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PROJECTED PROFITABILITY OF MICHIGAN DAIRY FARMS IN THE 1990's

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INTRODUCTION

The study was a whole farm budgeting evaluation followed by a sensitivity analysis of four representative dairy farm sizes which might be viable alternatives in Michigan by 1995. Each of the four sizes were budgeted with 5 ways of getting feed. They were buying all feed, growing all roughage and buying the remaining feed, or growing all roughage plus grain and buying only a few needed supplements. Roughages were either all hay and haylage, or half the roughage dry matter was corn silage with the rest being hay and haylage.

The core price, income, expense and yield assumptions were based on generally accepted levels attained by better dairy farm managers in 1988 and 1989. The main exception to this is the price for soybean meal and corn grain. There is some evidence in the years to come that soybeans, and consequently protein supplements, will become more expensive relative to corn and other energy feeds. Hence, the assumed soybean meal price was $350 per ton and the corn price paid by farmers was $2.50 per bushel.[2]

Expert opinion was solicited to select the most effective technology currently known for the representative farms. It was assumed that this would be in widespread use by 1995. (However, the possible use of bovine somatotropin was ignored.) This method set the size and type of milking facilities, manure handling system, and livestock housing.

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[1]The authors are professor, research assistance and graduate student, respectively, in the Department of Agricultural Economics, Michigan State University, East Lansing, MI.

[2]John N. Ferris, Trends and Projections for U.S. Agriculture Using "AGMOD", Agr. Econ. Staff Paper No. 88-90, 1988, p. 21.

The budgeting calculations were done as much as possible using the "Spartan"[3] ration balancer and "FINPACK".[4] These microcomputer programs are widely available. This means that the Michigan Cooperative Extension Service and individual farmers can readily do similar analyses on individual farm situations. However, it is recognized this model does not use the latest NRC coefficients, especially in the areas of protein solubility and degradebility. Inclusion of these factors might have modified the results of this study.

This study should be of help to the Michigan dairy industry as it moves into the last decade of the twentieth century. The representative farm situations indicated the expected profitability of various farm sizes. The financial results showed the importance of milk prices. Farm managers looking at the sensitivity analyses will see which changes could return the greatest profit from their attention. Researchers will see where the greatest need for new research exists when need is measured in profitability terms.

ASSUMPTIONS ON SIZE, QUANTITIES AND PRICES

Herd Sizes

The study analyzed four herd sizes. They were 60, 120, 250 and 400 cows, including both milking and dry cows. All replacements were born and raised on the farm. Free stall barns and herringbone milking parlors were assumed for all sizes. These parameters were a majority decision of the ad hoc committee that guided the recent Michigan dairy farm survey.[5]

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[3]H.F. Bucholtz, J.W. Thomas, J.P. Walter, R.A. Patton, S.T. Hayes, Spartan Dairy Ration Evaluator, CP-012, Version 1.0, Cooperative Extension Service Software Library, Michigan State University, 1987.

[4]Richard O. Hawkins, Dale W. Nordquist, Robert H. Craven, James A. Yates, and Kevin S. Klair, FINPACK, A Computerized Farm Financial Planning and Analysis Package, Version 7.0, Center for Farm Financial Management, Department of Agricultural and Applied Economics, University of Minnesota, 1987.

[5]Larry J. Connor, Larry G. Hamm, Sherrill Nott, Dale Darling, William Bickert, Roger Mellenberger, H. Allen Tucker, Oran B. Hesterman, John A. Partridge and John H. Kirk, Michigan Dairy Farm Industry: Summary of the 1987 Michigan State University Dairy Farm Survey, Special Research Report 498, Michigan State University Agricultural Experiment Station, 1989, 36 pp.

Alternative Feed Acquisition Strategies

For each of the 4 farm sizes, 5 different plans were analyzed. They differed in how feed was obtained. All corn grain was stored and handled as high moisture corn whether grown or purchased. Roughages were either all haylage (with some dry hay), or half the roughage dry matter was corn silage with the rest being haylage and hay. The final plan was to buy all feeds, both grain and roughage. Purchased roughage would be mostly baled hay. Following is a summary of the alternatives analyzed. The words in brackets are how the alternatives are identified in tables later in the paper:

Plan	Description
A	[All Grown Corn Silage & Alfalfa]
B	[All Grown Alfalfa]
C	[Roughage Grown Corn Silage & Alfalfa]
D	[Roughage Grown Alfalfa]
E	[All Purchased]

The alternative of harvesting seasonal feed as controlled grazing appears to have considerable potential, but it was not included in this publication.

Assumptions Summarized

Table 1 lists most of the price and yield assumptions used in the study. The Appendix contains complete details pertaining to the assumptions with discussion and footnoted references.

Table 1. SELECTED STUDY ASSUMPTIONS

Variable	Unit	Amount Assumed
Income related variables:		
Cows	Per head	$ 1,100.00
Bred heifers	Per head	$ 1,000.00
Heifers 6 - 15 months	Per head	$ 500.00
Calves under 6 months	Per head	$ 200.00
Cull cow sold	Per head	$ 574.00
Cull rate on herd	%	30.00
Bull calf at birth	Per head	$ 110.00
Bull calf death loss	%	5.00
Milk per cow	Lbs.	19,200.00
Percent of milk sold	%	95.00
Price of milk sold	Cwt.	$ 11.00
Land and feed related variables:		
Land price	Acre	$ 697.00
Land tax rate, % of value	%	2.30
Crop yields per acre, as fed:		
Alfalfa hay	Ton	4.40
Corn silage	Ton	14.30
Corn grain	Bu.	108.00
Crude protein of feeds, 100% dry matter basis:		
Hay and haylage	%	20.00
Grass hay	%	12.00
Corn silage	%	8.30
High moisture corn	%	10.00
Annual expense variables:		
Labor cost at the margin	Per hour	$ 6.50
Cost of herdsperson	Per year	$27,000.00
Debt to asset ratio		.20
Short & intermediate debt	APR	12.20
Long term debt	APR	11.50
Soybean oil meal	Ton	$ 350.00
Corn grain, No. 2	Bu.	$ 2.50
Alfalfa hay	Ton	$ 65.00
Corn silage	Ton	$ 18.00

PROFITABILITY OF REPRESENTATIVE FARMS

The whole farm budgeting analysis produced the annual profit (or loss) for each farm size and feed acquisition strategy as shown in Table 2. The list of income and expense categories are shown in Table 12. Profit (or loss) includes only milk and dairy animal sales on the income side, as the study assumed each farm

included just enough land to hold the farmstead and to grow the feed crops. No land was available for cash cropping. Because the analysis assumed a long run balance had been reached, there was no inventory change to consider. Depreciation and interest paid on the debt were expenses. Operator labor or family drawing accounts were not expense categories in the profit (or loss) statement.

Table 2. PROFIT (OR LOSS) BY SIZE AND CROP TYPE
Average Yields, 19,200 Lbs. Milk At $11.00 Per Cwt.

Feed Strategy	60 Cows	120 Cows	250 Cows	400 Cows
		Dollars		
All purchased	871	4,176	27,366	73,879
All grown Alfalfa	(7,095)	(8)	21,665	76,748
Roughage grown Alfalfa	(9,533)	(6,267)	6,748	51,343
All grown Corn silage & alfalfa	(13,004)	(11,193)	(1,531)	39,334
Roughage grown Corn silage & alfalfa	(14,876)	(15,299)	(11,040)	24,078

Size And Profitability

Table 2 shows that profitability increased (or losses decreased) as size increased for all but the bottom feed acquisition strategy. Where all feed was purchased, the profit was $15, $35, $109 and $185 per cow for the herd sizes of 60, 120, 250 and 400 cows, respectively. This size advantage generally remained when other profit measures were used; see Tables 4 and 6.

The typical southern Michigan dairy farm currently grows all the needed feed and nearly half the roughage is corn silage. The break-even milk price for this feed acquisition strategy is given in Table 3. The profit (or loss) on the 60 cow farm would have been zero if the price had been $12.19 instead of $11.00 per cwt. of milk sold. The 400 cow farm would have broken even if milk were as low as $10.46 per cwt.

Table 3. PROFIT (OR LOSS) BREAK-EVEN MILK PRICE
All Feeds Grown, Corn Silage And Alfalfa

Farm Size Cow Numbers	Profit (Or Loss) $11.00 Milk	Milk Price To Make Profit Equal To Zero
	Dollars	
60	(13,004)	12.19
120	(11,193)	11.51
250	(1,531)	11.03
400	39,334	10.46

Discussion. This study is similar to several other economic analyses of the past which indicate bigger is more profitable. This is not to say that 60 cow farms are about to fail. It was assumed all capital was purchased as new items. This resulted in depreciation being $38,240 on the 60 cow representative farm growing all feed with corn silage. The average of 50 to 75 cow farms in Michigan in 1988 had 63 cows and a depreciation of $20,030 for buildings and machinery.[6] Also, the 60 cow farm was assumed to have a milking parlor, while in reality most of the farms currently of this size are in stanchion barns. The other expense items were similar comparing the 60 cow representative farm with the 63 cow Telfarm average. Current individual farms in the 60 cow size range may well be profitable for several years to come if major reinvestments are not required.

Feed Acquisition Strategy And Profitability

The feed strategies are listed in Table 2 by their profitably level. The most profitable feed acquisition method was to buy all feeds, except on the 400 cow farm. The least profitable was to grow just the roughage where about half the roughage dry matter came from corn silage. This was true given the assumptions behind this study about crop yields, feed quality and costs.

Other conclusions emerge from Table 2. First, it is better to grow high moisture corn for grain where it is adapted than not to grow it. Second, including corn silage as half the roughage dry matter is the least profitable. Finally, at a milk price of $11.00 per cwt., dairy farms of typical size using traditional combinations of crops and technology could not make enough to cover the cost of purchasing new buildings and equipment.

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[6]Sherrill B. Nott, Business Analysis Summary for Specialized Michigan Dairy Farms, 1988 Telfarm Data, Agr. Econ. Report No. 528, 1989, p. 12.

Discussion. Buying all feed was the most profitable because little land and no cropping equipment was needed. This considerably reduced investments as indicated in Appendix Tables 8 and 11. It assumed management could purchase adequate amounts of high quality alfalfa hay crops. It also assumed that manure could be disposed of upon nearby land owned by others. Very few farmers in Michigan are currently buying all their feeds. This leads the authors to suspect that not all the costs got built into the projections for buying all feeds. There are likely risks and costs associated with buying roughage that are not adequately counted. It is a concept that looks good on paper and works in other parts of the country, but is yet to catch on noticeably in the Lake States Region.

Complete dependence upon alfalfa hay and haylage is another management strategy that is vigorously debated. Much has been written about it. Given a choice, dairy farmers in the past 40 years have generally embraced the growing and feeding of corn silage, even to the point of using little hay in the total ration. It had comparatively high energy, was easier to handle and freed up land for other uses. Corn silage did not appear as profitable in this study as did hay crops alone. This may be because of the assumed relative crop yields of 4.4 tons of alfalfa and 14.3 tons of corn silage per acre. These were 9 year average yields increased about 12 percent.

Critics of this study might say that it takes good management to consistently get 4.4 tons of alfalfa at a minimum protein level of 20 percent. (See Appendix Table 7.) It takes only mediocre luck to get 14.3 tons of corn silage; 18 to 30 tons per acre would be more typical of good management. On an individual farm, relative yields would depend on the soil types available. Critics would also wonder why the protein was balanced with $350 per ton soybean oil meal instead of using at least some nonprotein nitrogen (NPN). The authors doubted NPN would be relatively cheaper than soybeans by 1995, given that NPN is a petroleum based product. Current research indicates corn silage varieties may emerge with higher protein levels than those assumed in Appendix Table 7.

Several Michigan herds depend solely on alfalfa crops, with much of it harvested as haylage. The managers would argue the benefits of the protein being natural. The authors do not expect this study is the final answer to the ongoing alfalfa versus corn silage debate. They are aware that a better technique of analysis would be simulating weather and related risk variability. However, this study does make a strong case for expecting dairy farmers to move towards alfalfa and away from corn silage if the average yield levels and quality coefficients assumed are what can be attained. It is recognized that each farm is unique and the manager must make similar calculations based on their own resources and abilities.

Other Profit Measures

Cash surplus (or deficit). Many farmers believe a business is acceptably successful if it will "cash flow." Table 4 gives the cash flow results by farm size and feed strategy. The 60 cow farm growing all feed with the roughage being only alfalfa had a cash balance of ($115) at the end of the year. The three larger farm sizes had positive cash balances.

Table 4. CASH SURPLUS (OR DEFICIT) BY SIZE OF FARM
Average Yields, 19,200 Lbs. Milk At $11.00 Per Cwt.

Feed Strategy	60 Cows	120 Cows	250 Cows	400 Cows
		Dollars		
All grown Alfalfa	(115)	4,512	29,807	55,761
Roughage grown Alfalfa	(3,747)	(3,372)	14,636	36,907
All grown Corn silage & alfalfa	(4,960)	(4,885)	12,356	37,632
All purchased	(3,861)	(7,562)	1,964	11,041
Roughage grown Corn silage & alfalfa	(7,001)	(9,329)	2,568	24,960

The cash surplus was calculated by ignoring depreciation. Principal payments on the debts, family living, and federal income taxes, if any, were cash outflows. No cash provision for capital replacement was made; any such expenditures would have to come from additional borrowing.

Ranking of the feed acquisition strategies changed when cash surplus was the measure instead of profit or loss. Purchasing all feed was the most profitable in Table 2, but dropped in rankings when measured by cash flow in Table 4. However, Table 4 rankings of feed strategies are a compromise, because they differ depending on farm size. Purchasing all feeds was in third place on 60 cows, but in fifth place on the two largest farm sizes.

The break-even milk price for growing all feeds is given in Table 5. The 60 cow farm will end the year with a zero cash balance if the price goes from $11.00 up to $11.45 per cwt. of milk sold. The 400 cow farm would break-even at $10.41 per cwt.

Table 5. CASH SURPLUS BREAK-EVEN MILK PRICE
All Feeds Grown, Corn Silage And Alfalfa

Farm Size Cow Numbers	Cash Surplus (Or Cash Deficit) $11.00 Milk	Milk Price To Make Cash Surplus Equal To Zero
60	(4,960)	11.45
120	(4,885)	11.22
250	12,356	10.73
400	37,632	10.41

Return on net worth. Another profit measure is the percent return to net worth. The debt capital was paid at the assumed interest rates. The computer software used[7] calculates this by taking the farm profit (or loss) and subtracting the value of the farm operator's labor and management. The latter is $12,500 plus 5 percent of the value of farm production. With the opportunity cost of money being at least 4 to 5 percent on passbook savings accounts, Table 6 indicates no rational investor would consider buying into any of the representative dairy farms shown in this study if milk is expected to sell at $11.00 per cwt. Rankings of feed acquisition strategies again differ from Table 2, but those rations including corn silage remain the poorest choices.

Table 6. RETURN ON FARM NET WORTH BY SIZE OF FARM
Average Yields, 19,200 Lbs. Milk At $11.00 Per Cwt.

Feed Strategy	60 Cows	120 Cows	250 Cows	400 Cows
	Percent			
All grown Alfalfa	(5.4)	(3.1)	(1.2)	.8
All purchased	(5.6)	(4.1)	(1.3)	1.2
Roughage grown Alfalfa	(6.5)	(4.3)	(2.3)	(.3)
All grown Corn silage & alfalfa	(6.8)	(4.7)	(2.7)	(.8)
Roughage grown Corn silage & alfalfa	(7.5)	(5.5)	(3.5)	(1.6)

[7]Richard O. Hawkins, et al, FINLRB.

Labor and management earnings. This profit measure assumed the opportunity cost of the invested net worth was 6 percent. That amount was subtracted from farm profit or loss, resulting in the totally negative values in Table 7 given $11.00 per cwt. of milk sold. By this measure, the loss is smallest on the 60 cow farm compared to the other three sizes. On the fourth and fifth feed strategies listed, it appears the bigger the farm the worse the loss. In the top three rows of Table 7, the results are mixed. The feed acquisition strategies are ranked in Table 7 exactly as they were in Table 2. The rankings hold in Table 7 for all farm sizes except for second and third place under the 60 cow size.

Table 7. LABOR AND MANAGEMENT EARNINGS BY SIZE OF FARM
Average Yields, 19,200 Lbs. Milk At $11.00 Per Cwt.

Feed Strategy	60 Cows	120 Cows	250 Cows	400 Cows
		Dollars		
All purchased	(18,596)	(27,835)	(34,043)	(13,292)
All grown Alfalfa	(36,364)	(49,344)	(75,268)	(63,904)
Roughage grown Alfalfa	(36,227)	(50,751)	(80,516)	(74,312)
All grown Corn silage & alfalfa	(41,453)	(58,782)	(94,836)	(95,847)
Roughage grown Corn silage & alfalfa	(42,080)	(60,398)	(99,303)	(103,084)

Table 8 shows the break-even milk price needed when measuring profits by labor and management earnings. The 60 cow farm would need $14.79 per cwt. of milk sold in order to have zero labor and management earnings. That would mean net worth had earned 6 percent. The 400 cow level of $12.31 is close to the Michigan milk price in 1988 and early 1989; if that price could be expected in the future then 400 cow operations might earn 6 percent on the invested net worth if the operator would work for free.

Table 8. LABOR, MGT. EARNINGS BREAK-EVEN MILK PRICE
All Feeds Grown, Corn Silage And Alfalfa

Farm Size Cow Numbers	Labor And Management Earnings	Milk Price To Make Labor, Management Earnings Equal Zero
	Dollars	
60	(41,453)	14.79
120	(58,782)	13.69
250	(94,836)	13.08
400	(95,847)	12.31

Discussion. Four financial measures have been given to judge the feasibility of the representative farms. They have been consistently calculated using generally accepted formulas. They all give slightly different implications. The economic theoretician would choose labor and management earnings, Table 7, as the most correct, as opportunity cost of all investment is considered. The accountant would choose profit (or loss), Table 2, as it considers actual interest paid and depreciation while ignoring the cost of unpaid operator labor. From this format comes the popularly used "bottom line" term. Both these formats consistently rank the five feed acquisition strategies. Both formats indicate the importance of future milk prices being in the range of $12.10 to $12.40 per cwt. At $12.19 (Table 3) the accountant would encourage even the 60 cow farm to go into business. At $12.31 (Table 8) the economic theoretician would encourage entrepreneurs to invest in the latest technology associated with 400 cow farms.

Owners satisfied with drawing a family living out of the farm without regard to what their investment is earning, often consider only the cash flow, Table 4. If the milk price can stay above $11.50 per cwt., a dairy farmer can survive if milk per cow can stay at or above 19,200 pounds per year. Below $10.50 per cwt., even the two largest farm sizes will not be able to maintain a positive cash flow. Or, if the price falls to $11.00 per cwt. as used in this study, farmers with less than 250 cows will likely be driven out of business.

Financiers, or nonfarm investors, might be interested in Table 6, percent return on net worth. Table 6 indicates that outside investors will not likely be attracted to dairy farms and thereby cause an oversupply situation. But, neither would these returns attract venture capital to farm managers attempting to raise money on the stock market.

SENSITIVITY ANALYSIS

Sensitivity analysis in this study was defined as changing a single variable, while holding all other variables constant, and observing the change in profit (or loss) for the year. Each variable was changed plus or minus ten percent. It was done to the 120 cow farm because it was the smallest size that appeared likely to be profitable. The feed acquisition strategy was to grow all feeds with corn silage being nearly half the roughage dry matter. This was chosen because it most closely approximates how southern Michigan dairy farmers are currently organized.

Table 9 lists and ranks all the variables analyzed. It shows only the change, either up or down, in the variable which caused the profit or loss to increase. If the variables were income related, the change would have the variable increasing ten percent. If the variables were cost related, the change would have the variable decreasing ten percent. The loss from Table 2 was ($11,193). The following tables explain in more detail the relative change in several individual variables.

Table 9. SENSITIVITY TO 10% IMPROVEMENTS
All Feeds Grown; 120 Cows; 19,200 Lbs. Of Milk

Item Improved By 10%	Change In Profit (or Loss)
Price per cwt. of milk sold	$24,077
Milk sold per cow	8,459
Depreciation	5,132
Hired labor	5,041
All purchased feeds	4,449
Hours required per cow	4,164
Salary paid to herdsperson	2,700
Investment in milk, feeding equipment	2,388
Interest paid, all loans	2,364
Hay and haylage yield per acre	2,363
Percent in debt, or D/A ratio	2,342
Hourly wage paid to workers	2,341
Price per cwt. of cull cows	2,066
Investment in crop machinery	1,981
Milk and livestock marketing	1,970
Price per ton of soybean meal	1,922
Repairs, buildings and machinery	1,745
Investment in cow barns, storages	1,683
Corn silage yield per acre	1,627
Hours needed per acre, all crops	1,606
Short, intermediate term interest rates	1,256
Corn grain yield per acre	1,256
Fertilizer	1,213
Long-term interest rates	1,108
Livestock supplies	960
Farm land taxes	903
Veterinary	900
Land price per acre	895
Utilities	849
Investment in heifer barns, storages	690
Price per head of bull calves	627
Breeding fees	540
Hours for haylage, per acre	496
Crop chemicals	448
Hours for corn silage, per acre	431
Fuel and oil	425
Seed expense	388
Hours for corn grain, per acre	281
Farm insurances	267
Miscellaneous	176
Custom hire	144
Death loss in bull calves	33

Income Price Sensitivity

Income variables are shown in Table 10. Moving the milk price by ten percent caused the greatest change in profit (or loss), nearly three times the next closest item on the list. This helps explain the importance to dairy farmers of having strong marketing channels to enhance prices, and the importance of government price support programs. Cull cow prices rank well up on the list, while changing bull calf death loss percentages are the least important in Table 9.

Table 10. PROFIT (OR LOSS) SENSITIVITY TO OUTPUT PRICES
All Feeds Grown; 120 Cows; 19,200 Lbs. Milk

Item	-10%	Base	+10%	Base Profit (or Loss)	Change In Profit (or Loss)
Price of milk, cwt.	9.90	11.00	12.10	(11,193)	± 24,077
Price of cull cows, cwt.	36.90	41.00	45.10	(11,193)	± 2,066
Price of Bob Calves, hd.	99.00	110.00	121.00	(11,193)	± 627
Bull calf death loss, %	4.5	5.0	5.5	(11,193)	± 33

Milk Production Per Cow Sensitivity

Changing milk sold per cow was not done with all other things held constant. To change milk by nearly 2,000 pounds per cow as shown in Table 11, it was felt that feed disappearance, total milk hauling charges, and several other variable cost items would change. This was done, and contributes to the change in profit being the second highest on the list. Notice also that the change from minus ten to plus ten was seldom linear for this variable.

Table 11. IMPACT OF CHANGING MILK SOLD PER COW
All Feeds Grown; $11.00 Milk; 3 Profit Measures

	- 10 % 17,280 Lbs.	Base Milk Yield 19,200 Lbs.	+ 10 % 21,120 Lbs.
		Dollars	
60 Cows:			
Profit (or loss)	(18,013)	(13,004)	(8,877)
Return on net worth	(7.7%)	(6.8%)	(6.0%)
Cash surplus (or deficit)	(9,245)	(4,960)	(1,712)
120 Cows:			
Profit (or loss)	(17,737)	(11,193)	(2,734)
Return on net worth	(5.4%)	(4.7%)	(3.7%)
Cash surplus (or deficit)	(9,998)	(4,885)	1,827
250 Cows:			
Profit (or loss)	(12,392)	(1,531)	20,048
Return on net worth	(3.2%)	(2.5%)	(4.5%)
Cash surplus (or deficit)	4,473	12,356	28,655
400 Cows:			
Profit (or loss)	17,539	39,344	67,439
Return on net worth	(1.6%)	(.8%)	.3%
Cash surplus (or deficit)	24,875	37,632	51,514

Rank And Sensitivity Of Expenses

Table 12 is in the income statement format produced by the software. The expenses were ranked from high to low and the 10 percent change was shown. For these expenses, it was assumed that each could be changed while all other things remained the same. This is probably optimistic, as some things such as fertilizer might be hard to reduce ten percent while maintaining yields per acre. All the expenses in Table 12 were worked into Table 9. Depreciation was the single largest expense. Machinery was depreciated in equal amounts over 7 years; this means that in order to cut depreciation by $5,132 the investment would have to be cut seven times that amount. Buildings were depreciated over 20 years, giving a multiplier of 20.

Table 12. PROFIT OR LOSS STATEMENT FOR 120 COWS
All Feeds Grown, With Corn Silage; 19,200 Of Milk

Milk income	$11.00 per cwt.	$240,768	
Cull cow income		20,664	
Bull calf sales		6,270	
Gross Cash Farm Income		$267,702	10% of Each Expense
Depreciation		$ 51,316	$5,132
Hired labor		50,409	5,041
Purchased feed		44,487	4,449
Interest paid		23,418	2,342
Milk and livestock marketing		19,699	1,970
Repairs, buildings and machinery		17,445	1,745
Fertilizer		12,133	1,213
Livestock supplies		9,600	960
Farm land taxes		9,025	903
Veterinary		9,000	900
Utilities		8,494	849
Breeding fees		5,400	540
Crop chemicals		4,475	448
Fuel and oil		4,246	425
Seed		3,876	388
Farm insurances		2,673	267
Miscellaneous		1,755	176
Custom hire		1,444	144
Total Operating Expense		$278,895	
Profit (or Loss) From The Farm		($ 11,193)	

Labor Efficiency

Total labor cost can be affected by both wage rate and hours required to do a task. Both factors are worked into Table 13. The first three row sets deal with all labor, herds person labor (there was one per farm on the 3 larger farms) and hourly labor to pick up the remaining hours needed. The remaining row sets show the analysis assuming that the marginal rate of $6.50 per hour is the relevant variable. This is the type of labor that would come or go as labor efficiency changes. If all the labor for the 120 cows was charged at $6.50 per hour and took 53.39 hours, the total cost would be $41,644 for the year. If livestock labor per cow could be dropped from 53.39 hours to 48.05 hours per cow, savings would amount to $4,164 per year. This was in sixth place on Table 9. The milking center is a major use of livestock labor, and explains the importance of continuing past research efforts that developed better milking parlor design and automation. Table 13 shows that haylage would

be the most important crop enterprise on which to improve labor efficiency.

Table 13. PROFIT (OR LOSS) SENSITIVITY TO LABOR
All Feeds Grown; 120 Cows; 19,200 Lbs. Milk

Item	-10%	Base	+10%	Base Profit (or Loss)	Change In Profit (or Loss)
			Dollars		
Total hired labor	45,368	50,409	55,450	(11,193)	± 5,041
Herdsperson Salary	24,300	27,000	29,700	(11,193)	± 2,700
Hourly labor					
Per hour	5.85	6.50	7.15		
Total		23,409		(11,193)	± 2,341
Livestock labor					
Hours per cow	48.05	53.39	58.73		
Hourly at $6.50		41,644		(11,193)	± 4,164
Crops, acres		277.7			
Hours per acre	8.01	8.90	9.79		
Hourly at $6.50		16,065		(11,193)	± 1,606
Corn grain, acres		69.8			
Hours per acre	5.58	6.20	6.82		
Hourly at $6.50		2,813		(11,193)	± 281
Corn silage, acres		81.8			
Hours per acre	7.29	8.10	8.91		
Hourly at $6.50		4,307		(11,193)	± 431
Haylage, acres		84.8			
Hours per acre	8.10	9.00	9.90		
Hourly at $6.50		4,961		(11,193)	± 496

Investment Sensitivity

The impact of holding down investment costs is shown in Table 14. Reduced investment meant less depreciation and less debt. In the case of real estate, it also meant less land taxes. An important assumption here was that reducing building investment did not affect milk production per cow. If housing improvements could be shown to increase milk per cow, the impact would be greater than that given in Table 14.

Table 14. PROFIT (OR LOSS) SENSITIVITY TO INVESTMENTS
All Feeds Grown; 120 Cows; 19,200 Lbs. Milk

Investment	-10%	Base	+10%
		Dollars	
Land, per acre	627.30	697.00	766.70
Profit (or loss)	(10,298)	(11,193)	(12,089)
Cow barns, feed storage	170,442	189,380	208,318
Profit (or loss)	(9,510)	(11,193)	(12,887)
Heifer barns, feed storage	69,970	77,744	85,518
Profit (or loss)	(10,503)	(11,193)	(11,884)
Milk, feed and manure handling equipment	128,527	142,808	157,089
Profit (or loss)	(8,805)	(11,193)	(13,582)
Crop machinery	106,173	117,970	129,767
Profit (or loss)	(9,212)	(11,193)	(13,158)

Debt Management Impact

Table 15 shows that a movement up or down in both interest rates paid were about equal to changing the percent in debt, or debt to asset ratio. This would not be true if the interest rates were at a different level. Unfortunately, the main management tool implied by Table 15 is to not go into debt in the first place.

Table 15. PROFIT SENSITIVITY TO INTEREST AND DEBT
All Feeds Grown; 120 Cows; 19,200 Lbs. Milk

Item	-10%	Base	+10%	Base Profit (or Loss)	Change In Profit (or Loss)
Interest Rates:					
Short and intermediate term, %	10.98	12.20	13.42	(11,193)	± 1,256
Long-term, %	10.35	11.50	12.65	(11,193)	± 1,108
All interest rates				(11,193)	± 2,364
Percent in debt	18 (8,851)	20 (11,193)	22 (13,535)	(11,193)	± 2,342

Crop And Feed Sensitivity

Crop yields are changed in the first three row sets of Table 16, while soybean price changes are in the last set. Hay or haylage changes were analyzed with new seeding due to being closely related. It was assumed management changes that would change one would also change the other. All of the changes in Table 16 were assumed to come at no cost. Given this simplifying qualification, hay crop yield increases of 10 percent would increase profit the most of those items in Table 16.

Table 16. SENSITIVITY TO CROP YIELDS AND SOYBEAN MEAL
All Feeds Grown; 120 Cows; 19,200 Lbs. Milk

	-10%	Base	+10%
Hay and haylage,tons	3.96	4.40	4.84
New seeding, tons	1.80	2.00	2.20
Profit (or loss)	(14,077)	(11,193)	(8,830)
Cash surplus (or deficit)	(7,780)	(4,885)	(2,512)
Return on net worth	(5.0%)	(4.7%)	(4.4%)
Corn silage, tons	12.87	14.30	15.73
Profit (or loss)	(13,185)	(11,193)	(9,566)
Cash surplus (or deficit)	(6,884)	(4,885)	(3,252)
Return on net worth	(4.9%)	(4.7%)	(4.5%)
Corn grain, bu.	97.20	108.00	118.80
Profit (or loss)	(12,730)	(11,193)	(9,937)
Cash surplus (or deficit)	(6,427)	(4,885)	(3,624)
Return on net worth	(4.8%)	(4.7%)	(4.5%)
Soybean oil meal, $/ton	$315	$350	$385
Profit (or loss)	(9,271)	(11,193)	(13,115)
Cash surplus (or deficit)	(2,962)	(4,885)	(6,807)
Return on net worth	(4.4%)	(4.7%)	(4.9%)

FUTURE RESEARCH NEEDED

Long term outlook for milk prices to be received is needed. If it is expected to be close to the $11.00 used in this study, then research is needed on alternative ways to assemble and manage dairy farms, because few of the ones in this study appeared profitable. Only the very largest representative farms, and those purchasing all feeds looked viable. Intensive grazing of grassland systems, and possibly seasonal calving, should be explored if milk prices are expected to be low.

If the price is expected to stay at $12.50 per cwt. or more, then the traditional size and operating methods will be more likely to survive. Policy makers will want to consider the potential impacts of alternative milk price levels.

This study is but one more of several over the years that has analyzed corn silage versus alfalfa. This one is not conclusive. More research is needed to understand the risk and variability associated with both crops. Weather sensitive growth models inside simulation models should continue to be useful. Labor needs, especially with self-propelled forage harvesters in

the haylage system, need review. Identifying the response of high producing cows (above 20,000 pounds of milk per cow per year) to various forage qualities by plant species should continue.

Labor continues to be an expensive and frustrating input to manage. Any research to hold investment levels down while reducing labor needs and improving milk per cow will be of value.

SUMMARY

The largest of the 4 farm sizes studied had the most profit (or the least loss), the biggest cash flow and the best percent return to net worth. This was with milking parlor technology on representative farms with 60, 120, 250 or 400 cows. When returns were measured by returns to labor and management, the smallest farm had the least loss.

A milk price of $12.19 per cwt. was needed to get profit (or loss) up to zero on the 60 cow farm. This assumed the owner purchased everything new and borrowed only 20 percent of the total investment needed. The 400 cow farm could break even at $10.46 milk.

Assuming feed prices of $65 per ton hay, $20 per ton corn silage, $2.50 per bushel corn and $350 per ton soybean meal the most profitable feed acquisition strategy was to purchase all feed. Given the yields of 4.4 tons of alfalfa, 14.3 tons of corn silage and 108 bushels of corn grain per acre, the next best choice was to grow all the high moisture corn needed and grow all the roughage as alfalfa, much of it harvested as haylage. These assumptions, feed qualities and ration requirements are all debatable.

Farm profitability was closely tied to the price of milk. The other most sensitive variables, in rank order, were milk sold per cow, depreciation, labor cost, feed cost and hours needed per cow.

Three major conclusions emerged from this study: 1) Bigger farms are apparently more profitable; 2) Michigan farmers may find it profitable to swing more towards alfalfa haylage and less towards corn silage; and 3) Farm milk price must be $12.50 or more if Michigan's large number of farms with fewer than 100 cows are to replace their deteriorating capital and make a slight profit.

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APPENDIX: EXPLANATION AND SOURCES OF ASSUMPTIONS

Feeds

All feed items not in Table 1 were priced as given in the "Spartan" ration balancer plus an index number adjustment. The index for all production items (which includes feeds purchased) for the U.S. was:

147 in 1986
147 in 1987
157 in 1988
165 in July, 1989

where 1977 = 100.[8] From 1986 to July, 1989 the index increased 12.2 percent. This was the adjustment used for minerals, vitamins, calf feed, and other purchased feed prices.

Appendix Table 1. PRICES OF MAJOR FEED ITEMS

Feed	As Fed
Soybean oil meal, per ton	$350.00
Corn grain, no. 2 yellow, bu.	2.50
Alfalfa hay, high quality, ton	65.00
Corn silage, ton	18.00

Table 2 shows the assumed quantities of feed needed per cow per year after allowances for storage and feeding losses. It covered feed for both cows and their replacements.

[8]Michigan Agricultural Statistics Service, Michigan Agricultural Statistics, 1989, MASS-89-01, July 1989, p. 16. USDA, Agricultural Prices, Agricultural Statistics Board, National Agricultural Statistics Service, Pr 1(7-89), July 31, 1989, p. 29.

Appendix Table 2. FEEDS REQUIRED PER COW PER YEAR
Two Roughage Strategies; 19,200 Milk

Feed	All Roughage Alfalfa	Roughage Includes Corn Silage
	As Fed	
Hay crops, ton	6.68	4.20
Corn silage, tons	0	9.75
Corn grain, bu.	112.45	62.83
Dollars of protein, vitamins, minerals, calf feed, etc. purchased	$179.78	$337.74

Tables 3 and 4 summarize recent hay price data. The average price from 1981 through early 1989 for all hay, baled, was $62.98 per ton. Comparing the monthly prices in June, 1987 through September, 1989, alfalfa hay averaged $2.25 per ton more than all hay. In January, February and March, 1989, the auction price of high quality (NIR tested by CES[9] just prior to sale; all samples at the above prices ranged from 13.5 to 20.4 percent crude protein) alfalfa hay in Marion, Michigan, averaged $20.00 per ton more than average alfalfa hay. Starting with the all hay average of $62.98, and adding the $2.25 for alfalfa gave $65.23 per ton. This was rounded to $65 for use in the analysis. This assumed large quantities were purchased. If small quantities of very high quality hay were needed, the above observations indicate an added $20 per ton might be needed.

[9]Done with the portable near infra-red forage testing mobile lab by the Michigan Cooperative Extension Service.

Appendix Table 3. MICHIGAN HAY PRICE STATISTICS

	Marion Auction	Alfalfa Hay	All Hay Baled	Alfalfa Minus All Hay	Marion Minus Alfalfa
1989					
January	125	110	108	2	15
February	135	105	103	2	30
March	125	110	108	2	15
April		105	103	2	
May		110	108	2	
June			108		
July			53		
August			53		
September			63		
October					
November					
December					
1988					
January		70	68	2	
February		70	68	2	
March		65	63	2	
April		65	63	2	
May		75	73	2	
June		80	78	2	
July		100	98	2	
August		90	88	2	
September		85	83	2	
October		90	88	2	
November		105	102	3	
December		110	108	2	
1987					
June		50	48	2	
July		52	48	4	
August		62	58	4	
September		65	63	2	
October		65	63	2	
November		65	63	2	
December		75	72	3	
Averages:	128.33	82.46	78.64	2.25	20.00

Sources: Michigan Agricultural Statistics Service, Michigan Agricultural Statistics, 1989, MASS-89-01, July 1989, 88 pp.
Michigan Agricultural Statistics Service, Agriculture Across Michigan, Vol XI, monthly issues, 1989.
Gerald Lindquist, personal correspondence, 1989.

Appendix Table 4. MICHIGAN AVERAGE ANNUAL HAY PRICES

Year	Average Price All Hay, Baled
1981	$ 56.50
1982	54.50
1983	57.50
1984	61.50
1985	53.00
1986	52.00
1987	60.50
1988	81.67
1989	89.67
	Average: $ 62.98

Sources: Michigan Agricultural Statistics Service, Michigan Agricultural Statistics, 1989, MASS-89-01, July 1989. Michigan Agricultural Statistics Service, Agriculture Across Michigan, Vol XI, monthly issues, 1989.

Because a large volume of corn silage is not bought and sold, there are no market price series for it. One way to develop a value was derived from Ritchie as written up by Weinstock[10] using an energy dry matter comparison table. Given the above assumptions of $2.50 corn and $65.00 hay, interpolating from the table gave $12.72 per ton for corn silage. A long standing thumb rule has been that the price of corn silage was 5 to 6 times the price of corn grain plus $3. per ton.[11] Using those values and the above assumption of $2.50 corn, corn silage would be priced from $15.50 to $18.00 per ton. The highest value was used in this study because it made the gross value per acre of corn grain, hay, haylage and corn silage more nearly the same. It is also the closest to the inventory values dairy Telfarmers have used in recent years.[12]

[10]Weinstock, Dave, "Price It! Comparing Feed Values", Michigan Farmer, September, 1988, p. 12.

[11]Cooperative Extension Service, Guidelines for Salvaging Drought-Stressed Corn, Extension Bulletin E-798, Michigan State University, July 1975, p. 3.

[12]Sherrill B. Nott, Specialized Dairy Type of Farm Summaries, Agr. Econ. Reports, various years.

Livestock And Milk Prices

It was assumed the herd was of mixed ages and freshened about evenly through the year. Cows freshened at least once were valued at $1,100 per head. Bred heifers were valued at $1,000; heifers 6-15 months at $500 and calves below 6 months at $200.

The average price for cull cows during 1981 through September 1989 is shown in Table 5. This was rounded up to $41.00; cull cows were assumed to weigh 1,400 pounds, making the price $574 per cow sold. A cull rate of 30 percent was used; this means there was $172.20 of cull cow income per cow in the herd.

Appendix Table 5. CULL COW PRICES RECEIVED IN MICHIGAN

Year	Cull Cows Per Cwt.
1981	$41.30
1982	39.30
1983	39.10
1984	38.50
1985	36.10
1986	35.20
1987	42.80
1988	45.80
1989	47.10
Average:	40.58

All bull calves were sold within a week of birth for $110 per head. Assuming half the calves born were bulls, and that there was a 5 percent death loss on bull calves before they were sold, there was $52.25 of bull calf income per cow in the herd.

The base run amount of milk produced per cow was 19,200 pounds. This is the equivalent of Michigan DHIA average production of the last several years projected to 1995.[13] This was reduced by 5 percent to get the amount of milk sold per cow. A New York study in 1981 showed that milk sold ranged from 4.9 to 5.5 percent lower than milk produced.[14] Herds with more milk

[13]Dale Darling, A Financial Analysis of Michigan Prototype Dairy Farms for 1995, M.S. Thesis in progress, 1989, p. 33.

[14]C.A. Bratton, A Study of the Differences Between Pounds of Milk Produced and Pounds of Milk Sold per Cow on New York Dairy Farms, 1977 and 1978, A.E. Research 81-79, Cornell University Dept. of Agricultural Economics, 1981, p. 15.

per cow had lower percents, but larger herds had higher percents. The percentage range had not changed much since a similar study in the early 1960's.

The assumed milk price was $11.00 per cwt. on the base runs. This was lower than recent average price levels, and reflects a pessimistic outlook that support prices will drop lower in the future. In the sensitivity analysis, the lower range was $9.90 and the upper was $12.10; these range from a worst case possibility to the current situation at the time of doing the analysis.

Land Values And Real Estate Taxes

In 1987 the average value of agricultural land without improvements was $697 per acre in Michigan.[15] The average real estate tax rate of 46 mills was used[16] which is the same as 2.3 percent of current market value. This 2.3 percent rate was also found in the 1988 dairy Telfarm averages when comparing farm real estate taxes paid to total market value of real estate.[17] The tax rate was charged against the full price of the land. The rate was charged against 70 percent of the cost of new buildings. This recognized that farm improvements seldom realize a market value equal to their new cost.

Crop Yields Per Acre

Table 6 shows average Michigan crop yields from 2 data sources for 1981 through 1989. The impact of the 1988 drought was noticeable. The yields assumed for this study were the average of the Telfarm columns plus a management adjustment of 12.7 percent. This was the same percent difference between 1988 milk sold per cow in Telfarm and the amount of milk sold used in the analysis. The assumption was that if milk production could be that much higher, then crop production of a similar increase would be attained by the management. The yields used were: alfalfa of 4.4 tons, corn silage of 14.3 tons and corn grain of 108.0 bushels (rounded) per acre. The grain yield was based on 88 percent dry matter basis; if it had been on a high moisture basis, the yield would have been 122 bushels per acre.

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[15]Darling, p. 35.

[16]Ibid. p. 31

[17]Sherrill B. Nott, Business Analysis Summary for Specialized Michigan Dairy Farms, 1988 Telfarm Data, Agr. Econ Report No. 528, 1989.

Appendix Table 6. CROP YIELDS PER ACRE, MICHIGAN

Year	Alfalfa Hay MASS#	Alfalfa Hay Telfarm*	Corn Grain MASS#	Corn Grain Telfarm*	Corn Silage MASS#	Corn Silage Telfarm*
1981	3.5	3.9	96	94.2	14.0	13.0
1982	3.5	4.1	107	107.6	14.0	14.5
1983	3.6	4.0	92	94.3	14.3	12.9
1984	3.3	4.1	84	86.0	11.0	11.9
1985	3.6	4.4	105	104.9	13.5	13.9
1986	3.6	4.2	105	107.3	13.5	14.5
1987	3.2	4.0	95	99.5	13.0	12.8
1988	2.6	2.8	70	75.5	7.5	7.9
1989	3.6	na	105	na	na	na
Average	3.4	3.9	95.4	96.2	11.2	12.7
12.7 % Management Adjustment		4.4		108.4		14.3

\# = Michigan Agricultural Crop Reporting Service
* = Specialized dairy Telfarmers on owned cropland
na = Not available at time of writing
Sources: Michigan Agricultural Statistics Service, Michigan Agricultural Statistics, 1989, MASS-89-01, July 1989.
Michigan Agricultural Statistics Service, Agriculture Across Michigan, Vol XI, monthly issues, 1989.
Sherrill B. Nott, Specialized Dairy Type of Farm Summaries, Agr. Econ. Reports, various years.

Nutrient Quality Of Feeds

Table 7 shows the assumed levels of dry matter, protein and energy in the feeds used. They were high quality feeds, except for the grass hay. The grass was needed for the dry cow ration. The high level of protein in the alfalfa caused much of the reduction in dollars of protein purchased as shown in Table 2. Most of the feed composition levels were taken from the ration balancing software.

Appendix Table 7. NUTRIENT COMPOSITION OF FEEDS On 100% Dry Matter Basis

Feed	% DM	% CP	MCal NE/lb.	% ADF	% NDF
Early alfalfa hay	88	20	.61	33	40
Early alfalfa haylage	50	20	.61	30	40
Grass hay	88	12	.56	40	62
Corn silage	33	8.3	.69	28	51
High moisture corn	75	10	.93	5	13
Soybean meal	90	48	.85	10	14

Acres For Crops

Table 8 shows the total acres needed by crop to grow feed for the various feeding strategies outlined above and given the assumed yields per acre. It was assumed the hay crop ground would have to be reseeded every 5 years. This meant that land equal to 20 percent of the hay acres had to be seeded down each year.

Appendix Table 8. CROP ACRES NEEDED BY FEED STRATEGY
Future Crop Yields Per Acre; 19,200 Of Milk

Feed Strategy	60 Cows	120 Cows	250 Cows	400 Cows
		Acres		
All purchased, farmstead	2	3	6.5	8
All grown, alfalfa				
Haylage	68.1	146.8	305.0	490.4
Hay	9.1	20.3	42.6	66.9
New seeding	15.4	33.4	69.5	111.5
Corn grain	62.5	125.0	260.7	417.0
Total Acres	157.1	328.5	684.3	1,093.8
Roughage grown, alfalfa				
Haylage	68.1	146.8	305.0	490.4
Hay	9.1	20.3	42.6	66.9
New seeding	15.4	33.4	69.5	111.5
Total Acres	94.5	203.5	423.6	676.8
All grown, corn silage				
Haylage	39.3	84.8	176.0	283.1
Hay	9.1	20.3	42.6	66.9
New seeding	9.7	21.0	43.7	70.0
Corn silage	37.9	81.8	169.7	273.4
Corn grain	34.9	69.8	146.1	232.8
Total Acres	132.9	280.7	584.6	934.2
Roughage grown, corn silage				
Haylage	39.3	84.8	176.0	283.1
Hay	9.1	20.3	42.6	66.9
New seeding	9.7	21.0	43.7	70.0
Corn silage	37.9	81.8	169.7	273.4
Total Acres	98.0	210.9	438.5	701.4

Variable Costs Per Acre

The costs per acre were taken mostly from 1989 estimates for Michigan conditions.[18] In the analyses where corn grain was grown, it was assumed the manager would not own a combine or other grain harvesting equipment. Instead, it was custom harvested at the 1987 state average rate of $20.68 per acre.[19] It was felt that none of the grain acreages would be large enough to economically justify investing in grain harvesting equipment.

Table 9 gives two fixed costs that were included in the crop and livestock budgets. Telfarm data[20] was used; it indicated the unit costs in Table 9 changed as herd size changed.

Appendix Table 9. COST ASSUMPTIONS FOR INSURANCE AND MISCELLANEOUS

	Per Cow		Per Acre	
No. Cows	Insurance	Miscellaneous	Insurance	Miscellaneous
60	20.40	11.90	2.90	1.70
120	15.80	10.00	2.80	2.00
250	14.10	10.00	2.95	2.40
400	12.20	10.20	3.15	2.90

Acres For Farmstead

It was assumed the following acres would be needed for the farmstead buildings:[21]

Cows	Acres
60	2.0
120	3.0
250	6.5
400	8.0

The same $697 value per acre was used as for cropland, and was added to the initial building investments.

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[18]Sherrill B. Nott, et al, Estimates for Michigan Crop and Livestock Budgets, 1989, Agricultural Economics Report No. 524, Michigan State University, 1989.

[19]Gerald D. Schwab and Kurt Norgaard, Custom Work Rates in Michigan, Extension Bulletin E-2131 (New), CES, Michigan State University, 1988, p. 3.

[20]Nott, Specialized Dairy Type of Farm Summaries.

[21]Darling, throughout.

Variable Costs Per Cow

The variable costs were generally taken from the 1989 enterprise budget book, using budget 86 for the base analysis of 19,200 pounds of milk. The hauling, marketing and assessments were tied directly to milk sold in each analysis. As this budget was for the 20,000 pound level, it was also used for the upper sensitivity analysis of 21,120 pounds; breeding and health costs were increased 10 percent at this higher level. Budget 85 for 18,000 pound of milk was generally used for the lower sensitivity level of 17,280 pounds.[22] The variable costs included those needed for growing the replacements. Feed expenses, however, were treated separately for the cows and the heifers as described in previous sections.

Replacement Heifers

All replacements were assumed to be farm born and raised. With an average freshening age of 26 months, death loss of 10 to 15 percent, and a cull (or turnover) rate of 30 percent, the herd should be able to replace itself and allow for genetic progress. With those assumptions, herd size should be able to increase slowly, or some springing heifers might be available to sell. These latter two income possibilities were not used in this analysis.

Heifer numbers and their feed requirements were closely tied to the techniques used in Wisconsin research.[23] The variable costs of raising heifers were included in the livestock budgets previously described. Using Wisconsin proportions of heifers to cows for the 30 percent cull rate, Darling[24] developed the following feed needs for heifers:

	As Fed	100% Dry Matter
Hay	.83	.73 ton
Haylage	2.98	1.49 ton
High moisture corn	9.23	6.92 bu.
Soybean meal	14.44	13 lbs.

The above is expressed in terms of amounts per cow, per year to feed the age mix of replacements on hand during the year. In the

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[22]Nott, et al Estimates for Michigan Crop and Livestock Budgets, 1989, p. 27.

[23]R.A. Luening, et al, Wisconsin Farm Enterprise Budgets, Dairy Cows & Replacements, A2731, University of Wisconsin Agricultural Bulletin Room 245, 24 pp.

[24]Darling, p. 19.

analysis, these quantities were added into the feeds needed for the milking and dry cows. In addition, there were $33.00 of purchased feeds for heifers on a per cow per year basis for vitamins, minerals, and whole milk or replacer.

Hours For Cows And Crops

The following hours per cow were derived from labor disappearance equations.[25] The form is hours=A+B/X where A = a constant of 39.45; B = 1672.69 and X = the number of cows.

Herd Size	Hours Per Cow Per Year
60 cows	67
120 cows	53
250 cows	46
400 cows	44

This labor was used for milking, feeding, manure removal, and other chores about the farmstead.

Equations from the same source were used for the cropping enterprises in Table 10. The equations may have over estimated the hours required for crops on the smaller enterprises on the 60 and 120 cow farms.

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[25]Nott, et al, Estimates for Michigan Crop and Livestock Budgets, 1989, p. 2.

Appendix Table 10. HOURS PER ACRE FOR CROPS BY SIZE OF FARM

Crop	60 Cows	120 Cows	250 Cows	400 Cows
All feeds grown, alfalfa only:				
Hay	16.5	13.6	12.4	12.0
Haylage	9.2	8.8	8.6	8.6
New seeding	16.6	14.9	14.2	13.9
Corn grain	6.3	5.8	5.6	5.5
Roughage grown, alfalfa only:				
Hay	16.5	13.6	12.4	12.0
Haylage	9.2	8.8	8.6	8.6
New seeding	16.6	14.9	14.2	13.9
All feeds grown, with corn silage:				
Corn silage	8.9	8.1	7.7	7.6
Hay	16.5	13.6	12.4	12.0
Haylage	9.7	9.0	8.7	8.6
New seeding	18.4	15.8	14.6	14.2
Corn grain	7.0	6.2	5.8	5.6
Roughage grown, with corn silage:				
Corn Silage	8.9	8.1	7.7	7.6
Hay	16.5	13.6	12.4	12.0
Haylage	9.7	9.0	8.7	8.6
New seeding	18.4	15.8	14.6	14.2

Owner Management And Labor Time

The Telfarm accounting system has shown over recent decades that dairy farm owner-operators work about 3,200 hours per year on the farm. A New York management study done in the 1960's showed dairy farmers worked less hours per year at regular labor tasks and more on management tasks as farms got larger. Operators worked 81 percent, 76 percent and 68 percent of their total efforts as regular labor when farm sizes were less than 75 cows, 75-124 cows, and 125 cows and over, respectively.[26] The following assumptions were based on the above:

[26]Earl Hughes, Time Spent on Management and Related Activities by Dairy Farm Operators, A.E. Ext. 386, Department of Agricultural Economics, Cornell University, 1965, p. 1.

	% Spent as a Laborer	Hours as a Laborer
60 Cows	80	2,560
120 Cows	75	2,400
250 Cows	67	2,144
400 Cows	60	1,920

The remainder of the time was assumed to be spent managing the operation, time which would be needed in addition to the hours per cow and per acre previously given.

In 1988, dairy Telfarmers averaged 102 cows and drew out $22,384 for family living and personal income tax payments.[27] It was assumed for this analysis that the owner would be paid $12,000 plus 5 percent of the gross sales. This would provide family living. Taxes were based on a family of four. Personal tax payments, if any, would be a further cash draw from the business. This made the 60 cow farm draw less than, and the 120 cow farm draw more than, the $22,384 Telfarm average. Larger farms were expected to reward managers with larger family living allowances.

Hired Labor

The authors did a study of what dairy Telfarmers with herds of more than 200 cows were paying their labor during 1989. On an annualized basis, 199 employees on 15 farms averaged $5.47 per hour of cash wages. Fringe benefits were assumed to be 20 percent of total payroll.[28] This increased the hourly cost to $6.56 per hour. Rounding this off to $6.50 gave the hourly labor cost used in the analysis.

The labor study also identified what appeared to be a herds person on each of 14 farms. The individual was there most of the year and received the highest pay rate. Those people averaged to work 2,875 hours and received a cash wage of $7.77 per hour on an annualized basis. Adding the previously mentioned 20 percent fringe benefits load, that became $9.32 per hour, or an annual salary of $26,795. It was assumed in the analysis a herds person would work 2,875 hours per year at an annual salary of $27,000.

On the 60 cow farms it was assumed the owner would hire workers on an hourly basis at the average rate of $6.50 per hour for all work not done by the owner.

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[27]Nott, Business Analysis Summary for Specialized Michigan Dairy Farms, 1988 Telfarm Data.

[28]Nott, et al, Estimates for Michigan Crop and Livestock Budgets, 1989, p. 4.

On the 3 larger farms, it was assumed there would be one herds person hired at a flat salary of $27,000 per year. For this, the owner would get 2,875 hours per year. Any added labor beyond the owner and herds person would be hired hourly for $6.50 per hour.

Investment And Technology

Table 11 shows the investment levels that were assumed in the study for various types of assets. For income statement analysis, it was assumed that machinery and equipment would be depreciated at a straight line rate over 7 years. Buildings and improvements had a straight line rate over 20 years.

All 4 farm sizes used milking parlor technology, but at various levels of automation. Tractor size varied with size of farm. Self-propelled forage harvestors were budgeted for the two larger farm sizes. Table 12 shows the major technology assumptions behind the investments in Table 11.

Table 13 shows the storage and feeding losses derived from the technology in Table 12. Losses on the 60 cow farm were assumed to be smaller mostly because of the tower silo roughage storages.

Appendix Table 11. INVESTMENT IN FIXED TECHNOLOGY
By Farm Size And Feed Acquisition Strategy

Description	Raise All Feed: Part Corn Silage	Raise All Feed: All Hay or Haylage	Buy Corn Grain: Part Corn Silage	Buy Corn Grain: All Hay or Haylage	Buy All Feed
60 Cows					
Field Equipment	$79,595	$76,520	$77,995	$66,420	$ 0
Equipment for milking, feeding & manure system.	139,084	139,084	139,084	139,084	120,504
Barns and feed storages	155,075	155,075	155,075	155,075	155,075
Totals:	373,754	370,679	372,154	360,579	275,579
120 Cows					
Field Equipment	118,020	114,520	114,820	100,520	0
Equipment for milking, feeding & manure system.	156,788	156,788	156,788	156,788	137,204
Barns and feed storages	267,124	267,124	267,124	267,124	267,124
Totals:	541,932	538,432	538,732	524,432	404,328
250 Cows					
Field Equipment	257,700	250,000	254,500	230,300	0
Equipment for milking, feeding & manure system.	217,100	217,100	217,100	217,100	199,500
Barns and feed storages	531,800	531,800	531,800	531,800	531,800
Totals:	1,006,600	998,900	1,003,400	979,200	731,300
400 Cows					
Field Equipment	351,400	332,100	346,600	310,310	0
Equipment for milking, feeding & manure system.	249,932	249,932	249,932	249,932	224,612
Barns and feed storages	716,200	716,200	716,200	716,200	716,200
Totals:	1,317,532	1,298,232	1,312,732	1,276,442	940,812

Appendix Table 12. PARTIAL LIST OF TECHNOLOGY
All Feeds Grown

	60	120	250	400
45 hp Tractor	1	1	0	0
55 hp Tractor	0	0	1	1
80 hp Tractor	0	1	0	0
90 hp Tractor	0	1	1	0
110 hp Tractor	0	0	1	0
120 hp Tractor	0	0	0	1
130 hp Tractor	0	0	1	2
Skid steer	0	0	1	1
PTO forage harvester	1	1	0	0
SP forage harvester	0	0	1	1
Forage wagons	2	3	4	6
Hay	square	round	round	round
Haylage storage	tower	bunk	bunk	bunk
Corn silage, storage	tower	bunk	bunk	bunk
H.M. corn storage	tower	tower	tower	tower
Milking system*	D-4	D-6	D-8	D-10

*60-cow is manual take-off, rest have automatic take-offs.

Appendix Table 13. STORAGE AND FEEDING LOSSES

	60 Cows	Other Sizes
Hay	9%	18%
Haylage	18	24
Corn silage	18	24
H.M. corn grain	10	10
Soybean meal	2	2

Asset Values

It was assumed each farm had an average bank balance of $1,000 in cash and accounts receivable of 1/24th of gross milk sales. The latter was half a month's milk income. To get an average asset value of feed inventory over a year, it was assumed that a half year supply was on hand at the time the net worth statement was made. The remaining assets were listed at their initial investment value as shown above in Table 11. The livestock values were previously described.

Debt Status

In recent years Michigan dairy Telfarmers have averaged to have equity equal to more than 70 percent of total assets.[29] The assets have been conservatively valued in that series. This was a debt to asset ratio of .3 or less. In the 1987 Michigan dairy farm survey over 26 percent of the farms had a debt to asset ratio of .2 or less.[30] It was assumed in this study that an average debt to asset ratio of .2 existed on the base run farms. This meant 20 percent of the value of each asset group was borrowed money.

Interest Rates And Repayment Terms

It was assumed interest on long term debt was 11.5 percent. Short and intermediate term debt cost 12.2 percent. This was the average (rounded) of national average interest rates as shown in Table 14. By 1989 there was some indication that interest rates were on the rise. There was noticeable variation among lenders and among local associations within the Farm Credit Services. Localized Michigan data of a representative nature were not readily available.

Appendix Table 14. AVERAGE U.S. AGRICULTURAL INTEREST RATES

Year	Federal Land Banks	Production Credit Associations
1981	11.27	14.46
1982	12.27	14.58
1983	11.63	11.95
1984	11.76	12.47
1985	12.24	12.40
1986	11.61	11.22
1987	11.10	10.20
1988	10.10	10.56
1989	na	na
Average:	11.50	12.23

na = Not available
Source: USDA, Agricultural Finance Situation and Outlook Report, AFO-28, Economic Research Service, April 1988 (p. 70-71) and February 1989.

[29]Nott, Specialized Dairy Type of Farm Summaries.

[30]Connor, et al, p. 30.

The analysis was done on an annual basis. The debts were assumed to be amortized with equal annual payments. Short term debts were paid off in one year. Intermediate term debts were paid over 7 years. Long term debts had a 30 year repayment period.