is not included may be intuitively unappealing; however, the concentrate could come from oats or some other grain rather than corn.

In all situations management income declined when corn enterprises were restricted to one half of the tillable acres and declined further when hay was grown as the only roughage source. The difference was greater for the larger herd as would be expected and greater for the 13,000 pound production. The reason for the greater difference at 13,000 pounds is that roughage is a more important nutrient source at this production level, at 16,000 pounds production, the concentrate is much more important.

Roughage - Concentrate Mix

To further investigate the feasibility and cost of increased hay acreage to improve soil conservation, a least cost ration computer program ^{4/} was used to investigate the substitutability of hay for concentrate. Since very little substitution is possible while meeting the nutrient requirements of high producing dairy cows, only the 13,000 pound production level is discussed. The following prices are used:

Hay	--	\$50/ton
Corn grain	--	\$2.50/bushel
Oats	--	\$1.70/bushel
Soybean oil meal	--	\$200/ton

Separate least cost balanced rations were determined for the dry period, the first five months of lactation, and the last five months of lactation.

The amount of hay fed could be increased as much as fifty percent during the dry period; however, no substitution is possible in the first half of lactation, and the increase is limited to ten percent during the last half of lactation. Table 5 compares the cost and composition of the least cost rations and a feeding plan increasing hay fifty percent in the dry period and ten percent in the last half of lactation. As can be seen, a significant substitution of hay for concentrate is made with very little cost. In no instance did oats enter the least cost ration since oats are a poorer energy source than corn.

^{4/} This program was written by Stephen Harsh, Donald Hillman, and James Schoonaert of Michigan State University. See Smith, N. E. and E. L. LaDue, Least-Cost Dairy Rations, NEWPLAN Program 31: A Computer Program Users Manual, Cornell University, Department of Agricultural Economics, A. E. Ext. 73-22, A. S. Mimeo 23, October 1973, for further details.

Table 4A. PROFIT MAXIMIZING FORAGE PRODUCTION ON DAIRY FARMS

Assumed (Typical) Conditions:

	Average Size Dairy Farm	Larger Dairy Farm
No. of Cows	50	100
Tillable Acres	150	250
Milk Productions	13,000	13,000
	16,000	16,000
Corn Grain Purchase Price	2.50	2.50
Crop Yields		
Hay	3.5 T	3.5 T
Corn Silage	12.0 T	12.0 T
Corn Grain	70 bu.	70 bu.

Cropping Situations Considered:

- A. No restrictions.
- B. Corn can be grown on no more than 1/2 of the tillable acres.
- C. No corn silage can be grown.

Table 4B. RESULTS FOR AVERAGE SIZE FARM

	13,000 lbs. Milk				16,000 lbs. Milk			
	No Restrictions	Less than 75 Acres Corn	No Corn Silage		No Restrictions	Less than 75 Acres Corn	No Corn Silage	
Management Income	-\$4,724.34	-\$5,063.25	-\$7,165.48		\$1,300.00	\$503.05	-\$419.51	
Crop Acres								
Hay	66	66	92		43	75	89	
Corn Silage	35	35	0		55	20	0	
Corn Grain	49	40	58		52	55	61	
Bu. of Corn Purchased	710	1,273	3,170		415	2,596	3,722	
Tons Soybean Meal Purchased	25	25	12		44	30	22	
Percent Hay in Ration Fed Cows	50	50	100		25	72	100	

Table 4C. RESULTS FOR LARGER FARM

	13,000 lbs. Milk			16,000 lbs. Milk		
	No Restrictions	Less than 125 Acres Corn	No Corn Silage	No Restrictions	Less than 125 Acres Corn	No Corn Silage
Management Income	-\$2,026.10	-\$2,026.10	-\$6,880.40	\$6,821.56	\$6,032.75	\$3,411.53
Crop Acres						
Hay	133	133	184	85	125	179
Corn Silage	70	70	0	111	73	0
Corn Grain	47	47	66	54	52	71
Bu. of Corn Purchased	4,626	4,626	9,545	4,035	6,473	10,649
Tons Soybean Purchased	51	51	24	89	72	44
Percent Hay in Ration Fed Cows	50	50	100	25	49	100

Table 5. Comparison of Least Cost Feeding Plan and a Plan with More Hay

Item ^{a/}	Feeding Plan		
	Least Cost Level	More Hay ^{b/} Level	Change
Annual Cost/Cow	\$552.66	\$554.20	+ 0.3 %
Hay	5.61/T	6.15/T	+ 9.6 %
Corn Grain	87.96/Bu.	78.62/Bu.	-10.6 %

^{a/} Minerals are added as needed and are included in the annual cost.

^{b/} 50 percent more hay during dry period, no change in first half of lactation, and 10 percent increase in hay in last half of lactation.

Concentrate Sources on Dairy Farms

Soil conservation considerations are relevant whether the dairyman is growing or purchasing concentrate since the grain must be grown somewhere. The analysis, then, separately considers the alternative of growing or purchasing corn grain or oats. As background, oats contain 0.80 MCal energy per pound and 13.1 percent protein while corn grain contains 0.95 MCal energy and 10.2 percent protein.

The linear programming enterprise combination program is again used with oats entered as an alternative enterprise. Oats yielding 60 bushels per acre ^{5/} are included in the small farm, 13,000 pounds production, no corn silage situation. When \$40.00 credit is given to the oat enterprise for straw, the management income is reduced \$34.57 for each acre of oats introduced to replace corn grain. If the 58 acres of corn grain for this situation in Table 4B were replaced with oats, management income would be reduced \$2,003.

When the concentrate is purchased, oats are potential substitutes for corn grain; however, they are less attractive when the roughage is from hay crop because energy is usually the limiting nutrient. In order to investigate the substitutability of corn grain and oats, oats at \$1.70/bushel are included in the input for the least cost ration program described on page 14. Oats do not enter the least cost ration. To measure the costs of introducing oats, two alternative scenarios are entered:

- A. The concentrate must contain half oats.
- B. The concentrate in the dry period and months 6-10 of lactation must contain half oats; no oats are fed in months 1-5.

^{5/} Oats are introduced as corn grain equivalent based on energy values. This procedure introduces some bias against oats because they have more protein.

These two alternatives are compared to the least cost ration in Table 6. The inclusion of oats in the concentrate increases the cost, increases the hay fed, and decreases substantially the corn required.

Table 6. Comparison of Least Cost Feeding Plan and Two Plans with Oats in the Ration

Item	Least Cost <u>a/</u> Level	Plan A <u>b/</u> Level Change	Plan B <u>c/</u> Level Change
Annual Cost/ Cow	\$552.66	\$574.20 + 3.9 %	\$562.60 + 1.8 %
Hay	5.61/T	6.04/T + 7.7 %	6.38/T +13.8 %
Corn Grain	87.96/Bu.	39.54/Bu. -55.0 %	62.36/Bu. -29.1 %
Oats	0.0	83.09/Bu. --	22.03/Bu. --
Soybean Meal	484 lb.	371 lb. -23.3 %	484 0.0 %

a/ Minerals are added as needed and are included in the annual cost.

b/ The concentrate contains half oats.

c/ The concentrate in the dry period and months 6-10 of lactation must contain half oats, no oats are fed in months 1-5.

Corn Grain as a Cash Crop

Corn grain has become an important cash crop in Western New York.^{6/} Although no extensive analysis has been undertaken, I think it is safe to conclude that corn grain will remain an important cash crop in that region. The major reason is lack of alternatives. There is little expansion available for specialty crops. Acreages of dry beans are not likely to expand due to the risks involved and market limitation. Soybeans are not well suited to our climate. The other crops--hay, oats, etc.--cannot serve as the mainstay of a cash crop operation.

^{6/} See Riggins, Steven K., Corn Marketing in Western New York, Unpublished Ph.D. thesis, Cornell University, January 1978