Sustainable Farming Systems:

Demonstrating Environmental and Economic Performance

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Sustainable Farming Systems: Demonstrating Environmental and Economic Performance

Foreword

Farmers are searching for alternatives to current agricultural practices in order to reduce environmental risk and increase profit margins. In some areas, adverse impacts of agricultural practices on the environment have led to contentious interaction among land managers, the public, and governmental agencies.

Based on experience and observations, many farmers tell us that alternative systems are better for the environment and can be more profitable. However, the quantitative data to document this is limited. These observations led us to develop new partnerships to evaluate alternative farming practices. Our philosophy is that greater adoption of practices that make agriculture more sustainable requires increased efforts to include a wider audience and greater participation from farmers, researchers, land owners, private sector representatives, agency personnel, community members, and non-profit organizations. The goal of our project was to accelerate the adoption of community-based, sustainable farming systems by bringing all parties on board at project inception to help diffuse conflict and build lasting partnerships. Empirical data were needed to aid in this effort.

The Sustainable Farming Systems (SFS) Project was launched in 1997. Built around two Minnesota watershed teams (Sand Creek and the Chippewa River Watershed), the SFS participants researched the impacts of different farming systems on soil erosion, water quality, and the profitability of rotational grazing. We also looked at home and community quality of life of farmers and rural land owners. We were able to expand the range of monitoring tools available for farmers, including the breadth of what is being measured across disciplines or system components. Additionally, we identified a range of monitoring tools -- from informal to rigorous methods -- to assess impacts of their practices.

Teams used outreach mechanisms such as bird walks, canoe trips, slide shows, pasture walks, and stream-side workshops to educate themselves and other residents about the relationship between management decisions and environmental consequences. In the course of the four year project a total of 80 educational events were held that were attended by over 5,200 participants

This report presents some of the major findings of the SFS team, specifically highlighting the results of the water quality research (beginning on page 1) and the economic analyses (beginning on page 13). Other materials describing the team's work are available; contact the Minnesota Institute for Sustainable Agriculture to obtain more information.

Executive Summary:

Research and Economic Analysis Findings

It may seem obvious, but it is a fact too often not heeded on the land. New research documents once again that the more farmers choose to include plants that cover the soil in their farming systems, the cleaner the water that comes off their fields. Pastures, hay, and small grains provide the leafy cover that can soften and absorb a rainfall. On the other hand, the more farmers choose to plant corn or soybeans, the more soil and nutrients are washed by rainfall into receiving waters. Unfortunately, Minnesota's cropping trends are in direct conflict with cleaning up the water.

But a growing number of sustainable farmers are implementing farming systems that maximize the vegetation cover of their soil. Continuous vegetation in the form of permanent pasture for grazing livestock can be an ideal choice for minimizing pollution. Crop rotations of hay and small grains grown alternately with corn and soybeans are also proven to benefit water quality.

But what is best for the environment also has to be profitable for the farmer. New research documents that what is better for the land can also be a more profitable system. Dairy grazing systems in particular can net more income than traditional dairies that confine animals and harvest crops for feed.

The Sustainable Farming Systems Project profiled three farms in great detail, measuring soils, rainfall, and runoff from their fields. At the same time, extensive data on production and finances were analyzed to evaluate the bottom line. Four years of painstaking research proved that these sustainable farms simultaneously benefit the environment and economically benefit the farm family. The dual goal of sustaining the land and sustaining the farmer is proven to work.

Vegetative Cover Holds Back Pollution

One of the profiled farms is located in the Sand Creek watershed; this watershed is one of the biggest contributors of sediment in the entire Minnesota River Basin. Steep slopes, vulnerable soils, and higher than average rainfall could have contributed to disastrous soil losses. But the dairy farm that was studied, run as an organic grazing system, performed exceptionally well. A combination of pasture and contour strips rotated between alfalfa hay, corn, soybeans, and small grains constitute a farming system that demonstrated its ability to hold sediment and nutrients on the field. Normal rainfalls released almost no pollution.

The most erosion of the entire study was caused by one huge rain event, when over four inches of rain fell. But even that storm only released 52 pounds of sediment per acre, well below the accepted tolerance level. Meanwhile, another study being conducted nearby on exactly the same type of soil, showed dramatically different results. With the only difference being that corn and soybeans were the crops grown, fields that had been plowed resulted in 20,000 pounds (or ten tons) of eroded soil per acre. Corn fields under conservation tillage lost 10,000 pounds (or five tons) of eroded soil per acre. Those erosion levels are well beyond what can be replenished by natural soil building.

Results from a computer model supported the finding. The profiled farm was analyzed to predict how changing the crops would affect the runoff after major storms. Over the

twenty-year simulation, pastures are predicted to release virtually no sediment, about 18 pounds per year. Pasture rotated with crops is predicted to lose 900 pounds of soil per acre each year, and continuous corn would lose 5200 pounds per acre each year.

A second dairy grazing farm in the Sand Creek watershed, with a gently rolling pasture in continuous grass and legumes for over ten years, held the soil so well that even higher than average precipitation over the three years of monitoring resulted in no runoff, with one exception. In other words, permanent pasture not only held the soil and nutrients in place, but most of the time it absorbed all the rainfall. The exception was a torrential five-inch rainfall that did result in water runoff, but it was relatively clean runoff, carrying only minute amounts of sediment and nutrients.

The third profiled farm is located in the Chippewa River watershed, also part of the Minnesota River basin. It has a mostly flat pasture where beef cows and calves are rotationally grazed. Again, the soil cover of pasture prevented any runoff from most rainfalls. Three storms did cause some runoff that carried sediment, but at rates 20-40 percent less than average for the watershed. The computer model was again used to predict what would happen over twenty years, comparing pasture to a conventional corn/soybean system on flat land. The model predicts that a corn system would result in large increases in sediment and phosphorus losses — almost ten times more sediment and four times more phosphorus would be lost compared to a pasture system during an average storm.

Pasture Systems Profitable for Dairy Farms

Sure a sustainable system is better environmentally, but can you make money? Most emphatically, yes.

Two dairy grazing operations were intensely studied to examine their profitability. One farm has a smaller than average herd, 41 cows, producing organic milk. The other farm has a larger than average herd, 141 cows, producing regular milk. Both farms provide about one third of the feed needs from pasture during the growing season, and supply the rest from various grains grown on the farm.

Despite the unconventional grazing system, both operations were exceptionally healthy from a financial point of view. They each met the definition of stable to strong financial health for 16 whole farm indicators, with only one exception. (One of the farms had higher than recommended cash expenses one year due to improvements to the farm, but they made up for it by obtaining a conservation payment.) The net farm incomes for the two farms averaged $57,000 and $83,000. Expenses were held down relative to income, and it was done without the oppressive debt so common on today's livestock farms. High quality milk brought higher prices. Furthermore, each farm had diversified with alternative enterprises that accounted for one fifth of their income and helped to spread out their risk and increase profits.

But is a sustainable system as profitable as a conventional system? Again, an emphatic yes for the profiled farms.

The larger dairy grazing farm brought in two to three times the net farm income of similar dairy farms in the region, because they kept their input expenses and overall debt load relatively low. Although the grazing operation was slightly less productive in milk per

cow, it made up for that in reduced cow replacements and higher milk prices due to volume and quality premiums.

The smaller profiled dairy grazing farm also was more profitable than similar conventional farms. The grazing farm's net income was one and a half to three times higher than its peers. Again, the grazier reported below average milk production per cow, but made up for that in reduced cow replacements and higher milk prices — this time due to the 14 percent price premium paid for organic milk throughout the study period.

The farms' additional enterprises, produced using sustainable systems, were also more profitable than conventional enterprises in the same region. Both farms sold replacement heifers for a higher profit than their conventional peers. Moreover, one farm made fifteen times the average profit on 50 hogs a year by charging a premium to their direct market customers and using by cheap, on-farm feeds. The other saw five times the average net return for soybeans, thanks to organic market price premiums and lower costs. Note that yields were considerably lower per acre, but the net return per acre, what really matters to farmers, was substantially higher.

A separate analysis of the pasture enterprise suggests that pasture can be a profitable use of farmland. The two farms netted $22 and $96 per acre for their pasture enterprises. These returns do not represent cash income, but instead represent the opportunity cost of utilizing prime cropland for pasture. By comparison, other crop choices returned much less to other Minnesota farmers throughout the study period. Corn, for example, returned a negative $15 per acre (including government subsidies). Similarly, oats returned only four dollars per acre. On the other hand, alfalfa hay was slightly more profitable at $108 return per acre. Pasture and hay can both be more profitable crop alternatives that generate feed cost savings and higher profit.

The third profiled farm presents a less rosy picture. It is also a grazing operation, one raising beef cows and their calves. The 28-year old farmer expanded from 34 to 70 cow-calf pairs over the study period, using 145 acres of pasture and 90 acres of alfalfa and corn silage. This beginning farmer faced several problems common to many beginning farmers and other start-up businesses, in addition to some uniquely bad luck. Net farm income was negative, and both spouses worked full time jobs off the farm. Compared to other small farms in the region, the profiled farm was equally vulnerable on several financial measures, largely due to a relatively high level of debt, to be expected at a young age. The grazing system had a level of success with herd management similar to traditional beef cow systems, but higher feed costs ate into profits. Again, start-up costs are partly to blame, as the farmer is investing in pasture fertilization in these early years that will pay off later in lower feed costs. A combination of a barn fire that destroyed winter feed and other weather related herd mortality problems resulted in further losses.

This farm's data shows that sustainable farming systems find it just as difficult to overcome the barriers to beginning farmers as conventional farming systems. However, despite the problems of the start-up years, the financial analysis showed that there is potential for long-term profitability. Since herd management is good and operating expenses are kept low, this farm only has to reduce feed costs by increasing stocking rates of cattle on pasture acres, and reduce fertilizer costs to become competitive with traditional operations.

The research shows that sustainable farms demonstrate environmental and economic performances that match and often exceed conventional farms.

Water Quality Research

Introduction

Minnesota has experienced serious water quality degradation in the last century. Nowhere is this more evident than the Minnesota River, one of the most polluted rivers in America. The Metropolitan Waste Control Commission (1994) has documented frequent violations of state and federal acceptance levels for bacteria, phosphorus, turbidity, and dissolved oxygen at several monitoring stations along the Minnesota River. These problems, however, are not limited to the river. They also affect the Minnesota River's entire drainage system.

The Minnesota River Basin, which drains 15,000 square miles of Minnesota, has experienced a profound change in land use. A landscape that was once predominatly prairie and wetland has been drained, plowed, and settled. Row crop agriculture, intensive animal production, and urbanization now dominate the Minnesota River Basin. These significant land use changes are responsible for water quality degradation.

Farm management decisions have a direct impact on the quality of both ground and surface waters. In Minnesota, the use of agricultural chemicals, fertilizers, and animal manure have resulted in ground and surface water contamination. Nitrates and pesticides have been detected in domestic wells. Runoff containing agricultural chemicals and fertilizers has polluted the state's rivers and lakes. Eutrophication and decreased levels of dissolved oxygen in ponds and lakes have killed large numbers of fish and aquatic organisms. Eroded topsoil clouds surface waters and reduces the productivity of farmland. All of these problems are serious. An even greater concern is the far-reaching effects of Minnesota's water quality degradation, which go beyond the state's borders.

Land management practices in Minnesota and other Midwestern states are adversely impacting the waters of the Gulf of Mexico. Fertilizers and nutrients from Minnesota farms, feedlots, lawns, and gardens enter the Minnesota River, flow into the Mississippi River, and empty into the Gulf of Mexico. This nutrient laden water has been blamed for the appearance of a large hypoxic zone in one of the Gulf of Mexico's important fishing regions and the subsequent decline in the fishing industry (Downing et al., 1999).

Research is essential to quantify the impact of land and farm management practices on soil and water quality indicators. This study quantifies the impact of sustainable farming practices on water quality. Besides the use of fewer off-farm inputs, sustainable farmers use methods such as increased crop rotations, reduced tillage, permanent pasture, and forages. Benefits to the soil from these practices include increased aggregate stability, water infiltration rate, water holding capacity, and organic matter, and decreased soil erosion—all of which are thought to contribute to a healthier environment and cleaner water. The study also used a computer simulation model to predict the long-term impact on water quality from changes in these management systems.

Eight farms in the Minnesota River Basin were monitored. These farms used a wide range of management systems: organic grass milk production; rotational grazing of beef and dairy cattle, sheep, and hogs; conventional dairy production; and ridge-tilled row crops. Four farms were in the Sand Creek Watershed, which is a subwatershed of the Lower Minnesota River Watershed (Fig.1), and four were in the Chippewa River Watershed (Fig. 2). This report includes only those farms for which both water quality and financial data were available.

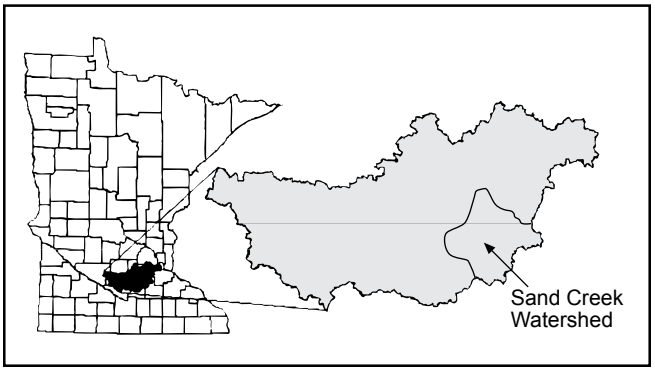

Figure 1. Lower Minnesota River Watershed.

Materials and Methods

Within each farm, one field-sized watershed between 6 and 100 acres was selected. Each site was surveyed and the topography mapped. The soils at each site were sampled according to soil type and landscape position. Soil samples were analyzed for nitrate-nitroge (NO_3-N), ammonium-nitrogen (NH_4-N), total nitrogen, available phosphorus, total phosphorus, pH, and soil organic matter. An automatic water monitor and sampler (ISCO 6700) (Fig. 3) was positioned so that all water leaving the site as runoff could be measured and sampled. Collected water samples were analyzed for: sediment; NO_3-N and NH_4-N; and soluble, particulate and total phosphorus. Each site had a rain gauge that collected rainfall at 5-minute intervals. Data on management inputs—such as tillage, planting, harvesting, grazing, and fertilizer application—were collected from the farmer. The monitoring season was April through October.

Long-term water quality simulations for this study were conducted with the Agricultural Drainage and Pesticide Transport (ADAPT) computer model. The ADAPT model runs on a daily time step and requires input data for precipitation, temperature, cropping system management, site topography, and soil information. The model was calibrated using the collected water quality and soil data. Long-term (20-year) simulations using different management scenarios were run with the calibrated model.

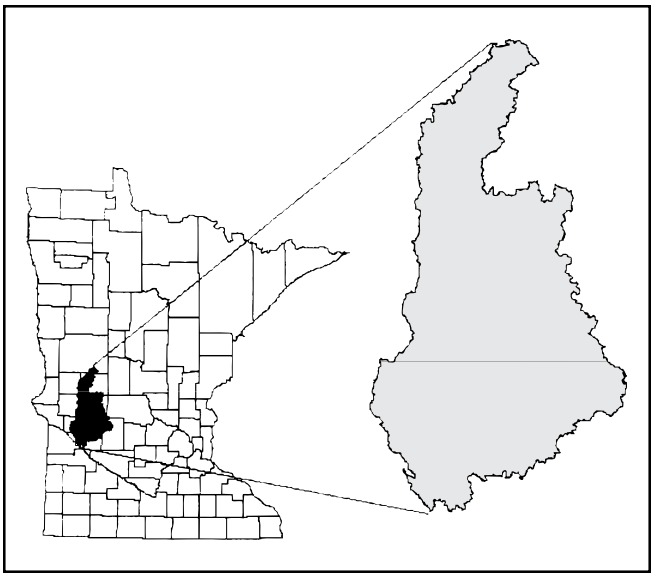

Figure 2. Chippewa River Watershed

Figure 3. Automatic water monitor and sampler, ISCO 6700, with rain gauge and tile line access manhole for instrument maintenance.

Sand Creek Watershed

Introduction

The Sand Creek Watershed lies within the Lower Minnesota River Watershed. The Lower Minnesota River Watershed, which is only about 12% of the Minnesota River Basin, releases a disproportionate amount of sediment and nutrients into the basin's waters: 26% of sediment, 12% of total nitrogen, and 32% of total phosphorus (Mulla, 1997). A Metropolitan Waste Control Commission report (1994) also noted that the Sand Creek Watershed has a high, disproportionately negative impact on the water quality of the basin. The Sand Creek Watershed comprises only 1.7% of the land area of the Minnesota River Basin, yet it is responsible for 13.2% of sediment, 3.6% of total nitrogen, and 8.6% of total phosphorus found in the Minnesota River as it empties into the Mississippi River. The higher rainfall and steeper topography of the Sand Creek Watershed compared to the Minnesota River Basin as a whole are two factors that explain these large contributions. However, land management practices that leave soil vulnerable to sediment and nutrient loss compound these natural conditions.

About 63% of the Sand Creek Watershed is tilled, with the majority (60%) under conventional tillage. Row crop corn/soybean systems, when combined with conventional tillage practices, are particularly vulnerable to erosion. Grass and forages provide ground cover for long periods of the year and hold soil in place during runoff events. However, management practices within the watershed that include grass and forages in crop rotations have been declining.

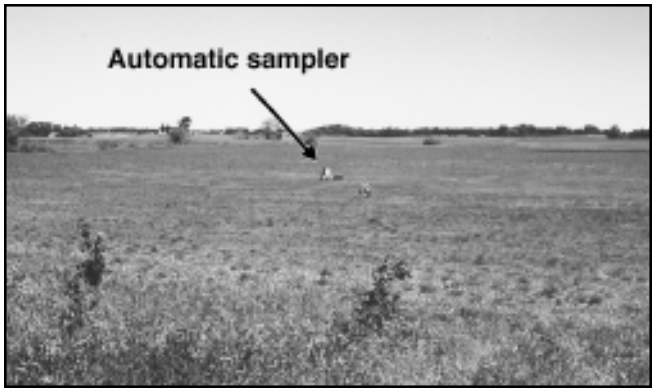

Figure 4. Farm One: Dairy Grazing Farm monitoring site, showing the location of the automatic water monitor and sampler.

This study specifically monitors the effects of alternative and sustainable farming practices, including permanent pastures and forages, on water quality. The two Sand Creek Watershed sites covered in this report are both grazing dairy farms. One is a sustainable Dairy Grazing Farm (Farm One), and the other is a certified Organic Dairy Grazing Farm (Farm Two).

Farm One: Dairy Grazing Farm

The first monitoring site was located on a Dairy Grazing Farm in a field that had been in grass/legume hay production for more than 10 years (Fig. 4). The monitoring site was 15.5 acres of gently rolling terrain with an average slope of 2% (Fig. 5). The soils were Lester loam, Le Sueur loam, and Webster silty clay loam, which developed on calcareous clay loam till under tall grass prairie. The Lester loam is well drained, has a slightly acid to neutral pH, and a soil organic matter content of 5%. The Le Sueur loam is moderately well drained with a neutral pH and 5% soil organic matter. The Webster silty clay loam is poorly drained, has a slightly acid pH, and 16% soil organic matter. Runoff from the watershed exited the site through a surface inlet. A manhole was installed downstream of the inlet to allow access for installing the automatic water monitor and sampler. The automatic water monitor was positioned so that all water leaving the site as runoff could be measured and sampled.

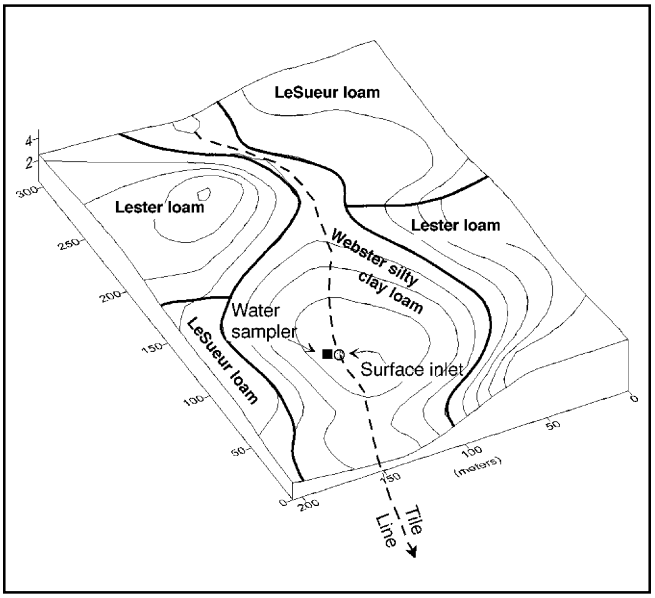

Figure 5. Topography and soil types of the Farm One monitoring site, showing location of the surface inlet and automatic water monitor and sampler.

Table 1. Rainfall, tile line flow, and water quality data from Farm One for the monitoring seasons of 1998, 1999, and 2000.

	Rainfall	Tile flow	Sediment	Nitrate	Phosphorus		
					Soluble	Particulate	Total
	--------(inches)--------		----------(lb./acre)----------				
1998							
April	3.0	0.00	0.0	0.00	0.00	0.00	0.00
May	4.3	0.00	0.0	0.00	0.00	0.00	0.00
June	8.7	0.35	0.8	0.01	0.03	0.02	0.05
July	3.5	0.00	0.0	0.00	0.00	0.00	0.00
Aug.	3.6	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	1.2	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	2.9	0.00	0.0	0.00	0.00	0.00	0.00
Totals	27.2	0.00	0.0	0.00	0.00	0.00	0.00
1999							
April	4.2	0.00	0.0	0.00	0.00	0.00	0.00
May	5.1	0.00	0.0	0.00	0.00	0.00	0.00
June	3.3	0.00	0.0	0.00	0.00	0.00	0.00
July	4.4	0.00	0.0	0.00	0.00	0.00	0.00
Aug.	4.2	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	1.3	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	1.2	0.00	0.0	0.00	0.00	0.00	0.00
Totals	23.7	0.00	0.0	0.00	0.00	0.00	0.00
2000							
April	0.8	0.00	0.0	0.00	0.00	0.00	0.00
May	5.3	0.00	0.0	0.00	0.00	0.00	0.00
June	6.1	0.00	0.0	0.00	0.00	0.00	0.00
July	3.4	0.00	0.0	0.00	0.00	0.00	0.00
Aug.	2.4	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	0.9	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	0.9	0.00	0.0	0.00	0.00	0.00	0.00
Totals	19.8	0.00	0.0	0.00	0.00	0.00	0.00

Water Quality

Water quality data for the growing seasons of 1998, 1999, and 2000 are reported in Table 1. Precipitation recorded at this site was higher than the 30-year normal (22.6 inches) for the first two years and lower than average in the last year. Only one runoff event was recorded during the three years of the study. This event occurred at the end of June 1998 as the result of a large, intense rainstorm. This rainstorm covered the entire watershed and was recorded at all Sand Creek Watershed monitoring sites. Despite the heavy and prolonged rainfall (more than 3 inches of rain in 3 hours; more than 5 inches total), sediment loss was only 0.8 lb/acre. Correspondingly low amounts of nitrogen and phosphorus were also recorded. This one rainfall accounted for 100% of all the sediment and nutrients leaving the field.

Whether a rainstorm causes runoff and erosion is dependent on land management practices. If the soil has no vegetative cover, it is vulnerable to erosion. This is easily seen when comparing Farm One to another University of Minnesota research site a few miles away, which experienced the same June rainstorm (Hansen, 1999). Dr. Neil Hansen was using a corn/soybean rotation to investigate the effects of tillage practices on water quality. The soils at his site were the same as Farm One, but with a steeper (6-8% slope) topography. Due to the sites' similarities, sediment loss from Farm One was compared to sediment loss recorded at Hansen's site. Hansen measured sediment loss of 5 and 10 ton/acre from chisel and moldboard plowed parts of his field, respectively.

Computer Model Simulation

Because there was only one runoff event during the three years of the study, insufficient data made it impossible to calibrate the ADAPT model. Therefore, long-term simulations were not conducted for Farm One.

Conclusion

It took rainfall from an unusually intense and heavy rainstorm to generate the one runoff event recorded at this site. As almost no soil was exposed to raindrop impact, sediment and nutrient loss were minimized, and the water quality of the runoff remained high. This site is not contributing to the water quality problems of the Sand Creek Watershed.

Farm Two: Organic Dairy Grazing Farm

The second monitoring site was located on 21 acres of an Organic Dairy Grazing Farm (Fig. 6). The site had a mixture of permanent pasture, forages, and crops (Fig. 7). The contour strips, situated on the steeper part of the site, had a rotation of oats/alfalfa/alfalfa or alfalfa/corn/alfalfa for the three years of the study. The soils on Farm Two are Lester loam, Le Sueur loam, and Webster silty clay loam (Fig. 8), which developed on calcareous clay loam till under tall grass prairie. The Lester loam is well drained, has a slightly acid pH, and 3.5-4% soil organic matter. This soil has a slope steepness of up to 18% and has undergone moderate erosion with the introduction of agriculture. The Le Sueur loam, with a 2% slope, is moderately well drained, has a slightly acid pH, and a soil organic matter content of 6%. The level Webster silty clay loam is poorly drained, has a slightly acid pH, and a soil organic matter content of 10-16%. Runoff from the watershed exited the site through a surface inlet. The automatic water monitor was positioned in the tile line downstream of the inlet such that all water leaving the site as runoff could be measured and sampled.

Water Quality

Water quality data for the growing seasons of 1998, 1999, and 2000 are reported in Table 2. Precipitation for the first two years was higher than the 30-year average (22 inches), with May and June being the wettest months. As expected, higher tile line flows from drainage and runoff occurred during the beginning of the growing season. Tile flow tapered off as rainfall decreased, and air temperatures and crop demand increased. Summer

Figure 6. Farm Two: Organic Dairy Grazing Farm monitoring site, showing permanent pasture, countour strips, and the location of the surface inlet.

rainstorms also caused runoff events and were responsible for the sediment, nitrate, and phosphorus recorded in the tile line flows from June through October. In the third year, rainfall was below normal; there were no runoff events except for two caused by small rainstorms in July and August.

As stated earlier in this report, there was a large, intense rainstorm at the end of June 1998 (more than 3 inches of rain in 3 hours; more than 5 inches in total). As a result, the site's losses of sediment, nitrate, and phosphorus were 52.8, 0.58 and 0.59 lb./acre, respectively (Table 2). This event was responsible for 97% of sediment, 67% of nitrate, and 100% of total phosphorus losses for 1998. A rainstorm of this severity occurs about once every 25 years. Though infrequent, these large storms are responsible for the majority of erosion.

The impact of land management practices on erosion can been seen by comparing this site to Neil Hansen's corn/soybean tillage research site a few miles away. The sites had the same soils. However, Farm Two had slopes of up to 18% compared to slopes of 6-8% at the tiled site. As a result of the June 1998 storm, Hansen measured sediment losses of 5 and 10 ton/acre from chisel and moldboard plowed parts of his corn/soybean rotation field, respectively. Despite the flatter slopes at the tillage site, these losses were substantially higher than Farm Two's sediment loss of 52.8 lb./acre.

Computer Model Simulation

Data from this site were used to calibrate the ADAPT model. The model was then run to predict the long-term impact on water quality as the result of a change in land management practices. Three scenarios were simulated: (1) no change from the existing permanent grass and forage/corn rotation, (2) a conventional corn/soybean rotation—a cropping system common in the watershed, and (3) permanent pasture over the entire site.

The results of the 20-year simulation predict that losses of sediment, nitrate, and phosphorus would greatly increase should this site be managed in a conventional corn/soybean system (Fig. 9). For example, at the 0.5 probability of a loss event (i.e. a rainstorm large enough to cause sediment and nutrient loss could happen once in every two years), sediment loss from grass, grass and crops, and corn systems would be 3.5, 670 and 3600 lb./acre, respectively. As the severity of rainstorm events increase, the model predicts slight increases of sediment, nitrate, and phosphorus loss in the grass-based systems. The model predicts large loss increases for the corn-based system, a prediction supported by Hansen's experience.

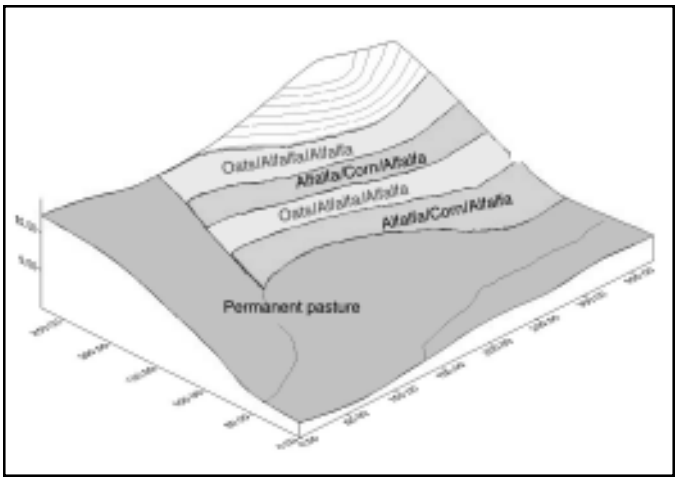

Figure 7. Cropping Systems of the Farm Two Monitoring Site.

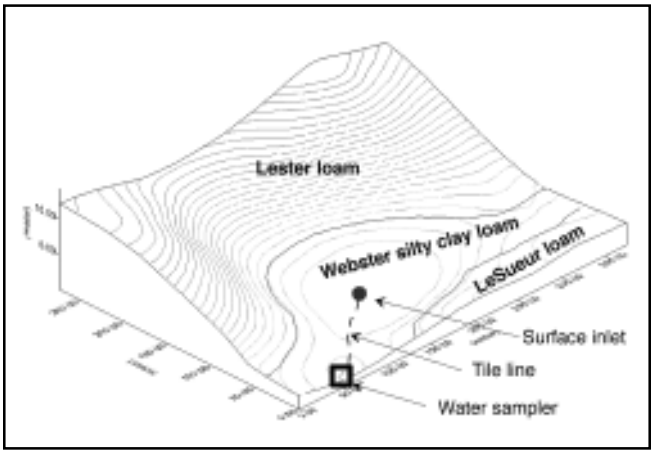

Figure 8. Topography and soil types of the Farm Two monitoring site, showing location of the surface inlet and automatic water monitor and sampler.

Conclusion

Farm Two reinforces the important role grass and forages play in reducing sediment and nutrient losses from the rolling topography found in the Sand Creek Watershed. This area of Minnesota receives much of its rain in the spring and early summer when row crops offer little protection against raindrop impact because they are not well established. Established grass and forages, on the other hand, are able to hold the soil in place all year round. A computer model predicts that there would be a large increase in sediment and nutrient losses if this site were managed in a conventional corn/soybean rotation.

Table 2. Rainfall, tile line flow, and water quality from Farm Two for the monitoring seasons of 1998, 1999, and 2000.

	Rainfall	Tile flow	Sediment	Nitrate	Phosphorus		
					Soluble	Particulate	Total
	--------(inches)--------		----------(lb./acre)----------				
1998							
April	1.8	7.6	0.0	0.00	0.00	0.00	0.00
May	5.1	0.3	1.0	0.03	0.00	0.00	0.01
June	7.8	5.2	52.8	0.58	0.27	0.32	0.59
July	4.0	2.1	0.4	0.24	0.00	0.00	0.00
Aug.	3.7	0.1	0.0	0.01	0.00	0.00	0.00
Sept.	0.9	0.0	0.0	0.00	0.00	0.00	0.00
Oct.	1.4	0.0	0.0	0.00	0.00	0.00	00.0
Totals	26.5	15.3	54.2	0.86	0.27	0.32	0.60
1999							
April	3.8	2.2	1.9	0.39	0.01	0.02	0.03
May	8.5	5.1	8.6	0.64	0.02	0.03	0.05
June	4.3	0.4	2.5	0.06	0.01	0.00	0.01
July	3.3	0.02	0.1	0.00	0.00	0.00	0.00
Aug.	3.6	0.03	0.2	0.01	0.00	0.00	0.00
Sept.	1.4	0.0	0.0	0.00	0.00	0.00	0.00
Oct.	0.9	0.0	0.0	0.00	0.00	0.00	0.00
Totals	26.4	7.70	13.3	1.10	0.04	0.06	0.09
2000							
April	0.9	0.0	0.0	0.00	0.00	0.00	0.00
May	3.7	0.0	0.0	0.00	0.00	0.00	0.00
June	4.3	0.0	0.0	0.00	0.00	0.00	0.00
July	3.1	0.001	0.02	0.00	0.00	0.00	0.00
Aug.	4.0	0.002	0.03	0.00	0.00	0.00	0.00
Sept.	1.2	0.0	0.0	0.00	0.00	0.00	0.00
Oct.	0.9	0.0	0.0	0.00	0.00	0.00	0.00
Totals	18.1	0.024	0.05	0.00	0.00	0.00	0.00

To reduce amount of soil and nutrients entering Sand Creek and, therefore, its contribution to the poor water quality of the Minnesota River, it is necessary to introduce more grass and forages into existing cropping systems. While most erosion losses are recorded as a result of major storm events, the suitable management of soil can mitigate these losses, as this site demonstrates.

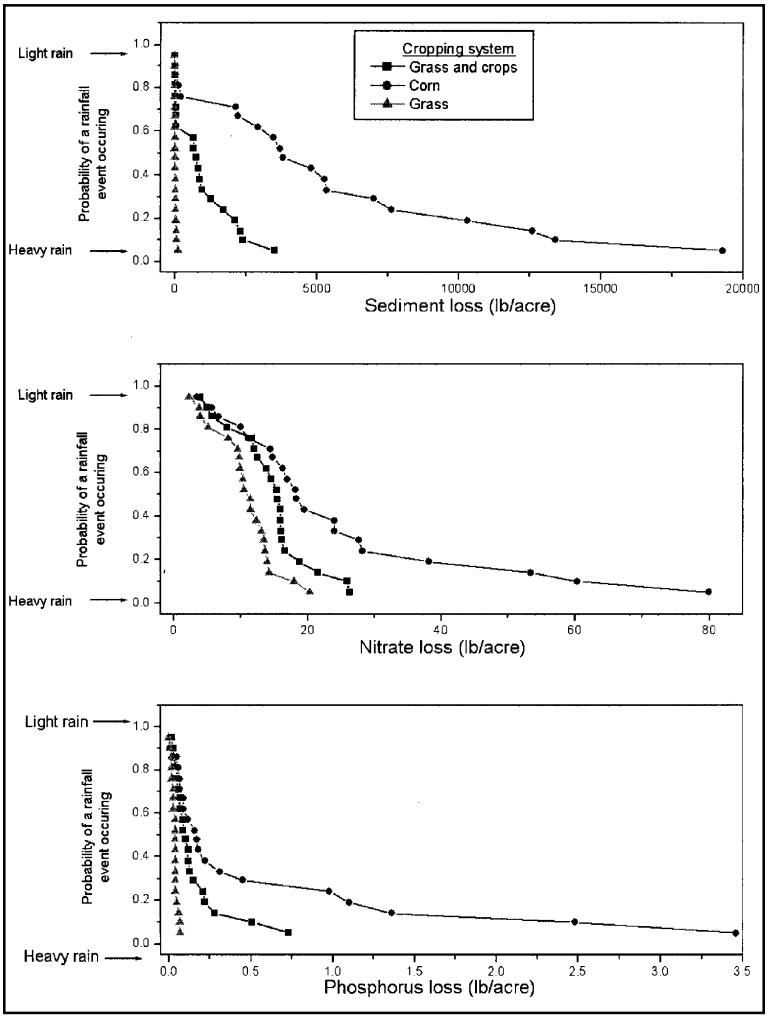

Figure 9. Results from the ADAPT computer model long-term (20-year) simulation. Predicted losses of sediment, nitrate, and phosphorus from three cropping systems at the Farm Two monitoring site.

Chippewa River Watershed

Introduction

The Chippewa River Watershed is located on the western end of the Minnesota River Basin. Of the two watersheds in this study, the Chippewa River Watershed contributes less to poor water quality than the Sand Creek Watershed. The Chippewa River Watershed, which drains 1.3 million acres of Minnesota, has been heavily drained; over 95% of the original wetlands in the lower basin are gone. Most of the watershed is intensively farmed, with row crops such as corn and soybean predominating. The Chippewa River Watershed comprises 14% of the land area of the Minnesota River Basin, and is responsible for 4% of the sediment, 2% of the nitrogen, and 6% of the phosphorus in the Minnesota River (Mulla, 1997). The lower rainfall in the west combined with flatter topography contributes to lower sediment and nutrient losses from the watershed compared to the Sand Creek Watershed.

Farm Three: Beef Cow-Calf Grazing Farm

The third monitoring site was located on a Beef Cow-Calf Grazing Farm in the southern end of the watershed. The farmer rotationally grazed a cow-calf beef herd in the summer months (Fig. 10). The site, which had been in a corn/soybean rotation, was in permanent grass/legume pasture during the study. The soils of the monitoring site are a McDonaldsville silty clay and a Rothsay-Zell silt loam (Fig. 11). The poorly drained and almost level McDonaldsville soil is on a former glacial lakebed and formed from fine textural lacustrine material over laying calcareous sandy outwash. This soil has a slightly acid pH and a soil organic matter of 5%. The Rothsay-Zell soil formed from delta outwash. This soil, which has a 5.5% slope, has experienced some erosion due to previous farming practices. It has a neutral pH and a soil organic matter of 2.5%. Runoff from the site was directed through a culvert under the township road and then through a Parshall flume. The automatic water sampler was placed at the flume (Fig. 12).

Water Quality

Water quality data for the growing seasons of 1998, 1999, and 2000 are reported in Table (3). There were three runoff events recorded at this site during the three years of the study. The runoff events came in the two drier years, 1999 and 2000. During these events, the sediment eroded—8.9 and 4.1 lb./acre for 1999 and 2000, respectively—was less than the 21.8 lb./acre average reported by the Chippewa River Watershed Project (Olson, 2000).

Whether a rainfall event causes runoff and erosion is highly dependent on land management factors. If the soil has little or no vegetative cover, it is vulnerable to erosion. The small runoff event in June 2000 was a case in point. Rotational grazing allows livestock to graze only a small area at one time. In this instance, the cattle—which had just entered the field—were restricted to a small area of pasture at the west end. This period of restriction coincided with a small but intense rainfall event (0.88 inches in less than one hour). The section of pasture, which had been grazed down by the livestock, was churned up by hoof action (Fig. 10). Consequently, the resulting runoff carried with it a higher-than-usual load of sediment.

Computer Model Simulation

The data from this site were used to calibrate the ADAPT model. The model was then employed to predict the long-term impact on water quality from a change in land management practices. Two scenarios were simulated: (1) no change from the existing permanent grass/legume pasture and (2) a conventional corn/soybean rotation—a cropping system common in the watershed.

The results of the 20-year simulation predict that losses of sediment, nitrates, and phosphorus would greatly increase should this site be managed in a conventional corn/soybean system (Fig. 13). For example, at the 0.5 probability of a loss event (i.e. a rain event large enough to cause sediment and nutrient loss could happen once in every two years), sediment loss from grass/legume and corn systems are 50 and 450 lb./acre, respectively. The model predicts large increases in sediment and phosphorus losses as the severity of rainstorms increase in corn-based systems as compared to losses predicted in grass-based systems.

Figure 10. Farm Three: Beef Cow-Calf Grazing Farm monitoring site.

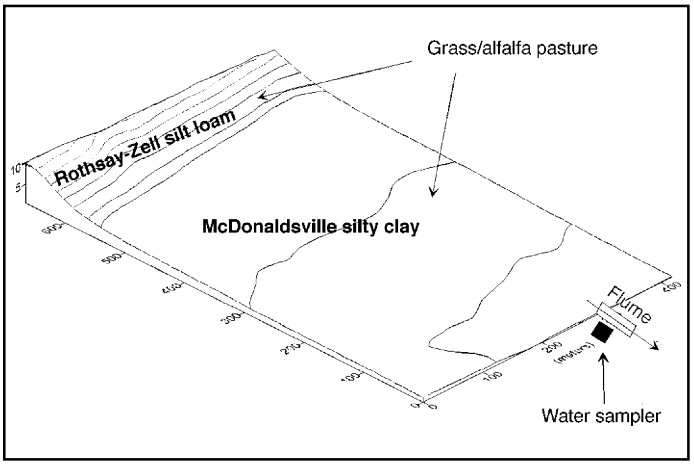

Figure 11. Topography and soils types of the Farm Three monitoring site, showing the location of the Parshall flume and automatic water monitor.

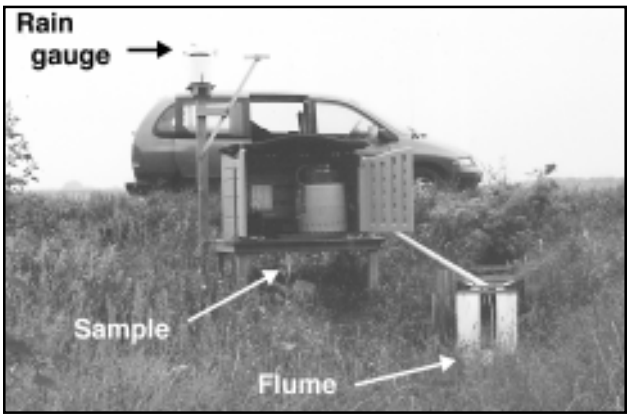

Figure 12. Parshall flume and automatic water monitor at the Farm Three monitoring site.

Table 3. Rainfall, runoff, and water quality from Farm Three for the monitoring seasons of 1998, 1999, and 2000.

	Rainfall	Tile flow	Sediment	Nitrate	Phosphorus		
					Soluble	Particulate	Total
	--------(inches)--------		----------(lb./acre)----------				
1998							
April	2.3	0.00	0.0	0.00	0.00	0.00	0.00
May	2.3	0.00	0.0	0.00	0.00	0.00	0.00
June	1.3	0.00	0.0	0.00	0.00	0.00	0.00
July	2.2	0.00	0.0	0.00	0.00	0.00	0.00
Aug.	2.7	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	0.7	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	3.9	0.00	0.0	0.00	0.00	0.00	0.00
Totals	19.4	0.00	0.0	0.00	0.00	0.00	0.00
1999							
April	1.3	0.00	0.0	0.00	0.00	0.00	0.00
May	3.0	0.11	2.9	0.01	0.02	0.01	0.03
June	3.4	0.00	0.0	0.00	0.00	0.00	0.00
July	5.7	0.18	6.0	0.02	0.00	0.04	0.05
Aug.	3.8	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	1.8	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	0.4	0.00	0.0	0.00	0.00	0.00	0.00
Totals	15.4	0.29	8.9	0.02	0.02	0.05	0.08
2000							
April	1.0	0.00	0.0	0.00	0.00	0.00	0.00
May	3.7	0.00	0.0	0.00	0.00	0.00	0.00
June	2.7	0.03	4.1	0.00	0.01	0.01	0.02
July	5.1	0.00	0.0	0.00	0.00	0.00	0.00
Aug.	1.1	0.00	0.0	0.00	0.00	0.00	0.00
Sept.	0.8	0.00	0.0	0.00	0.00	0.00	0.00
Oct.	1.7	0.00	0.0	0.00	0.00	0.00	0.00
Totals	16.1	0.03	4.1	0.00	0.01	0.01	0.02

Conclusion

The results of the monitoring and computer simulations for Farm Three reinforce the important connection between grass-based cropping systems and water quality, even at a site with flat terrain. When runoff occurs from land covered by grass, the water quality will be higher than if a row crop covered the site. That is, the runoff water will carry less sediment, nitrogen, and phosphorus. In a grazing situation, how the grass cover is managed can impact water quality. When over-grazing and over-stocking coincide with a rainstorm that generates runoff, soil erosion and poor water quality will result.

Water Quality Summary

This study shows that farm management decisions have a direct impact on water quality. Rainfall events large enough to generate runoff can occur at any time during the growing season. The majority of soil erosion and, hence, water quality degradation is caused by large infrequent rainstorms. Land management practices need to take this into account.

There are many management practices—such as conservation tillage, strip-till, contour strips, terracing, grass strips, etc.—that can be used on cropland to reduce soil erosion and protect water quality. However, large soil losses can still occur when rainstorm runoff events coincide with young crops. Grass-based management systems, in comparison, protect against soil erosion and prevent water quality degradation year round.

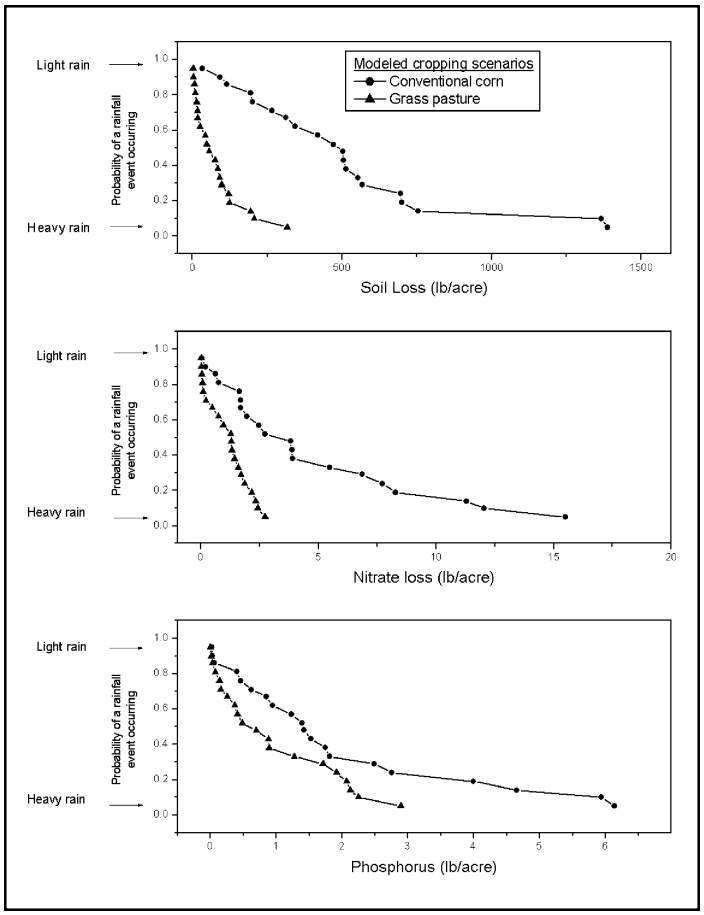

Figure 13. Results from the ADAPT computer model long-term (20-year) simulation. Predicted losses of sediment, nitrates, and phosphorus from two cropping systems at the Farm Three monitoring site.

Economic Analysis of Grazing Systems

Introduction and Hypothesis

Livestock farmers worldwide are looking at management intensive grazing (MIG) as a promising alternative to traditional, capital intensive management systems.

Existing economic research (based on surveys, case studies, modeling, and anecdotal evidence) attributes MIG with reduced feed costs, increased herd health, and smaller debt loads. Moreover, graziers' exposure to external economic risk (market price fluctuations) is lower than that of conventional system operators as a result of less reliance on external feed and other inputs (Rust et al., 1995). But there are also several economic concerns/risks associated with MIG including reduced productivity (output), lower overall equity and net worth (Watt, 1995), and lack of financial efficiency. In general, however, alternative livestock systems can be as profitable, if not more profitable, than their traditional counterparts when savings in feed costs balance productivity losses (Corselius and Wisniewski, 2001).

This study uses data from three Minnesota grazing operations to explore the Project's general economic hypothesis that alternative farming systems are an economically viable alternative to conventional management systems at the individual farm level. Grazing represents one of several generally recognized alternative management systems.

Unlike much of existing research, economic data and analysis for this study are based on: (1) year round monitoring (i.e., not limited to the grazing season); (2) multi-year analysis for each farm; (3) and inclusion of whole farm and enterprise data. Limitations of the study include: (1) a small-sample size; and (2) lack of random selection – profiled farms were not randomly selected; they were identified on the basis of their suitability for water quality monitoring. Moreover, like all economic analyses, the effect of management (a critical input for grazing systems) cannot be accounted for when analyzing the components of each farm's economic profitability.

Based on the above limitations, this study does not attempt to draw general conclusions about the overall competitiveness of grazing systems. Instead, this analysis aims to identify the strengths and weaknesses of these three, individual MIG operations as they compare with traditional Minnesota livestock management systems.

Profiled Farms

Economic monitoring took place on five grazing operations for the study period. Complete data is available for three of the five farms. All three farms practice MIG and supply the majority of livestock feed from pasture.

Farm type, primary operator age, experience, and farm size varies among the three profiled farms, but all three farms are considered diversified and conduct some direct marketing. Two of the five farms (located in South Central Minnesota) generate a majority of farm income (80 percent or more) from the dairy enterprise. One of these dairy operations is certified organic. The remaining profiled farm (located in West Central Minnesota) is classified as a beef cow-calf operation.

Primary operator age ranged from 28 to 59 years at the beginning of the study period while grazing experience varied from two to eight years. Annual gross income (representing farm size) for the profiled farms ranged from $25,500 to $395,460 over the study period. Herd size (also an indicator of farm size) varied from 36 head to 152 for the dairy operations. All of these factors – age, experience, and farm size – have been found to affect the economic performance of farming operations and are considered in the economic profiles. Age, for example, affects debt-to-asset ratios. Debt-to-asset ratios for farm operators are typically highest among young, beginning operators and decline steadily as age increases (Barry et al., 1995). Moreover, as farmers gain more experience and move forward in the transition from traditional to alternative farming operations, profitability often increases (Corselius and Wisniewski, 2001).

Data Collection and Sources

Data used in the economic analyses are taken from actual farm records for the profiled farms. Economic monitoring and data collection began in the winter of 1997/1998 and ended in January 2001. The economic study period is defined as January 1, 1998 – December 31, 2000.

Two accounting software packages (Quicken and AgBiz) were used by profiled farm operators to track cash inflows and outflows throughout the study period. All accounting was done using the accrual method. Final whole farm data is presented on a market basis unless otherwise noted. All enterprise data is presented on a cost basis.

Whole farm and enterprise data for each of the profiled farms were evaluated using FINPACK® (comprehensive financial analysis software) with assistance from MnSCU Minnesota Farm Business Management Program instructors (all profiled farm operators were enrolled as students in the Minnesota Farm Business Management Program). The final analyses are based on averages of FINAN results for each year in the study period. All prices used in the analyses are actual prices received and reported by the profiled farm operators. Organic feed and commodity prices were estimated using a multiplier of conventional county prices since organic market prices histories do not exist at this time. Appendix (D) lists the organic multiplier and prices used in the analysis. Pastures were valued using a method developed by West Central Research and Outreach Center researcher Margot Rudstrom. The pasture valuation method is described in Appendix (A) of this report. Data averages reported in the comparative analysis for the Minnesota grazier and traditional groups are drawn from annual MnSCU Farm Business Management Program reports and additional reports prepared by South Central Technical College Dean Dennis Jackson.

Analysis

Economic performance for each profiled farm is analyzed at the whole farm and enterprise levels. At the whole farm level, sixteen traditional economic indicators of liquidity, solvency, profitability, repayment capacity and financial efficiency are evaluated using University of Vermont Financial Guideline Measures and through a comparison of the indicators with other farms of similar size and age classes. The project's economic hypothesis is explored at the enterprise level through a comparative analysis in which the profiled farms are evaluated alongside other Minnesota graziers and similarly sized traditional livestock producers of like farm type.

In addition to traditional economic performance measures, the profiled farms are evaluated for financial longevity through a trend analysis of farm assets, liabilities and net equity. The overall level of farm liabilities and changes in net equity are important indicators of financial flexibility and economic strength. A large net equity position enables the farm business to survive in years of financial loss (Watt).

Economic conclusions are based on data from the three profiled farms as well as the MnSCU Farm Business Management Program grazier and traditional farm data set.

Farm One: Dairy Grazing Farm

Introduction/Background

Farm One is a diversified dairy and direct market livestock operation. The dairy herd and some replacements are grazed on 152 acres of intensively-managed pasture. The farm business is structured as an informal partnership between the primary operator and a full-time employee. On average, this farm generated 81 percent of its gross cash farm income from the dairy enterprise and 93 percent of gross cash farm income from the combined dairy and replacement heifer enterprises from 1998 through 2000. The farm's remaining income was generated through direct sales of pork, chicken, and cheese products that were processed locally.

Age and Experience. At the beginning of the study, Farm One's primary operator was 59 years old and had accumulated 31 years experience as a dairy producer. Farm One has practiced management intensive grazing since 1994. Farm One represents the oldest and most experienced grazier in our study group.

Soils and Topography. The soils on Farm One are Lester loam, Le Sueur loam, and Webster silty clay loam, which developed on calcareous clay loam till under tall grass prairie. The Lester loam is well drained, has a slightly acid to neutral pH, and a soil organic matter of 5%. The Le Sueur loam is moderately well drained, has a neutral pH, and a soil organic matter of 5%. The Webster silty clay loam is poorly drained, has a slightly acid pH, and a soil organic matter of 16%.

Size and Scale. Farm One is larger than the typical Minnesota dairy operation and more than three times the size of the average Minnesota grazing operation in the MnSCU data set. Throughout the study period, Farm One maintained a 141-cow milking herd on average.

Grazing and Pasture Management. Grazing took place mid-April through October on 152 acres of permanent pasture that were divided into 35 permanent and temporary paddocks. The milking herd was rotated among paddocks every 12 hours. Prior to the study period, pastures were composed of red clover, white clover, orchard grass, and brome grass. Beginning in 1998 – the first year of our study – interseeding was done with white clover, perennial rye grass, timothy, and chicory.

The dairy and replacement herds harvested approximately 27 percent of total annual feed through grazing from 1998 through 2000. Supplemental corn and distiller's grains were purchased and fed at a rate of six pounds/cow/day during the grazing season. This ration was increased to nine pounds/cow/day during the winter when cows were also fed corn silage and legume-grass balage in a dry lot. Cows were fed grain year-round during milking and given access to long-stem hay after milking only during the grazing season.

Herd Management. The dairy herd consisted of Holstein with some Brown Swiss, Jersey, and Normandy crosses. Approximately two-thirds of the herd calved in the spring between March 15 and June 15. The remaining one-third of cows calved during the fall between September 1 and October 31.

Additional Enterprises. In addition to the dairy and replacement enterprises, Farm One raised mixed hay on 78 acres of cropland and direct marketed a small number of turkeys, hogs, and chickens to friends, neighbors, and Twin Cities residents. Our study began tracking these individual enterprises in 1999.

Labor. All labor is supplied by the primary farm operator, his son, a full-time partner, and several part-time laborers. Total farm labor hours (paid and unpaid) averaged 3,608 hours/year for the study period with 79 percent of the total farm labor requirements being supplied directly by the farm family and business partner.

Economic Profile: Farm One

Farm One is analyzed at the whole farm level in Section (A) using indicators of liquidity, profitability, efficiency, solvency, and debt repayment capacity. In Section (B), Farm One is evaluated at the whole farm level and compared with other Minnesota graziers (sorted from the statewide MnSCU Farm Business Management database) and traditional dairy producers of a similar herd size (101-200 cows). In Section (C), Farm Two is compared with its traditional farm system counterparts at the dairy enterprise level. Section (D) explores the productivity and profitability of three additional farm enterprises: pasture, replacement heifers, and direct-market feeder finish hogs. Conclusions are presented in Section (E).

(A) Whole Farm Analysis

Farm One ranked "stable" to "strong" on average in the areas of liquidity, profitability, and financial efficiency over the three-year study period. Table 4 is a partial listing of the 16 traditional whole farm financial indicators examined. Data for all 16 indicators are available in Appendix (B).

Table 4 lists the 1998-2000 average liquidity, profitability, and efficiency values for Farm One. The current ratio, which indicates the extent to which total farm assets could be sold to pay for total farm liabilities, measured 1.74 on average over the study period. In other words, farm assets (if sold) would more than cover farm liabilities. A current ratio between 1.0 to 2.0 is considered "stable' by University of Vermont Financial Guidelines.

Net farm income averaged $82,976 between 1998-2000. The rate of return on equity – equivalent to the interest rate earned on farm assets – averaged 15.5 percent over the study period. This measure of profitability is ranked "very strong" by University of Vermont Financial Guidelines.

The operating profit margin averaged 35.9 percent over the three-year study period, indicating that Farm One was able to hold down expenses relative to its value of farm production. The operating profit margin, alongside the interest expense ratio, is also considered a good indicator of financial efficiency. Farm One averaged a very strong ranking in all areas of general financial efficiency over the three-year study period. In particular, Farm One generated an interest expense ratio equal to 6.5 percent and a net farm income ratio equal to 22.6 percent on average – indicating that Farm One spent 6.5 percent of gross cash farm income on capital financing while retaining 22.6 percent of gross cash farm income as profit.

In the areas of solvency and debt repayment capacity, Farm One managed its debt load well and concluded the study period with an average net equity equal to $774,871. Total farm liabilities were steadily paid down while farm assets grew from 1998 through 2000. The farm's ending farm equity-to-asset ratio averaged 51 percent, indicating that just under half of its assets were leveraged as debt. University of Vermont Financial Guidelines considers this level of debt leveraging "stable."

(B) Comparative Whole Farm Analysis

In this section, Farm One is compared at the whole farm level to other South Central (SC) Minnesota farm businesses of a similar age range (51-60 years) and size level ($200,001-$500,000 gross cash farm income). The same eight whole farm indicators of profitability, solvency, repayment capacity, liquidity, and financial efficiency that were examined in Section (A) are explored here and listed in Table 7 for Farm One and the other SC Minnesota farms in the comparison. In Table 8, farm assets, liabilities, and net equity are compared for Farm One and other SC Minnesota farms in its age and size class.

Based on data from the three-year study period, Farm One generated nearly three times the average net farm income of other farm operators aged 51-60 years and more than twice the net farm income of other farms in its size class. Farm One's net farm income is explained by its relatively high operating profit margin – 35.9 percent compared to 20.5 percent and 19.9 percent on average for other farms of a similar age and gross income class, respectively.

While generating a 35.9 percent profit margin, Farm One built equity at an above average level. Its return on equity averaged 15.5 percent for the 1998-2000 study period, compared with 4.4 percent and 6.9 percent for other farm operators of a similar age and gross income size class, respectively. Farm One's ending farm equity-to-asset ratio is considered average for all SC operators aged 51-60 years.

Only in the area of liquidity does Farm One lag behind other operators in its age and size class. The current ratio for Farm One averaged 1.74 for the study period. This is considered "stable" and clearly Farm One has more than enough farm assets to cover liabilities. However, other SC farms in its age class ranked very strong, as would be expected given that older farm operators tend to have accumulated a higher level of assets than younger or beginning farm operators.

Table 7 lists total farm liabilities, total farm assets, and total net equity for Farm One and its SC Minnesota counterparts. Farm One managed below-average farm liabilities and above average farm assets compared to all other farms in its age and size class for the 1998-2000 period. Consequently, Farm One averaged a net equity equal to $774,871 for the 1998-2000 period—77 percent and 116 percent above that of other SC Minnesota farms in its age and size class, respectively. During the study period, SC Minnesota farm operators aged 51-60 years averaged a net equity of $437,772 while farms with $200,001-$500,000 in gross income averaged a net equity equal to $358,476.

(C) Comparative Dairy Enterprise Analysis

Farm One is compared at the enterprise level with other Minnesota dairy grazing operations and traditional Minnesota dairies of a similar herd size (101-200 cows) in this section. Data from all three years (1998 – 2000) are averaged for each group in the comparison. Indicators of productivity, costs, and net returns are presented in Tables 8 – 10 for the dairy enterprise.

Table 8 lists indicators of productivity, herd health, and feed efficiency. Farm One, with more than twice the herd size of other Minnesota graziers, produced 11 percent less milk/cow on average. Likewise, Farm One under performed its traditional counterparts by 33 percent in milk production; Farm One generated 13,353 pounds of milk/cow/year on average compared to 19,785 pounds/cow/year for the Traditional Dairy Group. Milk production losses were somewhat balanced by a reduced culling rate; Farm One averaged a 19.4 percent culling rate over the study period, similar to that of other graziers, but well below the 27.2 percent recorded by the Traditional Dairy Group.

Lastly, Farm One ranked relatively high in feed efficiency with 3.5 pounds of milk for every one pound of feed grain and concentrate. By comparison, other Minnesota graziers and traditional dairies averaged a 2.5 and 2.2 feed efficiency rate, respectively. The feed efficiency calculation does not include forages. Therefore, we would expect grazing systems to be more efficient according to this standard measure since pasture is substituted for feed grains in the animals' daily feed ration. It is surprising, however, that the Grazing Group did not generate a higher feed efficiency ratio than the Traditional Dairy Group. In this case, reduced milk production nearly outweighed any feed efficiency gains made through use of pasture.

Table 9 lists the direct and indirect costs of production for the dairy enterprise of Farm One, the Grazing Group, and the Traditional Dairy Group. Feed costs, which typically represent half of a dairy operation's direct expenses, are categorized separately. Feed costs averaged $4.74/cwt for Farm One over the study period, compared to $5.21/cwt for the Grazing Group and $5.16/cwt for the Traditional Dairy Group.

Table 4. Liquidity, Profitability, and Efficiency, 1998 – 2000 Averages.

Indicator	1998-2000 Average
Current ratio	1.74
Net farm income (cost)	$82,976
Return on equity (cost)	15.5%
Operating profit margin (cost)	28.7%
Interest expense ratio	6.5%
Net farm income ratio	22.6%

Table 5. Solvency and Debt Repayment Capacity, 1998 – 2000.

	1998	1999	2000	Average
Total farm assets	$972,812	$1,051,335	$1,093,549	$1,039,232
Total farm liabilities	$290,400	$255,663	$247,019	$264,361
Net equity (ending)	$682,412	$795,672	$846,530	$774,871
Equity to asset ratio	46%	54%	53%	51%
Term debt coverage ratio	162%	191%	110%	155%

Table 6. Comparative Whole Farm Financial Indicators, 1998-2000 Averages.

Indicator	Farm One	SC Farms with Average Age: 51-60 years *(231 farms)*	SC Farms with Gross Income: $200K-$500K *(567 farms)*
Net farm income (cost)	$82,976	$29,087	$40,227
Return on equity (cost)	15.5%	4.4%	6.9%
Equity to asset ratio	51.0%	53.3%	46.5%
Term debt coverage ratio	155.0%	115.9	125.8%
Operating profit margin (cost)	35.9%	20.5%	19.9%
Interest expense ratio	6.5%	9.0%	8.4%
Net farm income ratio	22.6%	9.1%	12.6%
Current ratio	1.74%	2.14%	1.94%

Table 7. Comparison of Farm Assets, Liabilities, Net Equity ($), 1998-2000 Averages.

	Farm One	SC Farms with Average Age: 51-60 years *(231 farms)*	SC Farms with Gross Income: $200K-$500K *(567 farms)*
Total farm assets	1,039,232	853,275	767,808
Total farm liabilities	264,361	415,503	409,332
Net equity	774,871	437,772	358,476

Table 8. Dairy Production Comparison, 1998-2000 Averages.

	Farm One	Grazing Group (*46 farms*)	Traditional Dairy Group: 100-200 cows (*274 farms*)
Total # cows	141	49.1	134.1
Lbs. milk production/cow/year	13,353	14,998	19,785
Culling percent	19.4	18.7	27.2
Lbs. milk/lb. grain & conc.	3.5	2.5	2.2

Based on existing research, we expect that graziers would average lower feed costs than the traditional dairies. In this case, Farm One does maintain feed costs that are eight percent below those of similarly-sized traditional dairy operations. On the other hand, the Grazing Group (with a 49-cow herd average) reported feed costs that were slightly higher than those reported by the Traditional Dairy Group (with a 134-cow average herd size). Feed expenses may be a function of size as well as pasture stocking rates.

Despite some savings in feed costs, Farm One recorded higher than average direct and indirect costs as compared to its grazing and more traditional dairy counterparts. Higher total expenses are explained by Farm One's debt structure[1] at the beginning of the study period and larger hired labor-custom operating expenses.

Table 10 lists net returns for Farm One, the Grazing Group, and the Traditional Dairy Group. Farm One averaged a higher milk price than all other dairies in our comparison. Its higher milk market prices are the result of volume, quality, and component (butterfat and protein) premiums. Higher milk prices boosted Farm One's total value of production/cwt, so that its net return averaged 22 percent above that for similarly-sized traditional dairies with lower total costs. Other graziers, however, with total costs averaging $9.90/cwt, generated net returns that were nine percent above those of Farm One and 34 percent above those earned by traditional dairies with more than twice the herd size.

(D) Analysis of Additional Enterprises

Three additional enterprises are analyzed and compared to other SC Minnesota farms in Section (D): (1) replacement heifers (sold and transferred); (2) direct market finished hogs; and (3) pasture.

(D.1) Replacements. Farm One sold and transferred out an average of 100 replacement heifers in 1999 and 2000.[2] Gross income, direct and indirect expenses, and net returns for the replacement heifer enterprise are listed in Table 11.

Farm One grossed $519.94/head on average over this two-year period. Once direct and indirect expenses are subtracted, Farm One netted $202.69/head on average. This compares to a negative $8.15/head on average for other SC Minnesota dairy replacement heifer enterprises. Total expenses varied little between Farm One and its SC Minnesota counterparts. Therefore, the difference in net returns is explained by the average value/head earned by Farm One compared to all other SC operators.

(D.2) Direct-Market Hogs. Three direct market enterprises (hogs, turkeys, and chickens) accounted for 11 percent of total gross income between 1999-2000 on average. Table 12 lists net returns for Farm One's hog finishing enterprise – its largest direct-market enterprise. Farm One netted an average of approximately $51.99/cwt produced in 1999 and 2000 for its finished hogs. By comparison, other SC feeder finish hog operations netted $3.52/cwt. Hogs were finished out on Farm One at minimal expense – all hogs were allowed to root through the compost pile and were fed a mix of apples, greens, pumpkins, milk, and corn-based hog feed with no animal by-products. In addition, they were occasionally given access to a small amount of pasture. The disparity in net return between Farm One and its SC counterparts is explained by differences in the average market value (gross return) and indirect expenses. Although Farm One spent $65.27/cwt on average for marketing expenses, it managed to net almost 15 times the profit earned by all other SC feeder finish operations as a result of its direct marketing premiums. Farm One sold 51 hogs each year of the study period on average.

(D.3) Pasture. Farm One maintained 152 acres of pasture throughout the study period. Dairy cows consumed an estimated total of 408 tons of pasture forage/year. Pasture was valued at $40/ton on average throughout the study period. Table 13 lists average gross returns, direct and indirect expenses, and net returns for the pasture enterprise. Gross returns for the pasture enterprise averaged $113.13/acre over the study period. Once direct and indirect expenses are accounted for, Farm One netted $22.27/acre for- ts pastureland. As a crop enterprise, Farm One's pasture was highly competitive with government subsidized SC Minnesota feed crops, such as corn and spring wheat—which netted SC farmers an average of negative $14.75/acre and negative $1.04/acre, respectively, over the same period. Other SC Minnesota cash crops—such as sweet corn, peas, and federally supported soybeans—each returned more than double the net pasture value/acre during the study period.

(E) Conclusion

Farm One is considerably larger than most Minnesota graziers and traditional dairy producers – its herd size is more than double that of the average dairy producer in Minnesota. Moreover, Farm One's primary operator is considered an experienced grazier and the oldest farmer in our study. After accounting for size and operator age, it can be said that Farm One is financially competitive at the whole farm level and more profitable than traditional

Table 9. Comparison of Direct and Indirect Costs ($/cwt),1998-2000 Averages.

	Farm One	Grazing Group (*46 farms*)	Traditional Dairy Group: 101-200 cows (*231 farms*)
Feed costs/cwt	4.74	5.21	5.16
Total direct costs/cwt	8.97	7.72	7.95
Total indirect costs/cwt	2.39	2.18	2.61

Table 10. Comparison of Net Returns ($/cwt), 1998-2000 Averages.

	Farm One	Grazing Group (*46 farms*)	Traditional Dairy Group: 101-200 cows (*231 farms*)
Milk price	14.80	13.90	14.18
Total value of production	14.62	13.52	13.21
Other income	0.25	0.21	0.21
Gross return	14.87	13.73	13.42
Total costs	11.36	9.90	10.56
Net return	3.51	3.84	2.87

Table 11. Replacement Heifer Enterprise Returns ($/head), 1999-2000 Averages.

	Farm One	SC Average *(1,667 farms)*
Gross return	519.94	305.61
Direct expenses	265.90	248.06
Indirect expenses	51.37	65.71
Net return	202.69	(8.15)

Table 12. Hog Enterprise Returns, 1999-2000 Averages ($/cwt).

	Farm One Average	SC Average (*239 farms*)
Gross return	141.07	30.71
Marketing	65.27	0.15
Direct expenses	87.77	22.25
Indirect expenses	1.50	15.86
Net return	51.99	3.52

Table 13. Pasture Enterprise Returns, 1998-2000 Averages.

	1998-2000 Average ($/acre)
Gross return	113.13
Direct expenses	35.98
Indirect expenses	54.88
Net return	22.27

dairies at the enterprise level. Farm One's mix of alternative replacement heifer and feeder-finish hog enterprises generated supplemental cash farm income that pushed Farm One's total net farm income well above SC Minnesota whole farm averages.

Farm One was financially competitive with traditional dairy operations of a similar size—thanks to lower feed costs, better feed efficiency, and marketing premiums that outweighed its below-average milk production. Farm One netted $3.51/cwt for milk over the study period on average. By comparison, the Traditional Dairy Group (with a similar herd size) netted $2.87/cwt. These results support existing research. At the same time, Farm One steadily paid down liabilities and increased its farm assets—consequently improving its net farm equity base. Based on data from Farm One, large-scale dairy grazing appears financially competitive with traditional dairy management systems of a similar size.

One surprise, however, was that smaller-sized graziers proved more profitable, on average, than their relatively large-scale counterparts at the enterprise level on a per unit basis. Farm One recorded higher overall direct and indirect costs than other Minnesota graziers with the exception of feed costs on average. Consequently, graziers in the MnSCU data set (with an average herd size of 49 cows) netted $ 3.84/cwt on average between 1998-1999 – nine percent more than the average net return recorded for our large-scale grazier, Farm One. While this is promising for smaller-scale producers, it should be noted that the Grazing Group herd average was so small that at the whole farm level, small-scale graziers would not be able to maintain a decent standard of living.

Farm One's use of cropland as pasture appears to be a financially profitable decision. Its pasture enterprise netted up to five times that of other SC feed crop enterprises throughout the study period. This enabled Farm One to cut its feed expenses in the dairy enterprise to eight percent below those of other similarly-sized traditional dairy operations.

[1]At the beginning of the study period, Farm One had a disproportionate amount of current debt that acrued higher interest rates. In the year 2000, current debt was restructured as intermediate and long-term debt at lower interest rates.

[2]The replacement heifer enterprise was not tracked in 1998 due to insufficient reocrds.

Profile Two: Organic Dairy Grazing Farm

Introduction/Background

Farm Two is a certified organic dairy. On average, 81 percent of this farm's gross cash farm income came from organically-certified milk sales during the study period. Another seven percent of gross cash farm income came from the sale of replacement heifers and 4.3 percent from the sale of organically-certified soybeans.

Age and Experience. At the beginning of our study period, Farm Two's principal operator was 38 years old and had been grazing for nine years. Family members have managed all owned cropland organically for over fifty years.

Size and Scale. The farm is smaller than most Minnesota dairies[1] but is typical in size of Minnesota graziers; it has a 47 head milking herd and 67 acres of pasture.

Soils and Topography. The soils on Farm Two are Lester loam, Le Sueur loam, and Webster silty clay loam, which developed on calcareous clay loam till under tall grass prairie. The Lester loam is well drained, has a slightly acid pH, and a soil organic matter of 3.5-4%. This soil has a slope steepness of up to 18% and has undergone moderate erosion with the introduction of agriculture. The Le Sueur loam, with a 2% slope, is moderately well drained, has a slightly acid pH, and a soil organic matter of 6%. The level Webster silty clay loam is poorly drained, has a slightly acid pH, and a soil organic matter of 10-16%.

Grazing and Pasture Management. Pasture paddocks average three acres and cows are moved every 12 hours. Pastures are composed of 40 percent legumes (red clover, birdsfoot trefoil, and white clover) and 60 percent grass (alfalfa, orchard grass, timothy, and brome grass). Interseeding is done every five to seven years. Pastures are fertilized in the fall with composted manure. The grazing season ranges from mid April to late October.

Approximately 31 percent of total dairy and replacement heifer feed needs are met through pasture. The dairy herd is fed a mixed ration of 45 pounds of corn silage, cob corn, oats, and dry hay/cow/day during the grazing season. The ration is increased to 90 pounds of corn silage, cob corn, oats, dry hay, and balage/cow/day during winter when cows are fed in a dry lot. Almost all supplemental and winter feed is raised on the farm.

Herd Management. The milking herd consists of Holstein-Jersey crosses. All replacements are raised on the farm. Calving takes place throughout the year. Milk from the dairy enterprise is marketed organically through a cooperative at premium prices. These prices averaged 29 percent above conventional statewide milk prices for the study period.

Additional Enterprises. Farm Two owns 135 acres of cropland, cash rents 68 acres of cropland, and share rents approximately 72 acres of cropland. Alfalfa, corn, soybeans, and small grains (such as oats and barley) are grown in rotation and managed organically. All crops are fertilized using composted manure from the dairy and replacement herds. Approximately 15 acres of soybeans are certified and marketed organically each year.

Labor. Ninety percent of total farm labor is supplied directly by Farm Two family members. Both husband and wife work full time on the farm and are assisted by their five children who ranged in age from 6- 21 years old at the beginning of the study period. Total farm labor hours (paid and unpaid) averaged 4,839 hours/year for the study period.

Economic Profile: Farm Two

Farm Two is analyzed at the whole farm level in Section (A) using indicators of liquidity, profitability, efficiency, solvency, and debt repayment capacity. In Section (B), Farm Two is evaluated at the whole farm level and compared with other Minnesota graziers (sorted from the statewide MnSCU Farm Business Management database) and traditional dairy producers of a similar herd size (less than 50 cows). In Section (C), Farm Two is compared with its traditional farm system counterparts at the dairy enterprise level. Section (D) explores the productivity and profitability of three additional farm enterprises: pasture, replacement heifers, and organically-marketed soybeans. Conclusions are presented in Section (E).

(A) Whole Farm Analysis

Farm Two is analyzed at the whole farm level on the basis of financial profitability, solvency, repayment capacity, liquidity, and efficiency. Tables 14 and 15 present a partial listing of the 16 traditional whole farm financial indicators examined. Data for all 16 indicators are available in Appendix (C).

Table 16 lists the 1998-2000 average liquidity, profitability, and efficiency values for Farm Two. The current ratio – an indicator of liquidity – is the first financial measure explored. Farm Two averaged a current ratio equal to 5.89 over the study period – indicating that its farm assets, if sold, would more than cover farm liabilities. A current ratio of 2.0 or greater is generally considered "strong."

Farm Two recorded an average net farm income of $56,642 for the study period. Profitability, measured by the rate of return on equity and the operating profit margin, ranked "stable" to "strong" based on University of Vermont Financial Guidelines. Return to equity averaged 20.3 percent over the study period – indicating that Farm Two generated a very strong return on assets invested in the business. Similarly, Farm Two generated an operating profit margin equal to 23.4 percent over the study period on average. This is considered healthy by farm business standards and suggests that Farm Two is doing a good job of balancing farm expenses against gross income.

The interest expense ratio suggests that Farm Two is financially "efficient" – less than six percent of gross cash farm income was used to make interest payments on borrowed capital. University of Vermont Financial Guidelines rank any interest expense ratio below 10 percent as "strong." The net farm income ratio is the second indicator of financial efficiency explored in this study. Farm Two averaged a net farm income ratio of 38.4 percent over the study period – indicating that 38 percent of gross cash farm income was retained as profit. Again, University of Vermont Financial Guidelines rank anything above 20 percent as "strong."

Table 15 lists solvency and repayment capacity indicators for the 1998-2000 average, as well as for each year in the study to explore trends in overall debt management. Farm Two increased its total farm assets over the study period from $514,139 in 1998 to $665,932 in the year 2000. At the same time, Farm Two reduced its total farm liabilities from $171,941 in 1998 to $152,201 in the year 2000. On average, total farm liabilities accounted for 29 percent of total farm assets. In other words, Farm Two retained more than 70 percent of its farm assets as equity from 1998 through 2000 on average. Consequently, net equity grew 50 percent over the study period from $342,198 at the end of 1998 to $513, 731 at year-end 2000.

The equity-to-asset ratio is a good general indicator of solvency. According to University of Vermont Financial Guidelines, a farm equity-to-asset ratio of 40-70 percent is considered "stable." A ratio above 70 percent is ranked "strong." Farm Two edged up slightly from its 67 percent "stable" ranking in 1998 to a 73 percent "strong" ranking

in 1999. However, in the year 2000, Farm Two slipped back to a "stable" ranking and ended the study period with an average equity-to-asset ratio of 66 percent. In other words, 66 percent of Farm Two's total farm assets were not being leveraged as debt.

Despite its stable solvency base, Farm Two is ranked vulnerable in the area of repayment capacity based on its average 65 percent term-debt-coverage ratio. This measure of repayment capacity indicates whether there is enough cash income to make intermediate and long-term debt principal and interest payments. A term-debt-coverage ratio of 65 percent indicates that, on average, Farm Two did not generate enough cash income to make its term debt payments once family living expenses had been paid. This is a sign of potential repayment problems and, based on annual records, only became a real problem in the year 2000.

During the last year of the study, Farm Two recorded a negative 20 percent term-debt-coverage ratio. Increased cash farm expenses explain this negative ratio during the year 2000; cash farm income and family living expenses remained relatively unchanged from previous years. Increased cash farm expenses were tied to high equipment repairs and the addition of a new hoop house and milking parlor facilities. Farm Two financed these expenses, among other things, with a $100,000 permanent easement contract that was signed with the Minnesota Department of Transportation (MnDOT) in the year 2000. The permanent easement was recorded as a capital sale for record-keeping purposes and helps to explain some of the increase in Farm Two's overall farm asset base.

In general, Farm Two ranked "stable" to "strong" in all but one area of financial performance. Its strengths at the whole farm level are its ability to hold down expenses relative to farm income and generate above average net returns. This enabled Farm Two to reduce its total liabilities over the three-year study period while building net equity. Farm Two's financial weakness cropped up in the year 2000 in the area of liquidity. A weak liquidity ranking that year can be explained by one-time above average expenses that were financed using cash from a capital sale (permanent easement) signed with MnDOT.

(B) Comparative Whole Farm Analysis

In this section, Farm Two is compared at the whole farm level to other South Central (SC) Minnesota farm businesses of a similar age range (31-40 years) and size level ($100,001-$200,000 gross income). The same eight whole farm indicators of profitability, solvency, repayment capacity, liquidity, and financial efficiency that were examined in Section (A) are explored here and listed in Table 16 for Farm Two and other SC Minnesota farms in the comparson. Assets, liabilities, and net equity levels are then compared for Farm Two and its SC Minnesota counterparts.

Based on data from the three-year study period, Farm Two appears to have built a relatively high level of equity (return on equity, current ratio) compared to other farms of similar experience (age) and size. Likewise, Farm Two ended the study period with a net worth that ranged 11-16 percent above that of other SC farms in its age and size class, respectively.

Farm Two retained a higher percentage of gross farm income as profit in comparison with other farms in its size and age class. Farm Two generated a net farm income that was more than double that of other similarly-sized farms and 44 percent above that earned by other farm operators aged 31-40 years.

Turning to overall financial worth, Table 17 lists average total farm assets, total farm liabilities, and farm business equity for Farm Two and other SC Minnesota farms in its age and size class. Farm Two recorded fewer farm assets than other farms in its age group and 20 percent more farm assets than other farms in its gross income class. On the liabilities side, Farm Two fared very well; it recorded less than half the farm liabilities of other farms in its age class and 33 percent fewer liabilities than other farms in its size class. Consequently, with similar total farm assets and fewer farm liabilities, Farm Two built above average equity during the study period given its age and size.
The whole farm analysis suggests that Farm Two is competitive with other SC Minnesota farms – it has clearly built a relatively high level of equity and profit given its level of experience (age) and size. Reduced overhead expenses associated with the grazing system combined with organic price premiums may explain Farm Two's financial advantages. The comparative dairy enterprise analysis in Section (C) explores these ideas.

Farm Two signed a $100,000 perpetual easement agreement in the year 2000 with the Minnesota Department of Transportation (MnDOT). The MnDOT funds enabled Farm Two's operators to fulfill several long-term goals at the end of the study period, including restoration of a wetland, construction of a hoop-barn for storage, remodeling of the milking parlor, and the creation of a savings account for retirement and college tuition.

(C) Comparative Dairy Enterprise Analysis

Farm Two is analyzed at the enterprise level on the basis of production, expenses, and income. In the analysis, Farm Two is compared to other Minnesota dairy graziers and traditional Minnesota dairies with a similar herd size (less than 50 cows). Tables 18 – 20 list the average production, expense, and income data from the 1998-2000 study period for Farm Two, the MN Grazing Group, and the Traditional MN Dairies.

Three production indicators representing animal performance, herd health, and feed efficiency are presented in Table 18. Milk production for Farm Two averaged 14,008 pounds/cow/year over the study period – slightly below the production average for other graziers and 18 percent below that of traditional Minnesota dairies of a similar herd size. The culling percentage, an indicator of herd health, averaged 15.5 percent for Farm Two, compared to 18.7 percent and 27.63 percent for Minnesota graziers and traditional dairies, respectively. Turning to feed efficiency, Farm Two ranked above that of other Minnesota graziers and similarly sized traditional Minnesota dairies. Pounds of milk/pound of grain and concentrate averaged 3.3 for Farm Two over the study period, compared to 2.5 and 2.23 for the Minnesota graziers and traditional dairies, respectively.

Table 19 lists direct and indirect expenses for the dairy enterprise. Feed costs, the most significant direct expense, are categorized separately in Table 19 from other direct expenses. Based on the average expense data reported for the study period, average feed costs for Farm Two are slightly lower than those of other Minnesota graziers and traditional Minnesota dairies over the same time period. Feed costs for Farm Two averaged $4.88/cwt as compared to $5.21/cwt for other Minnesota graziers and $5.16/cwt for traditional Minnesota dairies of a similar herd size during the study period. Above average feed costs were expected for Farm Two since its feed is valued at organic (premium) prices. However, Farm Two managed feed costs that were six percent below those of other graziers and five percent below the Traditional Dairy Group – likely due to above average feed efficiency.

Turning to other direct and indirect costs, Farm Two reported above average expenses as compared to other Minnesota graziers and similarly-sized traditional dairies for the study period. Total direct costs for Farm Two averaged $8.39/cwt – or nine percent above total direct costs for other Minnesota graziers and seven percent above those direct costs recorded by the Traditional Minnesota Dairy Group. Higher machinery repairs, fuel, and oil expenses help explain the difference between average direct expenses for Farm Two and all other farms. Total indirect costs averaged $3.11/cwt over the study period for Farm Two. By comparison, indirect expenses reported by the Minnesota Grazing Group and the Traditional Dairy Group averaged $2.18/cwt and $2.12/cwt, respectively. Higher hired labor, insurance, interest, and depreciation expenses explain the above average indirect expenses recorded by Farm Two for the study period.

Despite below average milk production and above average expenses, Farm Two netted more than twice the average income/cwt recorded by other Minnesota graziers and similarly-sized traditional dairies. Table 20 lists the total value of production, other income, gross returns, and net returns for Farm Two and other farms in the comparison. Farm Two averaged a net return equal to $7.93/cwt over the study period. By comparison, the Minnesota Grazing Group averaged $3.84/cwt and the Traditional Minnesota Dairy Group averaged $3.22/cwt. Farm Two's organic premiums explain its significantly higher net returns. Farm Two earned $18.11/cwt for its certified organic milk on average over the study period. At the same time, the Minnesota Grazier Group earned $13.90/cwt and the Traditional Dairy Group earned $13.71/cwt.

Based on the 1998-2000 whole farm and enterprise data for Farm Two, it appears that organic grazing is financially competitive with other management intensive grazing and traditional dairy management systems. The advantage of the organic management system lies, not surprisingly, in Farm Two's opportunity to market commodities at price premiums. So long as the premium effect outweighs productivity losses and other input expenses associated with field labor and higher-priced feed, organic grazing appears to be a very competitive management system as compared with other grazing and traditional dairy systems.

(D) Analysis of Additional Enterprises

Three additional enterprises for Farm Two are analyzed and compared to similar enterprise averages for other SC Minnesota farm operations in this section: (1) replacement heifers (sold and transferred); (2) pasture; and (3) organically-certified soybeans.

Table 14. Liquidity, Profitability, and Efficiency, 1998-2000 Averages.

Indicator	Average
Current ratio	5.89
Net farm income (cost)	$56,642
Return on equity (cost)	20.2%
Operating profit margin (cost)	23.4%
Interest expense ratio	5.6%
Net farm income ratio	38.4%

Table 15. Solvency and Debt Repayment Capacity, 1998-2000.

	1998	1999	2000	Average
Total farm assets	$514,139	$595,509	$665,932	$591,860
Total farm liabilities	$171,941	$163,253	$152,201	$162,465
Net Equity (ending)	$342,198	$432,256	$513,731	$429,395
Equity to asset ratio	67%	73%	59%	66%
Term debt coverage ratio	87%	128%	(20)%	65%

Table 16. Comparative Whole Farm Financial Indicators, 1998-2000 Averages.

Indicator	Farm Two	SC Farms with Average Age: 31-40 years *(451 farms)*	SC Farms with Gross Income: $100K-$200K *(375 farms)*
Net farm income (cost)	$56,642	$39,305	$18,353
Return on equity (cost)	20.3%	8.1%	3.1%
Equity to asset ratio	66%	44.2%	49.5%
Term debt coverage ratio	65%	129.8%	104.1%
Operating profit margin (cost)	23.4%	18.7%	19.2%
Interest expense ratio	5.6%	7.3%	11.0%
Net farm income ratio	38.4%	12.4%	12.2%
Current ratio	5.89	1.85	1.99

Table 17. Comparison of Farm Assets, Liabilities, and Net Equity $, 1998-2000.

Indicator	Farm Two	SC Farms with Average Age: 31-40 years *(451 farms)*	SC Farms with Gross Income: $100K-$200K *(375 farms)*
Total farm assets	591,860	605,711	491,512
Total farm liabilities	172,482	337,414	259,100
Net Equity	419,378	268,297	232,412

Table 18. Dairy Production Comparison, 1998-2000 Averages.

	Farm Two	Grazing Group *(46 farms)*	Traditional Dairy Group: <50 Cows (*707 farms*)
Average # of cows	47.4	49.1	38.07
Lbs. milk production/cow/year	14,008	14,998	17,084
Culling percent	15.5	18.7	27.63
Lbs. milk/lb. grain & concentrate	3.3	2.5	2.23

(D.1) Replacements. Farm Two sold and transferred out 20 replacement heifers annually in 1999 and 2000 on average. Gross income, direct and indirect expenses, and net returns for the replacement heifer enterprise are listed in Table 21.

Farm Two grossed $468.34/head in1999 and 2000[2] on average. Once direct and indirect expenses are subtracted, Farm Two averaged a net return of $83.45/head during the two-year period. This compares to an average of negative $8.15/head for other SC dairy replacement heifer enterprises during the same period. Differences in the value/head earned by Farm Two and its SC counterparts explain the difference in net returns among the SC average and Farm Two. Farm Two grossed an average of 53 percent more income/head than all other farms in the SC average. This more than made up for the higher direct expenses recorded by Farm Two.

(D.2) Pasture. Farm Two maintains 68 acres of pasture. Table 22 lists average gross returns, direct and indirect expenses, and net returns for the pasture enterprise. Gross returns for the pasture enterprise averaged $158.77/acre over the study period. Once direct and indirect expenses are removed, Farm Two netted $96.36/acre for its pastureland on average. While the pasture enterprise did not generate cash income, it was examined as an enterprise to explore the opportunity costs of utilizing what is considered prime cropland for grazing.

A $96.36/acre return for pasture land compared favorably to the alternative of raising feed crops – on average, SC Minnesota farms net negative $14.75/acre for corn, $4.22/acre for oats, and $107.60/acre for alfalfa hay during the 1998-2000 period. Similarly, cash crops in SC Minnesota returned negative $1.04/acre for spring wheat, $44.76/acre for soybeans, $52.30/acre for sweet corn, and $98.84/acre for peas over the same period[3] on average. In other words, Farm Two netted more profit/acre with its land in pasture than most other SC Minnesota producers who planted federally-subsidized corn, spring wheat, and soybeans, as well as oats and sweet corn. The only competitive alternatives to pasture over the 1998-2000 period were alfalfa hay and peas.

(D.3) Organically-Certified Soybeans. Farm Two planted soybeans under a 50-50 share rental agreement on an average of 22 acres in 1999 and 2000. Table 23 lists gross income, direct and indirect expenses, net returns, and yields for the soybean enterprise.

Farm Two grossed 1.5 times the SC average for share-rented soybeans thanks to organic market price premiums --$181.75/acre compared to $123.39/acre for the SC farms in the MnSCU data set. Organic soybean prices received by Farm Two averaged $12.15/bushel during the 1999-2000 period compared to the SC average of $5.15/bushel. Farm Two averaged yields that were considerably lower than those recorded by traditional SC soybean enterprises – 29.74 bushels/acre compared to 44.20 bushels/acre for other SC soybean growers. Despite reduced yields, however, Farm Two net a total of $117.85/acre – more than five times the average net return reported by other SC share-rental soybean producers. For Farm Two, savings in direct expenses (such as crop chemicals, seed, and insurance) combined with the organic market price premiums more than offset its lower yields during the 1999-2000 period.

(E) Conclusion

Based on the 1998-2000 whole farm and enterprise data for Farm Two, it appears that organic grazing is a financially stable alternative for smaller-scale producers. Farm Two netted farm income returns that were well above those of similarly-sized management intensive grazing and traditional dairy management systems while steadily improving its net equity base.

The advantage of the organic management system lies, not surprisingly, in Farm Two's opportunity to market commodities at price premiums; so long as the premium effect outweighs productivity losses and other input expenses associated with field labor and higher-priced feed, organic grazing appears to be a very competitive management system compared to other grazing and traditional dairy systems. Farm Two averaged net returns for its dairy enterprise that were 62 percent and 95 percent above those returns averaged by the Minnesota Grazing Group and Traditional Dairy Group, respectively. Moreover, it maintained above average feed efficiency. Throughout the study period, Farm Two's relatively high input expenses and below-average milk production were far outweighed by organic milk price premiums.

When organic premiums are removed (but feed still valued organically), Farm Two performs financially much like other graziers and below that of its traditional dairy counterparts due to below-average productivity. However, as long as organic premiums remained 11 percent or more above traditional milk market prices during the 1998-2000 period, Farm Two would have remained financially competitive with its traditional counterparts[4]. In other words, organic premiums could fluctuate downward by more than half of the study period average before Farm Two would begin to lose its competitive edge over traditional dairies of a similar size. Moreover,

Table 19. Expense Comparison ($/cwt), 1998-2000 Averages.

	Farm Two	Grazing Group *(46 farms)*	Traditional Dairy Group: <50 Cows (*707 farms*)
Feed costs/cwt	4.88	5.21	5.16
Total direct costs/cwt	8.39	7.72	7.83
Total indirect costs/cwt	3.11	2.18	2.12

Table 20. Income Comparison ($/cwt), 1998-2000 Averages.

	Farm One	Grazing Group (*46 farms)*	Traditional Dairy Group: <50 cows (*707 farms)*
Average milk price	18.11	13.90	13.71
Total value of production	19.15	13.52	12.92
Other income	0.27	0.21	0.25
Gross return	19.42	13.73	13.18
Total costs	11.50	9.90	9.96
Net return/cwt	7.93	3.84	3.22

Table 21. Replacement Heifer Enterprise ($/head), 1999-2000 Averages.

	Farm Two	SC Average *(1,667farms)*
Gross return	468.34	305.61
Direct expenses	334.34	248.06
Indirect expenses	50.65	65.71
Net return	83.45	(8.15)

Table 22. Pasture Enterprise Returns ($/acre), 1998-2000 Averages.

	1998-2000 Average
Gross income	158.77
Direct expenses	14.89
Indirect expenses	47.52
Net return	96.36

Table 23. Soybean Enterprise Returns (Share-Rented Land), 1999-2000 Averages ($/acre).

	Farm Two	SC Average *(66 farms)*
Gross income	181.75	123.39
Direct expenses	29.54	65.64
Indirect expenses	34.36	36.10
Net return	117.85	21.66
Yield	29.74 bu/acre	44.20 bu/acre

the use of prime SC cropland for pasture appears to be a financially profitable alternative to cash crops for Farm Two. Its pasture enterprise netted substantially more income/acre with its land in pasture than other SC Minnesota producers who planted federally-subsidized corn, spring wheat, soybeans, oats, and sweet corn.

[1] Measured by herd size or "average number of cows per farm."

[2] The replacement heifer enterprise was not tracked in 1998 due to insufficient records.

[3] Net returns for feed and other cash crops reported for "owned land." Source: South Central Minnesota Farm Business Management Annual Report, various years.

[4]Eleven percent minimum premium calculated as follows: Total costs = $11.50/cwt for Farm Two. Net return for Traditional Dairy Group = $3.22/cwt. Minimum gross return = 11.50 + 3.22 or $14.72/cwt. Gross return for Traditional Dairy Group = $13.18/cwt. Gross difference = (14.72-13.18) = 1.54. Traditional milk price = 13.71. Calculation of minimum organic premium: (traditional milk price)(X percent) = (gross difference) or [(13.71)(X)]= (1.54) where X = 0.112 or 11 percent.

[5] All measures are reported at cost basis unless otherwise noted.

Farm Three: Beef Cow-Calf Finishing Farm

Introduction/Background

Farm Three is a beginning, part-time beef cow-calf grazing operation that is expanding into finished beef sales. Located in West Central Minnesota, Farm Three generated 32 percent of gross cash farm income from beef calf sales on average during the 1998-2000 study period. A small number of calves were held over and finished out as stockers in the year 2000, accounting for less than five percent of gross cash farm income. Finished backgrounder steers, purchased for the first time in the year 2000, supplied 38 percent of gross cash farm income. Beef calves and background steers are sold in traditional markets. However, a small number of stockers (held over from the cow-calf herd) are processed and sold directly to a growing number of local customers. The remaining 26 percent of gross cash farm income came from a combination of government deficiency payments and Conservation Reserve Program payments during the study period.

Age and Experience. Farm Three established its beef cow-calf operation in 1997 – one year before our economic monitoring began. The farm's operator was 28 years old at the beginning of the study period and represents the youngest and least experienced participant in our study group.

Size and Scale. Farm Three is a small-scale operation – generating less than $40,000 in gross income annually for the 1998-2000 study period on average. In 1998, the farm's operator was managing 34 cow-calf pairs. By the year 2000, the herd had gradually been expanded to 70 cow-calf pairs. The farm has approximately 145 acres dedicated to permanent pasture.

Soils and Topography. The soils of Farm Three are a McDonaldsville silty clay and a Rothsay-Zell silt loam. The poorly drained McDonaldsville soil is on a former glacial lakebed. It formed from fine textural lacustrine material overlaying calcareous sandy outwash. This soil has a slightly acid pH and a soil organic matter of 5%. The Rothsay-Zell soil formed from delta outwash. This soil, which has a 5.5% slope, has experienced some erosion due to agricultural use. It has a neutral pH and a soil organic matter of 2.5%.

Grazing and Pasture Management. Grazing took place April-October on 145 acres. Hay was cut from paddocks when there was excess growth. All pasture, which was previously enrolled in the Conservation Reserve Pro-

gram, was composed of approximately 70 percent alfalfa and 30 percent orchard grass. The farm's cow-calf pairs were stocked at a rate of 1.5 animals/acre and rotated every 24 hours within permanent paddocks during the study period. Background steers were stocked at a rate of approximately two animals/acre for the four months that they were maintained on pasture.

Approximately 41 percent of total feed needs were met through pasture during the 1999-2000 period on average. While on pasture, all animals are fed one-half pound of grain/day, which acts as a carrying medium for bloat guard supplement. During winter, cow-calf pairs are fed a ration of two pounds of corn/animal/day along with a protein supplement and unlimited access to hay.

Herd Management. The farm's cow-calf herd consists primarily of Red Angus-Hereford crosses. Calving takes place once a year in April. Each year a small number of calves are held over the winter for finishing.

Unusually low levels of moisture and stressed pasture growing conditions caused bloat to become an issue on West Central Minnesota farms in 2000. Farm Three lost seven background steers to bloat; these losses had a significant negative impact on the farm's financial performance in the year 2000. During the same year, the farm also lost another two steers to lightning strikes.

Additional Enterprises. In addition to the primary beef cow-calf and background steer enterprises, Farm Three maintained an average of 90 crop acres of alfalfa hay for winter feed during the 1998-2000 study period. Farm Three also manages a 20-head Corriente beef cow-calf roping herd for "entertainment" value.

Labor. Farm Three's primary operator supplies all labor for the farm; no hired labor is utilized. Labor was estimated to total 1200 hours/year for the farm's crop and livestock enterprises. Farm Three's primary operator and spouse worked full time at off-farm jobs throughout the study period.

Economic Profile: Farm Three

Farm Three is analyzed at the whole farm level in Section (A) using indicators of liquidity, profitability, efficiency, solvency, and debt repayment capacity. In Section (B), Farm Three is evaluated at the whole farm level and compared with traditional beef cow-calf producers of a similar herd size (less than 50 cows). In Section (C), Farm Three is compared with its traditional farm system counterparts at the beef cow-calf enterprise level. Section (D) explores the productivity and profitability of two additional farm enterprises: pasture and direct-market finished beef. Conclusions are presented in Section (E).

(A) Whole Farm Analysis

Farm Three is analyzed at the whole farm level on the basis of financial profitability, solvency, repayment capacity, liquidity, and efficiency. Tables 24 and 25 represent a partial listing of the 16 traditional whole farm financial indicators examined. Data for all 16 indicators are available in Appendix (E).

Liquidity, profitability, and efficiency indicators are listed in Table 24. Farm Three averaged a "stable" ranking throughout the study period in terms of liquidity, as indicated by its current ratio of 1.3. This means that farm assets, if sold, would more than cover all short-term cash liabilities. Turning to profitability, however, Farm Three did not perform well during three of its first four years in operation. Between 1998-2000, Farm Three averaged a negative net farm income equal to $9,678 on a cost basis. In other words, when income due to market valuation was removed, the farm business lost nearly $10,000 annually throughout the study period on average. Likewise, Farm Three ranked very vulnerable on the basis of its operating profit margin, which averaged negative 18.1 percent for the study period. This indicates that expenses were high in proportion to gross cash farm income.

Although negative returns are not unusual for a business in its start-up phase, Farm Three encountered extraordinary events throughout the study period that help explain its negative net returns. In 1998, the farm suffered a barn fire and consequently lost all of its stored winter feed. In the year 2000, nine animals were lost to bloat and lightning strikes.

Based on the vulnerable profitability ranking, it is not surprising that Farm Three also ranked vulnerable in financial efficiency. The net farm income ratio, which compares profit to gross farm income, averaged negative 8.5 percent throughout the study period. In other words, cash farm expenses outweighed gross cash farm income on average.

Table 25 lists annual assets, liabilities, and net equity, as well as solvency and debt repayment capacity indicators for Farm Three. Over the three-year study period, Farm Three steadily increased its farm assets. Farm liabilities were initially paid down from $246,704 in 1998 to $241,490 in 1999. However, annual liabilities grew to $298,294 in the year 2000 due to death losses and the addition of feeder livestock. Consequently, Farm Three's net equity eroded over the study period from $75,068 in

1998 to $69,538 in the year 2000. The equity to asset ratio, a measure of financial solvency, ranked vulnerable throughout the study period. At the same time, the term debt coverage ratio, an indicator of repayment capacity, eroded from a strong ranking in 1998 to very vulnerable ranking in the year 2000. In 1998, the farm enterprises were generating enough cash to cover all farm and non-farm debt payments. However, beginning in 1999 and continuing into 2000, Farm Three was unable to cover its debt payments with cash farm income.

(B) Comparative Whole Farm Analysis

In this section, Farm Three is compared to other West Central (WC) Minnesota farm businesses of a similar age range (less than 30 years) and size class (less than $40,000 in gross farm income). The same eight whole farm indicators of liquidity, profitability, solvency, repayment capacity, and financial efficiency that were looked at in Section (A) are explored here and listed in Table 26 for Farm Three and other WC Minnesota farms in the comparison. Assets, liabilities, and net equity levels are then compared to discern what level of profitability and debt is typical for relatively young, small-scale farm business operations.

Farm Three does not perform as well financially as other farms in its age and size class in all areas of liquidity, profitability, solvency, repayment capacity, and efficiency. However, the comparison does indicate that the vulnerable profitability rankings for Farm Three may be tied to size; other farms in the Farm Business Management (FBM) database with less than $40,000 in gross cash farm income recorded very vulnerable operating profit margins and returns on equity. Farm Three's financial rankings do not, however, appear to be closely related to age and (presumably) experience for WC Minnesota farmers. WC farms in the FBM database whose operators were less than 30 years old ranked "stable" to very "strong" in all areas of financial performance throughout the study period.

Table 27 lists total farm assets, liabilities, and net equity for Farm Three and its WC counterparts. A comparison of these indicators suggests that Farm Three's relatively high level of debt may be explained, in part, by its operator's age. Total liabilities for Farm Three averaged $262,163 throughout the study period, compared to $225,023 for all similarly aged WC farm operators. WC farms with annual gross incomes of less than $40,000, on the other hand, only averaged $80,855 in total farm liabilities during the study period. On average, these farms also recorded farm assets equal to $197,315—40 percent below that of Farm Three. Despite their relatively low level of farm assets, however, WC operations with gross incomes of less than $40,000 averaged a net equity of $116,460 throughout the study period – 46 percent above the net equity base reported by similarly sized Farm Three.

(C) Comparative Enterprise Analysis

Farm Three is analyzed at the beef cow-calf enterprise level on the basis of production, expenses, and income. In the analysis, Farm Three is compared with other WC traditional beef cow-calf enterprises from the MnSCU database.

Table 28 lists six productivity indicators for the beef cow-calf enterprise. Farm Three managed average pregnancy and calving rates and maintained slightly below average weaning weights and calf sales during the 1999-2000 period as compared with other WC cow-calf producers. Herd management for Farm Three, therefore, may be characterized as comparable with other WC cow-calf enterprises.

Table 29 lists average feed costs/cow and total direct and indirect costs/cow for Farm Three and its WC counterparts. On average, Farm Three reported feed costs/cow that were 82 percent higher than those costs reported by all other traditional beef cow-calf producers in WC Minnesota. Above average feed costs are surprising since pasture-based enterprises typically offer feed cost savings. The herd's relatively low pasture stocking rate (1.5 animals/acre), high levels of corn supplementation due to a shortage of winter feed, and the operator's decision to retain calves from the herd through winter may partially explain Farm Three's high feed costs. High feed costs account for Farm Three's above average total direct costs. Turning to overhead expenses, Farm Three managed to keep costs, such as machinery and hired labor, down to $59.72/head compared with $110.22/head for the typical WC cow-calf producer.

Table 30 compares beef cow-calf net returns/cow for Farm Three and its WC counterparts. Farm Three grossed $561.19/cow compared to $450.42/cow over the 1999-2000 year period. Farm Three's receipt of "other income" – insurance payments for the loss of some cows, direct marketing income, and stipends from participation in various research-related projects—explains the majority of the difference in gross returns. Despite above average gross returns, however, Farm Three net a negative $52.05/cow on average for 1999-2000 due to above average total (feed) costs.

Table 24. Liquidity, Profitability, and Efficiency, 1998-2000 Averages.

Indicator	1998-2000 Average
Current ratio	1.30
Net farm income	$(9,678)
Return on equity (cost)	(12.4)%
Operating profit margin (cost)	(18.1)%
Interest expense ratio	21.7%
Net farm income ratio	(8.5)%

Table 25. Solvency and Debt Repayment Capacity, 1998-2000 Averages.

Indicator	1998	1999	2000	Average
Total farm assets	$321,772	$336,385	$367,832	341,996
Total farm liabilities	$246,704	$241,490	$298,294	262,163
Net equity (ending)	$75,068	$94,895	$69,538	$79,833
Equity to asset ratio	18%	28%	19%	22%
Term debt coverage ratio	158%	56%	7%	74%

Table 26. Whole Farm Financial Indicators, 1998-2000 Averages.

Indicator	Farm Three	WC Farms Average Age: less than 30 years *(46 farms)*	WC Farms Gross Income: <$40,000 *(33 farms)*
Net farm income (cost)	$(9,678)	$45,554	$8,533
Return on equity (cost)	(12.4)%	18.7%	(0.3)%
Equity to asset ratio	22%	44%	55%
Term debt coverage ratio	74%	189%	212%
Operating profit margin (cost)	(18.1)%	20.6%	10.9%
Interest expense ratio	21.7%	6.4%	10.6%
Net farm income ratio	(8.5)%	19.2%	25.5%
Current ratio	1.30	1.48	2.27

Table 27. Comparison of Farm Assets, Liabilities, and Net Equity, 1998-2000 Averages.

	Farm Three	WC Farms Average Age: less than 30 years *(46 farms)*	WC Farms Gross Income: <$40,000 *(33 farms)*
Total farm assets	$341,996	$388,932	$197,315
Total farm liabilities	$262,163	$225,023	$80,855
Net equity (ending)	$79,833	$163,909	$116,460

Table 28. Beef Cow-Calf Production Comparison, 1999-2000 Averages.

	Farm Three	Traditional WC Beef-Cow Calf Group: <50 Cows *(194 farms)*
Pregnancy percentage	95.7%	96.7 %
Calving percentage	95.7%	94.6%
Lbs. weaned/exposed female	418 lbs.	430 lbs.
Avg. weaning weight	450 lbs.	488 lbs.
Avg. weight/beef calf sold	538 lbs.	581 lbs.
Calves sold/cow	0.70	0.84

(D) Analysis of Additional Enterprises

In this section, three additional enterprises are analyzed for Farm Three and compared to similar enterprise averages, where possible, for other WC Minnesota farm operations. The additional enterprises analyzed below are: (1) background beef; (2) pasture; and (3) Corriente beef cow-calf herd.

(D.1) Background Beef. Table 31 lists productivity, expenses, and net return indicators from the year 2000 for Farm Three's background beef enterprise and for those of all other background beef enterprises in Minnesota.[1] In its first year of background beef production, Farm Three netted $19.62/head compared with $43.44/head for the Minnesota average. As with the cow-calf enterprise, the differences in net returns can be attributed to Farm Three's above average feed costs – $168.49/head compared to $110.11/head for the Minnesota Average – as well as its below-average daily gain rates.

(D.2) Pasture. Farm Three owned 85 acres and cash rented another 60 acres of intensively-managed pasture in 1999-2000. Table 32 lists gross income, direct and indirect expenses, and net returns for Farm Three's owned and cash rented pasture enterprises.

On average, Farm Three netted negative $24.94/acre and negative $14.68/acre for its pasture enterprises on owned and cash rented land during the 1999-2000 period, respectively. Long-term interest expenses for owned land outweighed the rental charge for the cash rented pasture. Nevertheless, Farm Three lost money on both pasture enterprises during the study period. Some of the negative net returns for owned and rented pasture are explained by Farm Three's relatively high fertilization rates. Since starting his farm business, Farm Three's operator has been applying fairly high levels of slow-release phosphorus and lime to build long-term soil properties. Consequently, soil admendment expenses totaled $11.84/acre for both pasture enterprises on average. These are expenses that he does not expect to incur after 2001.

The pasture enterprises were not economically competitive with WC cash crops, such as corn and soybeans—which netted negative $5.55/acre (with government payments) and $24.85/acre (with government payments), respectively. However, as Farm Three is able to reduce its soil amendment expenses and consequently its machinery and fuel costs in the future, the pasture enterprise may begin to compete financially with the WC region's cash crops.

(D.3) Corriente Beef Cow-Calf Roping Herd. Farm Three maintained a 20-cow Corriente roping cow-calf herd throughout the study period for "entertainment" purposes. Table 33 lists the total value of the Corriente cows, as well as direct and indirect expenses associated with their production. Farm Three lost money on its Corriente herd each year of the study – $424.83/head on avergage. Feed costs account for the high direct expenses. On average, this enterprise accounts for more than $8,000 worth of total net farm income losses throughout the study period.

(E) Conclusion

Farm Three is a young business in its start-up phase. During the study period, Farm Three expanded its cow-calf herd from 34 pairs to 70 pairs, expanded into background beef finishing, and continued to apply long-term soil building amendments to its pasture land. All of these economic factors, combined with unusual animal losses and lack of winter feed during 2000, hurt Farm Three's short-term financial prospects.

At the whole farm level, Farm Three under-performed other farms in its age and size class. It ended the study period with what the University of Vermont considers "vulnerable" profitability, solvency, debt repayment, and financial efficiency rankings. Although some of these below-average rankings may be expected for a start-up business, they clearly do not appear to be a function of age or size. Other WC operators of similar age class, for example, ranked "stable" to "strong" in these areas of financial performance.

However, Farm Three does appear to have potential for long-term profitability. At the enterprise level, Farm Three's herd management is comparable with other beef cow-calf and background operators in Minnesota. Moreover, with the exception of feed costs, Farm Three managed to keep its other direct and indirect operating expenses down to levels below those reported by other beef cow-calf and background beef producers, respectively. If Farm Three is able to reduce its feed costs (through a combination of increased stocking rates, reduced supplementation, and fewer soil amendments), it may prove competitive with traditional beef cow-calf and background beef operations. Moreover, with the elimination of its Corriente beef cow-calf herd, whole farm profitability would improve dramatically.

[1] An enterprise sort for WC beef background enterprises was not available for the year 2000.

[2] All measures are reported on a market basis unless otherwise noted.

Table 29. Expense Comparison ($/cow), 1999-2000 Averages.

	Farm Three	Traditional WC Beef-Cow Calf Group: < 50 Cows *(194 farms)*
Feed cost/cow	$451.93	$248.15
Total direct costs/cow	$553.52	$329.92
Total indirect costs/cow	$59.72	$110.22

Table 30. Income Comparison ($/cow), 1999-2000 Averages.

	Farm Three	Traditional Beef-Cow Calf Group: < 50 Cows *(194 farms)*
Total value of production	519.05	450.15
Other income	42.14	0.27
Gross return	561.19	450.42
Total costs	613.24	440.14
Net return/cow	(52.05)	10.28

Table 31. Comparison of Background Beef Productivity, Expenses, Net Returns, 2000.

	Farm Three	MN Average (*18 farms*)
Number transferred in	41	101
Number sold/transferred out	36	106
Average daily gain (lbs)	2.03	1.37
Lbs feed/lb gain	12.96	12.53
Feed cost /head ($)	168.49	110.11
Direct costs/head ($)	219.10	154.18
Indirect costs/head ($)	12.72	22.66
Total costs/head ($)	231.83	176.84
Gross return/head ($)	251.45	220.28
Net return/head ($)	19.62	43.44
Avg. purchase price/cwt ($)	82.40	97.67
Average sales price/cwt ($)	74.10	82.67

Table 32. Pasture Enterprise Returns ($/acre), 1999-2000 Averages.

	Owned Land	Cash Rent
Gross income	61.38	61.38
Direct expenses	38.94	68.12
Indirect expenses	47.38	7.94
Net return	(24.94)	(14.68)

Table 33. Corriente Beef Cow-Calf Roping Herd Returns ($/head), 1999-2000 Averages.

	Farm Three
Total value	254.07
Direct expenses	596.56
Indirect expenses	82.35
Net return	(424.83)

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Glossary of Terms

Crop residue. Plant material remaining after crop harvest, including leaves, stalks, and roots.

Cropping system. The combination of tillage and agricultural practices used to grow and manage a crop.

Eutrophication. Describes process by which a body of water becomes enriched in dissolved nutrients, particularly nitrate and phosphate, that stimulate the growth of aquatic plants. Death and subsequent bacterial decomposition of these plants depletes the oxygen content of the water, resulting in the death of fish and other aquatic animals.

Flume. An open channel flow measuring structure. There are several designs: Parshall, cutthroat, H, trapezoidal, etc.

Hypoxia. Very low dissolved oxygen concentrations.

Nitrate. Water-soluble inorganic nitrogen of the form NO_3 An important plant nutrient that moves readily through the environment, can cause eutrophication in surface waters. Consumption of nitrates can cause methemoglobinemia ("blue baby syndrome"). The EPA drinking water maximum concentration is 10 ppm.

Phosphorus. An important plant nutrient that can be found in many forms:

Soluble phosphorus. Plant available water-soluble phosphorus in the form $H_2PO_4^-$. This form of phosphorus can cause eutrophication in surface waters.

Particulate phosphorus. Non-water-soluble phosphorus that has adhered to soil particles.

Total phosphorus. The sum of all the forms of phosphorus (soluble + particulate).

Runoff. Portion of the total precipitation that flows overland and enters surface streams rather than infiltrating through soil.

Sediment. Soil particles.

Surface inlet. A pipe that rises vertically from a tile line to the land surface to carry away excess surface water.

Tile lines. Perforated pipes buried below the soil surface that are used to drain excess water away from agricultural land.

Watershed. The portion of a drainage basin that contributes runoff and ground water to a surface water body.

Appendices

Appendix A: Pasture Valuation

Pastures were valued in the study using two methods. The first, and most straightforward method, involved the sampling and testing of pasture clippings to determine actual yield and forage quality. This method was used for Farm Three. When clipping samples were unavailable, as was the case for Farm One and Farm Two, the following method was used to estimate pasture yield and quality.

1. Pasture yields were estimated first using animal weights, the number of animals grazed, the number of days grazed and the number of acres grazed. In Table 1, this method of pasture yield estimating is demonstrated using 1998 data for Farm One and Farm Two.

Table 1. Estimating Pasture Yield.

	Farm One	Farm Two
Number animals grazed (A)	47	122
Avg. body weight (pounds) (B)	1150	1100
Consumption as % of body weight (C)	3.5	3.5
Pounds consumed/day (D) = (A*B*C)	1892	5852
Number of days grazed (E)	150	150
Total forage consumed (tons)(F) = (D*E)	141	351
Number of acres grazed (G)	67	152
Pasture yield (tons acre) (H)=(F/G)	2.11	2.31

2. After calculating pasture yields, we determined the gross value/acre (measured as dry matter). All pasture, based on forage composition, was valued as "average quality hay" using annual prices listed by the University of Minnesota Extension Service "Haylist Summary." Again, 1998 data from Farm One and Farm Two is listed in Table 2 to show how these pasture values were calculated in the study.

Table 2. Calculating Pasture Values.

	Farm One	Farm Two
Pasture yield (tons/acre) (A)	2.11	2.31
Crop value ($/ton) (B)	39.00	39.00
Gross value/acre (wet hay, $) (C)=(A*B)	82.29	90.09
Gross value/acre (dry matter, $) (D)=(C*.90)	74.06	81.08

Appendix B: Farm One Financial Indicators[1]

Indicator	1998	1999	2000	1998-2000 Average
Current ratio (ending)	0.76	0.87	3.58	1.74
Working capital (ending) ($)	(28,176)	(16,019)	81,686	12,497
End farm debt-to-asset ratio (%)	54	46	47	49
End farm equity-to-asset ratio (%)	46	54	53	51
End farm debt-to-equity ratio (%)	118	86	90	98
Rate of return on assets (cost) (%)	40.2	39.3	24.4	34.6
Rate of return on equity[2] (%)	14.1	24.6	7.8	15.5
Operating profit margin (cost) (%)	28.9	31.1	26.3	28.7
Net farm income (cost) ($)	78,893	104,953	65,083	82,976
Term debt coverage ratio (%)	162	191	110	155
Capital replacement margin ($)	33,355	49,108	3,716	28,726
Asset turnover rate (cost) (%)	139.1	126.5	92.9	119.5
Operating expense ratio (%)	65.6	66.3	66.8	66.2
Depreciation expense ratio (%)	5.1	3.0	5.9	4.7
Interest expense ratio (%)	7.9	4.4	7.3	6.5
Net farm income ratio (%)	21.4	26.3	20.0	22.6

Appendix C: Farm Two Financial Indicators[3]

Indicators	1998	1999	2000	1998-2000 Average
Current ratio (ending)	4.33	5.86	7.48	5.89
Working capital (ending) ($)	31,588	43,748	54,180	43,172
End farm debt-to-asset ratio (%)	33	27	41	34
End farm equity-to-asset ratio (%)	67	73	59	66
End farm debt-to-equity ratio (%)	50	38	69	52
Rate of return on assets (cost) (%)	11.7	19.9	1.7	11.1
Rate of return on equity (cost) (%)	28.1	36.9	(4.3)	20.3
Operating profit margin (cost) (%)	25.3	40.7	4.2	23.4
Net farm income (cost) ($)	64,001	77,829	28,096	56,642
Term debt coverage ratio (%)	87	128	(20)	65
Capital replacement margin ($)	(3,167)	6,811	(27,280)	(7,879)
Asset turnover rate (cost) (%)	26.5	26.2	20.6	45.2
Operating expense ratio (%)	51.1	40.8	64.3	52.1
Depreciation expense ratio (%)	3.9	1.5	6.1	3.9
Interest expense ratio (%)	0.5	7.4	9.0	5.6
Net farm income ratio (%)	44.4	50.3	20.5	38.4

Appendix D: Farm Two—Organic Feed Prices Used In Livestock Analyses ($)

Crop	M	98C	98O	99C	99O	00C	00O
Alfalfa Hay (<125 RFV)	1.10	N/a	N/a	N/a	N/a	60.00/ton	66.00/ton
Alfalfa Hay (125 RFV)	1.10	80.00/ton	88.00/ton	80.00/ton	88.00/ton	80.00/ton	88.00/ton
Alfalfa Hay (150 RFV)	1.10	85.00/ton	93.50/ton	N/a	N/a	85.00/ton	93.50/ton
Barley	1.25	1.79/bu	2.24/bu	1.75/bu	2.00/bu	2.00/bu	2.50/bu
Corn	2.00	1.70/bu	2.25/bu	1.61/bu	3.22/bu	1.65/bu	3.30/bu
Corn Silage	1.50	18.00/ton	27.00/ton	18.00/ton	27.00/ton	18.00/ton	27.00/ton
Grass Hay (low quality)	1.10	30.00/ton	35.00/ton	30.00/ton	35.00/ton	35.00/ton	38.50/ton
Grass Hay (med. quality)	1.10	N/a	N/a	49.00/ton	54.10/ton	50.00/ton	55.00/ton
Oats	1.80	1.00/bu	1.80/bu	1.00/bu	1.80/bu	1.25/bu	2.25/bu
Oatlage	1.25	12.00/ton	15.00/ton	N/a	N/a	18.00/ton	22.50/ton
Pasture/Mixed Hay	1.20	70.00/ton	84.00/ton	40.00/ton	48.00/ton	40.00/ton	48.00/ton
Rye Silage	1.25	N/a	N/a	N/a	N/a	10.00/ton	12.50/ton

Where:

M = multiplier or organic premium as estimated by farm operator. Used to convert conventional prices to organic prices.

C = conventional or county average price as reported in the Annual Farm Business Management Reports.

O = local organic price as estimated using the multiplier; (C) * (M) = (O)

Appendix E: Farm Three Financial Indicators[4]

Indicators	1998	1999	2000	1998-2000 Average
Current ratio (ending)	1.34	1.74	0.82	1.30
Working capital (ending) ($)	$11,386	$27,082	$(18,446)	$6,674
End farm debt-to-asset ratio (%)	82	72	81	78
End farm equity-to-asset ratio (%)	18	28	19	22
End farm debt-to-equity ratio (%)	460	254	429	381
Rate of return on assets (cost) (%)	(1.3)	6.4	(6.0)	(0.3)
Rate of return on equity (cost) (%)	(9.0)	10.4	(38.7)	(12.4)
Operating profit margin (cost) (%)	(19.1)	69.6	(104.9)	(18.1)
Net farm income (cost) ($)	(4,849)	10,845	(35,030)	(9,678)
Term debt coverage ratio (%)	158	56	7	74
Capital replacement margin ($)	18,154	(13,722)	(28,581)	(8,050)
Asset turnover rate (cost) (%)	7.0	9.3	5.7	7.4
Operating expense ratio (%)	94.5	43.9	119.7	86.0
Depreciation expense ratio (%)	17.5	(27.7)	12.4	0.7
Interest expense ratio (%)	2.3	43.3	19.7	21.7
Net farm income ratio (%)	(14.3)	40.5	(51.8)	(8.5)

[1] All measures are reported at cost basis unless otherwise noted.

[2] The rate of return on equity is commonly valued on a cost basis. In this case, 1998-1999 equity returns were unavailable and therefore, this indicator is valued here at the market.

[3] All measures are reported at cost basis unless otherwise noted.

[4] All measures are reported on a market basis unless otherwise noted.