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Financial performance of dairy farms participating in
Minnesota Dairy Initiative (MDI) over time

By

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ECONOMICS**

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Introduction

The dairy industry in Minnesota continues to evolve as farms consolidate and expand their operations, becoming more efficient with the adoption of new technology. In December 2022, there were 1,996 licensed dairy farms operating throughout the state of Minnesota, which is a decrease of approximately 33% from 5 years earlier in December 2017 when 3,105 dairies were in operation (MDA, 2023). Many farms are either consolidating or exiting the industry, however, farmers that enter the industry or remain in it are seeking support to be financially successful.

The Minnesota Dairy Initiative (MDI) is a program available for Minnesota dairy farmers of all sizes and experience levels. Over the last 30 years, the MDI program has helped more than 1,000 farms navigate farm business challenges and decisions (mn-dairy-initiative.org). Within the MDI program, participants are paired with a coordinator who assists in determining goals and areas where opportunities may lie. The coordinator also connects the participant with industry professionals such as a veterinarian, milk processing representative, farm business management educator, crop consultant, lender, or nutritionist to meet their farm business goals.

The purpose of this research is to evaluate farm characteristics and financial performance, as measured by profitability, liquidity, solvency, and efficiency ratios of Minnesota dairy farmers participating in MDI using FINBIN (finbin.umn.edu) data from Minnesota from 1998-2021. Farms that participate in the MDI program are compared to non-participants based on the number of consecutive years of data. Some farms were not in the MDI program when they started contributing data to FINBIN but entered the program at some point throughout the 24-year time period. These farms have data such that financial performance can be compared as a

direct result of entering the MDI program. This study evaluates the impact of MDI and how it may impact farmers' financial performance over time.

Methods

Farms are divided into three categories, *non-participants*, *participants*, and *entrants* to perform two distinct studies. The first group, “*non-participants*” includes farms that never participated in the MDI program but contributed data to FINBIN. The “*non-participants*” serves as the baseline control group for the analysis. The second group, “*participants*,” consisted of the farms that always participated in MDI while contributing data to FINBIN. The third group, “*entrants*,” include farms that did not participate in MDI when they first contributed FINBIN data and joined the MDI program while participating in the Farm Business Management (FBM) program. Farms were coded into one of these three categories to perform *across-farm* and *within-farm* comparisons.

The *across-farm comparison* analyzes farm characteristics and financial performance of *participants* and *non-participants*. The second study is a *within-farm comparison* in which the farm's performance before entering the program, at program entry, and after entering the program are analyzed. The separate studies are conducted to determine (1) how farms in the MDI program compare with farms not in the program and whether their performance is statistically different from their peers due to program participation and (2) what areas of financial performance are impacted when entering MDI and when the impacts are realized.

Across-Farm Comparison

The across-farm study compares farm and financial characteristics of *participants* to *non-participants* using nearest-neighbor matching methodology, comparing farms with 1, 2, 3, 4, and 5-10 years of consecutive data (Abadie, et al., 2004). Years 5-10 are combined into one group for data confidentiality purposes. Because the dairy industry is highly volatile and the study time period covers 24 years (1998-2021), if average values were compared, they may be skewed depending on which years more of the observations are derived from (Blayney and Normile, 2017). For example, participants could have a majority of their observations from 2014 when dairy was a highly profitable industry, and non-participants could have a number of observations from low profitability time periods. In this case, the MDI participants would have a substantial, favorable financial performance, but this would be biased, and the impact of the program would be overestimated as the estimates would capture the differences in the overall state of the industry. Therefore, rather than averaging different characteristics between the groups, nearest-neighbor matching is used using the “nnmatch” command in Stata (StataCorp, 2021). In this method, *participants* and *non-participants* are matched based on the observation year and the number of years they were in the dataset. MDI participant farms in their first year in the dataset are matched with non-participants farms in their first year in the dataset, and these are also matched on the data year.

Within-Farm Comparison

The within-farm study analyzes *entrants*, which are the farms that did not participate in MDI when they first started contributing data to FINBIN and entered the MDI program at some point throughout the 24-year time series. For this group, the farm’s performance is compared against itself over time to determine the impact of the MDI program. Farm performance is

recorded before entering the program and after participating, so the direct impact of the program on the farm is obtained. Due to market conditions and the year in which the observations are derived from, there will be volatility between average values of the financial variables and farm characteristics. Therefore, the average year-over-year changes are compared at initial entry to the MDI program, 1 year after entry, and 2 years after program entry. Creating the year-over-year change variable eliminates volatility from market conditions and observation year to show the direct impact from the MDI program.

Data

This research uses FINBIN (finbin.umn.edu) data which is a farm financial data source housed by the Center for Farm Financial Management (CFFM) at the University of Minnesota. Data are collected through a collaboration between CFFM and the Minnesota Farm Business Management (FBM) program and are publicly available in an aggregate format. This research utilizes data from Minnesota farms categorized as dairy farms or dairy and crop farms from 1998-2021 to compare the financial performance and farm characteristics of dairy farmers participating in MDI¹. Comparing MDI participants with non-participants demonstrates the impact MDI has for dairy producers. One unique characteristic of FINBIN data is that farmers report data annually. Farm financial performance can be measured over time rather than at one independent point of time. Within the data, farms are coded annually as MDI participants or non-MDI participants. Farms participating in the MDI program are not required to participate in the

¹ FINBIN farms are coded by type (crop, dairy, crop and dairy, hog, crop and hog, beef, crop and beef, sheep, crop and sheep) based on which enterprise(s) generates 70% or more of the farm's income. If no crop, livestock, or crop and livestock enterprise generates over 70% of revenue, the farm is categorized as other.

Farm Business Management program, and as a result, the sample of MDI participants in this data does not include all MDI participants throughout the state.

Figure 1 reports the number of MDI and non-MDI participants submitting data to FINBIN annually. The number of MDI participants has remained fairly constant over time with approximately 60 farm observations in a given year. Meanwhile, the number of observations for non-MDI participants has decreased substantially over the 24 years from over 500 observations in 1998 to approximately 150 observations in 2021. The overall decrease of dairy and dairy and crop farms in Minnesota participating in FINBIN from 1998-2021 is nearly 70%, and the U.S. has been experiencing similar decreases in the number of licensed dairy farms. USDA-NASS reported a 57.6% decrease in dairy farms from 2003-2021 (70,375 in 2003; 29,858 in 2021).

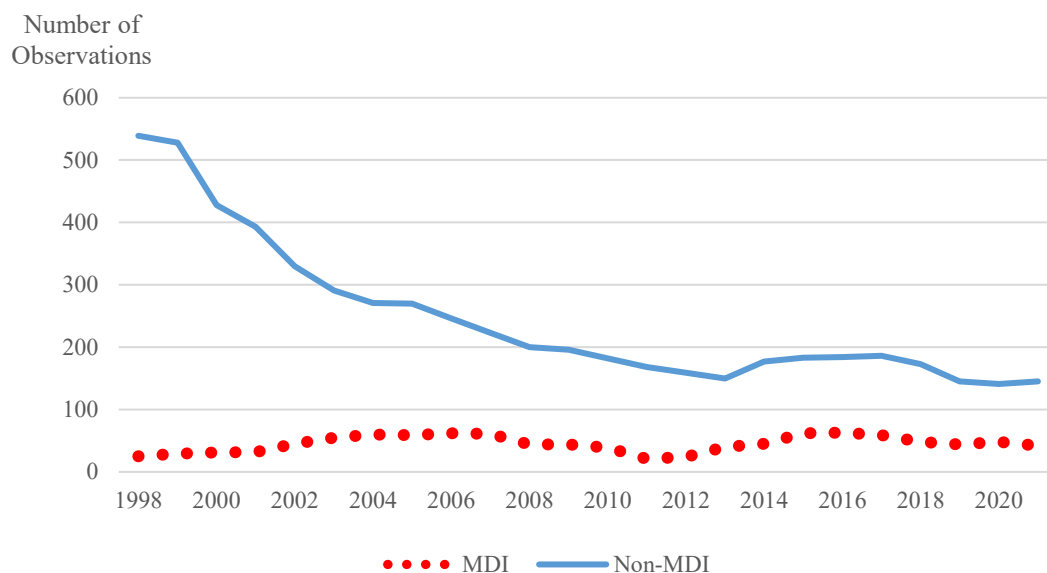


Figure 1: Number of MDI and Non-MDI participants annually, 1998-2021

In this analysis, farm performance is evaluated over time rather than looking at a single point in time. This is an important aspect as current market conditions impact a farm's

performance and the program likely builds upon itself. For that reason, farm financial performance is compared based on the number of years of consecutive data the farm contributed to FINBIN. A farm can enter and leave the program and dataset annually, therefore, analyzing a farm's financial performance based on the years of consecutive data allows for a true representation of the benefits of the MDI program. Farms with 1, 2, 3, 4, and 5-10 years of consecutive data are analyzed to determine the impact of the MDI program on farmers' performance over time. Farms that exited and reentered the dataset are not included, and farms with 5-10 consecutive years of data are combined into one group due to data confidentiality purposes.

Some farms were in the MDI program and then exited the program but remained in the dataset. In this case, the years of observations for the farm after exiting the program were not included since the farm had previously received the program benefits and cannot be used as a control. The final sample used in this study contained 6,990 observations of which 5,273 observations were *non-participants*, 658 were *participants*, and 1,059 were *entrants* (Table 1).

Table 1: Farm participant group definitions and sample size, 1998-2021

Group	N	Definition	Study used in
Non-participants	5,273	Farm never participated in MDI	Across-farm
Participants	658	Farm participated in MDI every year	Across-farm
Entrants	1,059	Farm did not participate in MDI initially, but entered the program at some point throughout the study period	Within-farm

Eleven farm and financial characteristic variables were studied. Farm characteristics include herd size, acreage, and percent of acreage owned. Financial characteristics include measures of profitability (operating profit margin, rate of return on assets, net farm income per

cow), liquidity (current ratio), solvency (debt-to-asset ratio), and efficiency (operating expense ratio, interest expense per head, depreciation per head) (Table 2). The operating profit margin, rate of return on assets, current ratio, debt-to-asset ratio, and operating expense ratio are winsorized to control for extreme outliers². Net farm income, interest expense and depreciation expense are all measured on a per head basis and inflated to 2021 dollars using the Minneapolis Fed Consumer Price Index (Federal Reserve Bank of Minneapolis, 2022).

Table 2: Variables and descriptions

Variable	Definition	Calculation
<i>Farm Characteristics</i>		
Herd Size	Herd size	Herd size
Total Acres	Total operated acres	Total operated acres
Acres owned (%)	Percent of acres owned	Total owned acres / Total operated acres
<i>Financial Characteristics</i>		
OPM ⁺	Operating profit margin	Operating profit / Total revenue
RROA ⁺	Rate of return on assets	Return on assets / Average assets
NFI ⁺	Net farm income per cow	Net farm income / Herd size
CR ⁺	Current ratio	Total current assets / Total current liabilities
DA ⁺	Debt-to-asset ratio	Total liabilities / Total assets
OER ⁺	Operating expense ratio	(Total expense – interest expense – depreciation expense) / Total revenue
Interest Expense [*]	Interest expense per cow	Total interest expense / Herd size
Depreciation Expense [*]	Depreciation expense per cow	Total depreciation expense / Herd size

Notes: “+” indicates variable is winsorized. “*” indicates variable is inflated to 2021 dollars. Operating profit and return on assets are equivalent measures. These are calculated as (Net farm income from operations + interest expense – the opportunity cost of labor and management)

Results Discussion

Summary statistics are reported for the full sample and each of the three groups that were created for the analyses (Table 3). These summary statistics provide a baseline and cannot be

² Winsorizing variables control for extreme outliers by replacing any observations with a value below the 1% level with the 1% value and any observations with a value above the 99% level is replaced with the 99% value (Hastings et al., 1947 Ludwig-Mayerhofer, 2020).

directly compared across groups because of changing market conditions. One group may have many observations from years in which the dairy industry had high profitability and growth while another group may have a substantial proportion of its observations from periods of economic hardships. The Farm Financial Standards Council (FFSC) provides benchmarks on the commonly used measures of financial performance (Table 4; cffm.umn.edu). These benchmarks are used to describe the financial performance summary statistics.

The average farm size operated 347 acres and milked 122 cows, and this ranged across groups (Table 3). Farms in the dataset owned approximately 49% of their operated acres on average. The average farm had a vulnerable operating profit margin. However, retaining 10.59-12.57 cents per dollar of revenue generated is substantial considering this is a 24-year time series. Regardless of segmentation, farms have a fair rate of return on assets ranging from a 5.97% to 6.79% return on all investments on the farm. Dairy farmers are highly liquid as feed inventory is a current asset, and this is shown with a strong current ratio. Farmers had fair levels of solvency and efficiency as measured by the debt-to-asset ratio and operating expense ratio.

Table 3: Summary Statistics, 1998-2021

Variable	All		Participants		Non-Participants		Entrants	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
<i>Farm Characteristics</i>								
Herd Size	6,381	121.53	649	121.83	4,717	123.29	1,015	113.15
Total Acres	6,601	346.94	617	293.96	4,956	354.32	1,028	343.20
Acres owned (%)	5,860	49.08	507	46.27	4,430	49.49	923	48.63
<i>Financial Characteristics</i>								
OPM ⁺ (%)	6,601	12.12	617	11.07	4,956	12.57	1,028	10.59
RROA ⁺ (%)	6,589	6.61	617	6.26	4,944	6.79	1,028	5.97
NFI ⁺ (\$/cow)	5,986	971.39	617	867.43	4,385	1,021.86	984	811.69
CR ⁺ , (\$)	6,273	3.88	603	3.36	4,686	4.12	984	3.07
DA ⁺ (%)	6,600	52.23	617	53.75	4,955	51.31	1,028	55.76
OER ⁺ (%)	6,600	73.25	617	75.13	4,955	72.87	1,028	73.93
Interest Expense* (\$/cow)	5,981	335.72	616	295.75	4,382	340.20	983	340.81
Depreciation Expense* (\$/cow)	5,973	376.90	617	342.87	4,372	391.31	984	334.21

Notes: Data are from FINBIN, 1998-2021. “+” indicates variable is winsorized. “*” indicates variable is inflated to 2021 dollars. Total number of observations for each variable is not 6,990 as some have missing values.

Table 4: Farm Financial Scorecard Ratio Ratings

Variable	Vulnerable	Fair	Strong
OPM	<15%	15-25%	>25%
RROA	<4%	4-8%	>8%
CR	<1.3	1.3-2.0	>2.0
DA	>60%	30-60%	<30%
OER	>80%	60-80%	<60%

Across-Farm Comparison

Farms with 1, 2, 3, 4, and 5-10 years of consecutive data are compared. These farms are matched by the data year and years of consecutive data to define the average treatment effect. Results are displayed in Table 5. “1” refers to the first year farms are in the dataset, “2” refers to the second year of data for the farm, and so forth. Coefficients with an asterisk indicate that there are statistically significant differences for the *MDI participants* and *non-participants* for that specific variable of interest.

In the first year MDI participants have a larger herd size. Their dairy herd has 25 more cows than non-participants. MDI participants also have favorable interest and depreciation per head expenses. Participants incur an interest expense \$36 per head lower than that of non-participants and their depreciation expense is \$54 per head lower than non-participants. This suggests that the MDI program helps dairy farmers manage their debt load early in their career. Participants had no statistically significant difference in profitability, liquidity, or solvency in their first year.

In the second year of consecutive data, the only characteristic that has a statistically significant difference between MDI and non-MDI participants is the depreciation expense per

head. Again, MDI participants had a favorable measure with an average depreciation expense that was \$80 per head lower than non-participants. There is no difference in the farm characteristics, current ratio, debt-to-asset ratio, operating expense ratio, interest expense per head, or the three profitability measures between participants and non-participants from a statistical standpoint in the second year.

In the third year, farms differ in liquidity and solvency. Non-MDI participants have favorable ratios with a higher current ratio and lower debt-to-asset ratio. The participants' debt-to-asset ratio is 7.7% higher than non-participants. Similar to the results from the second consecutive year, there is no difference in profitability or farm characteristics.

Results for the fourth year of consecutive data are not presented as none of the characteristics have statistically significant coefficients, indicating that there are no differences between MDI and non-MDI participants once they are in their fourth year in the program. This suggests that the MDI program may be beneficial for farms early in their career to build a financial structure that is sustainable long-term.

Furthermore, in years 5-10, the non-MDI participants have a favorable rate of return on assets, net farm income per cow, debt-to-asset ratio, operating expense ratio, and percentage of acres owned, but no statistically significant difference in the interest expense or depreciation expense as found earlier. It is likely that after 5 years, MDI participants and non-participants have other factors driving their success. Participants may also be investing in non-depreciable assets such as land to enhance business viability which would impact financial performance. The authors also recognize that data granularity may confound these results since the 5th-10th years are combined into one group. This was done due to low sample size and data confidentiality, and

it is possible that aggregating five years of data together caused the differences between participants and non-participants.

Table 5: Average treatment effect results for MDI Participants and Non-Participants

Consecutive Years		1		2		3		5-10
Variable	N	Coefficient	N	Coefficient	N	Coefficient	N	Coefficient
<i>Farm Characteristics</i>								
Herd Size	1611	25.3111** (11.385)	945	11.353 (11.466)	628	10.041 (17.197)	1297	-27.592 (19.048)
Total Acres	1707	-10.378 (42.914)	974	-12.343 (30.050)	657	29.365 (84.457)	1309	-48.491 (77.747)
Acres owned (%)	1451	-0.234 (3.314)	851	0.887 (4.083)	587	3.316 (5.834)	1198	-16.9741*** (4.565)
<i>Financial Characteristics</i>								
OPM ⁺ (%)	1707	0.529 (2.159)	974	2.029 (2.283)	657	1.368 (2.278)	1309	-3.215 (2.119)
RROA ⁺ (%)	1698	0.774 (0.859)	971	-0.364 (0.912)	657	-0.546 (0.783)	1309	-1.4135* (0.823)
NFI ⁺ (\$/cow)	1482	-34.620 (94.231)	873	-87.017 (113.111)	583	-146.950 (129.342)	1227	-273.1563* (165.702)
CR ⁺ (\$)	1625	-0.181 (0.607)	927	-0.915 (0.617)	632	-1.8436*** (0.455)	1236	0.742 (1.272)
DA ⁺ (%)	1707	-2.061 (2.709)	973	1.717 (3.358)	657	7.6928** (3.889)	1309	14.5178*** (5.117)
OER ⁺ (%)	1707	1.406 (1.284)	974	0.218 (1.684)	657	0.749 (1.802)	1309	3.8625** (1.559)
Interest Expense* (\$/cow)	1479	-36.5347* (20.762)	872	-26.037 (25.008)	583	18.534 (32.795)	1227	21.169 (19.030)
Depreciation Expense* (\$/cow)	1475	-54.1966** (24.000)	868	-80.4542*** (27.237)	583	-25.989 (50.279)	1226	-52.020 (47.308)

Notes: Coefficients for the average treatment effect of participating in MDI are displayed. Standard errors in parentheses. The column header “1” refers to the first year of data, “2” refers to the second year of consecutive data for the farm, and “5-10” are grouped together. “*”, “**”, and “***” indicate significance at the 10%, 5%, and 1% levels respectively.

Within-Farm Comparison

Entrants are farmers that were not in the MDI program initially but entered the program at some point in the dataset, and these farmers have farm data before and after entering the program. The annual year-over-year changes are compared to determine the impacts the program had on those farms, but there are no statistical significance implications. The year the farmer entered the program, one year after entry, and two years after entering the MDI program are analyzed (Table 6). The expectation is that participation in the MDI program would increase the farm's financial performance.

In the program entry year, many areas of financial performance were worse compared to the year before starting the program, but the magnitude is small. As time progresses and the farmer participates in the program, a positive impact is realized for most of the financial characteristics, but there are large standard deviations suggesting that these results should be interpreted cautiously as there may be no statistical significance. The percent of acres owned and depreciation expense were the only characteristics that moved in a favorable manner in the year of entry. When a farmer enters the MDI program, the farm's operating profit margin was lower. The farm retained 1.78 cents less in profit than the year before on average. However, as participation in the program continues, this difference is eliminated, and the farm was better off on average with positive, annual increases in the operating profit margin. The results are similar for the rate of return on assets and net farm income per cow where initially the farm has a slightly lower profitability than the prior year, but after a few years, the farm has gained the skills to experience an increase in profitability relative to the prior year. The debt-to-asset ratio, operating expense ratio, and interest expense were similar in that it took 1-2 years to realize favorable gains from the program.

Herd size and acreage increase each year, which is not surprising as this is the overall trend in agriculture, and these are likely not due to the MDI program but rather the overall industry trends. The percent of acres owned decreases over time which indicates that farms are increasing their acreage through renting.

The current ratio had net decreases annually, however, dairy farmers tend to be highly liquid, and it is possible this is not an area that the MDI program focuses on improving. Lastly, the depreciation expense per head decreased in the program entry year and the year after entry but increased two years after entering the program. It is possible that the increased profitability led the farmer to purchase more equipment and depreciable assets over time which would then increase the depreciation expense for the farm.

Table 6: Summary Statistics of the average annual changes for Entrants: at entry, 1 year after entry, & 2 years after entry

Variable	At entry			1 year after entry			2 years after entry		
	Obs	Mean	Std dev.	Obs	Mean	Std dev.	Obs	Mean	Std dev.
<i>Farm Characteristics</i>									
Herd Size	163	6.98	19.42	96	4.79	11.87	52	3.96	12.96
Total Acres	174	13.24	103.54	92	6.59	48.23	51	26.18	93.46
Acres owned (%)	147	0.88	16.53	80	-0.71	13.19	45	-4.63	13.39
<i>Financial Characteristics</i>									
OPM ⁺ (%)	174	-1.78	28.25	92	1.71	29.99	51	4.86	19.23
RROA ⁺ (%)	174	-0.94	11.84	92	-0.01	10.37	51	0.86	9.37
NFI ⁺ (\$/cow)	154	-15.06	1101.70	92	-61.97	1062.05	51	145.66	839.94
CR ⁺ , (\$)	163	-0.28	7.14	87	-0.21	4.69	49	-0.25	3.29
DA ⁺ (%)	174	0.53	13.23	92	-1.29	11.93	51	-2.18	7.28
OER ⁺ (%)	174	1.07	16.56	92	0.83	15.64	51	-2.84	10.80
Interest Expense* (\$/cow)	154	0.34	165.93	92	-7.80	108.53	51	-15.27	117.41
Depreciation Expense* (\$/cow)	154	-15.14	151.25	92	-24.66	161.78	51	46.58	152.64

Notes: Data are from FINBIN, 1998-2021. “+” indicates variable is winsorized. “*” indicates variable is inflated to 2021 dollars. Net farm income, interest expense, and depreciation expense are measured on a per head basis. Each variable is measured as the change from the previous year.

Conclusion

This research examined the impact of the Minnesota Dairy Initiative program, evaluating eleven areas of farm characteristics and financial performance of Minnesota dairy farmers from 1998-2021. Three groups were created that include farms always in the MDI program (*participants*), farms never in the MDI program (*non-participants*), and farms that enter the MDI program at some point within the dataset (*entrants*). Given these groups, two different studies were imposed.

The first was an across-farm comparison of participants and non-participants. This comparison showed that in the first year, MDI participants had larger herd sizes and favorable interest and depreciation expenses per head than non-MDI participants, but overtime these results become insignificant. Specifically, in the fourth year, there is no difference between MDI participants and non-participants, suggesting that the impacts from the MDI program are felt early on, especially as it pertains to debt management skills. Non-participants had favorable financial performance in the 5-10 year category which may be due to participants investing in non-depreciable assets, such as land.

The second part of the study was a within-farm analysis that compared farmers once they enter the MDI program and determine how their performance changed. Some of the changes are likely due to industry trends such as increased herd size and acreage. Many other characteristics had favorable outcomes one to two years after entering the program such as the operating profit margin, rate of return on assets, net farm income per head, debt-to-asset ratio, operating expense ratio, and interest expense per head, suggesting that the program benefits are lagged.

This research analyzed the Minnesota Dairy Initiative program which directly impacts producers, and program participation resulted in many favorable outcomes. Understanding the impact of the MDI program is essential for potential participants and could increase visibility of the program as well as enhance the longevity of the dairy industry.

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