Case Study

Automated Milking Systems: A Case Study of a U.S. Midwest Dairy Farm Decision-Making Process

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Abstract

This case study examines the Schmidt family's decision at Pioneer Farm in the U.S. Midwest: whether to adopt Automated Milking Systems (AMS) on their dairy farm. AMS are robots that autonomously milk cows, potentially increasing operational efficiency, reducing labor reliance, and improving milk quality. However, installing AMS requires high upfront costs, maintenance expenses, and adjustments to farm management practices, making it a challenging decision for small and mid-sized dairy operations. Using detailed financial data from Pioneer Farm—a fictional farm based on a real farm in the Midwest—the case enables students to analyze the economic feasibility of AMS adoption and explore its impacts on labor dynamics, animal welfare, and long-term sustainability.

The case draws on general industry insights; however, it specifically examines Pioneer Farm's unique circumstances, providing a realistic and practical framework for classroom discussion. The case illustrates that while AMS can offer substantial long-term economic benefits, initial investment, and maintenance can be major constraints, leading to lackluster adoption rates nationwide. Engaging students in this decision-making process gives them valuable insights into the opportunities and trade-offs associated with technological innovation in the dairy industry. This research also offers valuable lessons for policymakers and educators, contributing to the ongoing discourse on technological innovation in agriculture.

1 The Pioneer Farm

Today, Friday, June 21, 2024, is an important date for the Schmidt family. ***Grandpa Joe***, 80 years old, has decided to retire after dedicating 60 years of hard work to ***Pioneer***, his dairy farm. Located near Madison, WI, the Pioneer Farm is a cherished legacy business that has been the primary source of income for three Schmidt generations and has adapted to the structural changes and challenges that have impacted the dairy industry throughout the decades. As Joe passes the reins to his only son, ***Jack***, he reflects proudly on the farm's journey. With optimism, he believes the farm is well-positioned to thrive in the evolving landscape of dairy farming. Currently, the dairy operation milks 175 cows twice a day in a 20-year-old free-stall barn and parlor. Pioneer also has 1,033 acres of land devoted to cash crops, 430 of which are owned by Pioneer Farms and another 603 acres are rented.

Jack—who is currently 55 years old—plans to keep the operations as usual, milking the cows twice a day, and occasionally hiring two or three temporary workers to help in the barn and the field. However, Joe warns him that it is currently difficult to find farm workers, expressing his frustration with recent experiences: "*We used to get help from Martin's twins, but they are about to finish high school, so they are focusing all their time on studying and college applications. And our last worker, Ernest, used to*

show up late almost every day; and sometimes he would not even show up! Unfortunately, nobody else wanted the job."

To address the issue of labor, ***Erika***, a 25-year-old animal science graduate and Jack's only daughter, proposes an alternative: modernizing the old barn by installing ***automated milking systems*** (**AMS**). Erika visited a couple of farms using this technology while taking a *Dairy Economics* class. "*AMS are robotic boxes that can milk cows on their own; it's super cool! The cows just walk to the machines and get milked. This could solve our issue with the workers.*"

Joe shares this vision with his granddaughter: "*Oh, right! Our neighbor Mike has just installed a couple of robots on his farm, and he really likes them. But I want to leave that decision to Jack, as I am about to retire.*" However, Jack expresses concerns about the financial implications of such an investment: "*I have seen the robots on Mike's farm. Yes, he was happy about it, but he also told me that each robot cost him about 200 grand! Not to mention the cost of installation and barn redesign. It is just too much money!*"

"*But imagine how much money you would save from hiring workers, and also, production will increase because cows will be milked more often with the robots!*" Erika responds.

This debate between Jack and Erika continues for hours, with both providing valid arguments. Joe then interjects, "*It is great to see how passionate both of you are when it comes to our farm; there is no doubt that our legacy is in good hands. I have an idea that could help with this discussion. What about hiring a consultant? Our neighbor Michael did the same before deciding to install AMS. In fact, I have a business card that Mike gave me in case I needed them.*"

"*Isn't that costly?*" interrupts Jack.

"*No, because these are professionals working at a university; they provide their service for free to dairy farmers in Wisconsin and California,*" responds Joe, while looking at his pockets—"*Hey, I just found it! It is called Louis Lab, an economic group with headquarters at UC Davis*. *Let's call them to hear their perspective on this issue.*"

"*Sounds good; in that way, we have an impartial third party,*" responds Jack, to which Erika agrees.

"*Okay, it's settled then. I will call them on Monday morning,*" concludes Grandpa Joe.

2 Meet the Schmidts

Joe Schmidt was raised amid the scent of fresh hay and the lowing of cattle. He inherited the farmstead when he was 50 years old. From dawn until dusk, he has toiled under the sun, nurturing the herd and tending the fields with weathered hands and a heart of gold. Through seasons of plenty and times of drought, Joe's grit and determination never wavered. With a lifetime of stories etched in the soil, he stands tall as a steward of tradition and a pillar of his community, embodying the timeless spirit of Wisconsin's farming heritage.

Jack Schmidt is on the cusp of inheriting the family homestead. Though the farm's future beckons, Jack's cautious demeanor prevails. With a reluctance for change, he clings to traditional practices, wary of innovation's unknowns. While the prospect of inheritance looms, Jack's risk aversion casts a shadow over his optimism. Amid whispers of modernization, he remains steadfast, rooted in the tried-and-true methods of his forebears. Yet, as the mantle of responsibility draws near, Jack grapples with the tension between tradition and progress, embodying the timeless struggle of preserving heritage in an evolving world.

Erika Schmidt is fresh out of college and brimming with ambition. Armed with a degree in animal science, she's eager to modernize the Schmidt farm with robotic milking technology. With a keen eye for efficiency and innovation, Erika envisions a future where automation revolutionizes their operations. Despite her youth, she's undaunted by the challenges ahead, driven by a passion for progress and a deep love for the family farm. As she navigates the intricacies of tradition and technology, Erika emerges as a trailblazer, poised to lead her family's legacy into a new era of dairy farming.

3 Louis Lab

Louis Lab is a multidisciplinary and multistate group that aims to improve the financial resilience of the U.S. dairy farm industry (official website: https://drlouis.us/louis-lab/). This effort is led by Dr. Luis Peña-Lévano, a professor at the University of California, Davis. The lab also has partnerships with many universities and institutions across the globe. The lab partners are currently working on multiple projects related to dairy automation, labor issues, sustainable practices, and farmers' perception of dairy policy programs.

On Monday, June 24, 2024, Dr. Luis received a call from Joe requesting the lab's services to assess the feasibility of adopting AMS on his farm. Your team is part of Louis Lab and eagerly volunteers to conduct an economic and financial analysis for the Pioneer dairy farm. This consultancy requires a thorough analysis and will be presented to the family on July 29, 2024.

Dr. Luis and Dr. Shaheer Burney, a professor at the University of Wisconsin – River Falls, have arranged an in-person meeting with the three members of the Schmidt family on Friday, July 12, 2024. Your team will accompany them on this visit and utilize all the information gathered to construct the analysis. In anticipation of the meeting, you have received introductory materials covering the Wisconsin dairy industry, how AMS work, insights into their functioning and adoption over time, and the 2023 Pioneer's financial statements.

4 Wisconsin Dairy Industry

Wisconsin is a dairy state, home of the largest number of dairy operations in the nation (Peña-Lévano, Burney, and Beaudry 2023). As of September 2022, there were 6,275 licensed herds registered in the state, with a production of 31.7 billion pounds of milk (Fig. 1). Wisconsin dairies generate an annual revenue of $45.6 billion—equivalent to 14 percent of the U.S. milk output (Dairy Farmers of Wisconsin 2023), making it the second largest dairy producing state—only surpassed by California.

The Wisconsin dairy landscape is unique, comprising primarily small- and medium-scale dairy farms. Most of these operations are family-owned (Peña-Lévano, Burney, and Beaudry 2023), with multiple generations managing these farms. Nevertheless, the state's industry has faced structural changes in recent decades. While production has steadily grown over time, the number of dairy cows has remained relatively constant. However, due to consolidation, the number of operations has decreased from 11,761 farms (in 2012) to only 6,275 farms (in 2022). Approximately 43 dairy herds have closed operations or sold to a larger farm every month from 2012 to 2022 (Fig. 1). As of April 2024, there are now 5,595 licensed herds in the state (Wisconsin Department of Agriculture, Trade, and Consumer Protection)

Dairy owners are currently facing consistent declines in net returns, volatile milk prices, supply chain bottlenecks, labor shortages, and wage pressure; issues intensified after the COVID-19 pandemic (Peña-Lévano, Burney, and Adams 2020; Luckstead, Nayga, Jr., and Snell 2021; Njuki 2022). Rising inflation has also led to higher feed cost, freight, fertilizer, and fuel, further exacerbating production costs (Liebrand 2022).

Wisconsin dairy farms are mostly family owned, relying heavily on family members to accomplish the daily activities of the farm (Peña-Lévano, Burney, and Beaudry 2023). Depending on the operation size, farmers also rely on hired agricultural workers. Overall, labor represents the second or third highest cost after feed cost, comparable to herd and herd replacement costs, representing 20 to 30 percent of the total milk production cost. Retaining farm workers has become a major challenge for dairy enterprises, reducing business farm efficiency (Tranel 2017). In 2008, the national labor turnover ratio was on average about 11.9 percent (Rosson 2012), higher than in other comparable industries. Recent conditions suggest that this situation may have worsened in the fifteen years since this survey

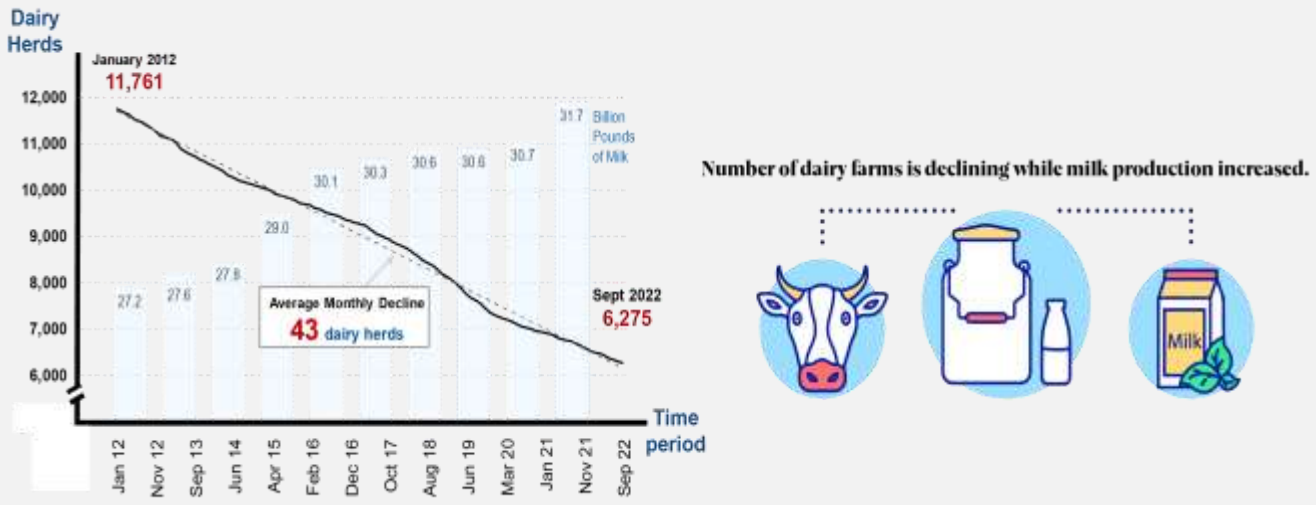

Figure 1. Wisconsin Milk Production and Number of Licensed Herds

Source: Peña-Lévano, Burney and Beaudry (2023).

was conducted.

Adopting AMS addresses the growing challenges of farmworker retention and high turnover in the dairy industry by automating labor-intensive tasks such as milking, equipment cleaning, and fixed scheduling, as cows voluntarily enter the milking unit (Tranel 2017). Additionally, AMS enhances herd management by automating health monitoring, reducing the need for manual tracking of milk yield and activity levels (Steeneveld et al. 2012). By ameliorating labor constraints, AMS allows farmworkers to shift their focus to higher-value tasks such as system maintenance, data analysis, and herd management, improving overall efficiency and productivity (Peña-Lévano, Burney, and Beaudry 2023).

Figure 2. A Model of an Automated Milking System

Source: Designed by the authors, based on the DeLaval prototype VMS 300

5 Automated Milking Systems

AMS are milking robots; each robot can milk between 60 to 70 cows per day (Fig. 2). Overall, AMS technology enables cows to be milked autonomously between two to four times daily, depending on the milking permission settings (previously set by the farmer in the robot) and the cow's health indicators. Feed pellets are offered at the other end of the robot to encourage cows to enter the unit.

To correctly identify each animal and collect data, each cow has a collar (or transponder) uniquely identifying it within the system. This identification enables the AMS to track individual cow data, such as milking frequency, milk yield, activity, and health data. Cows enter the robot milking unit, and once identified, the system determines whether the cow is either milked or rejected.

The AMS initiates the milking process for the cows accepted within the system. Automated brushes or cleaning cups clean and disinfect the cow's teats to maintain hygiene before milking (i.e., called *preparation*). Next, robotic milking arms or teat cups are attached to the cow's udders using 3D cameras and/or lasers. Sensors on the AMS measure information such as milk yield and quality data—including somatic cell counts and cow health parameters (Fig. 3). This data is stored and accessible through a computer or mobile device. Also, the AMS units will apply post-milking teat disinfectant after milking to prevent infections. After completing the milking process, the cow leaves the robot, and another cow is allowed to enter. For an interactive visual representation, please visit https://drlouis.us/louis-lab/.

6 A Brief Overview of the Adoption of Robotic Milking Systems

AMS emerged during the latter half of the twentieth century. The conceptual framework for automation was developed in the early 1950s. Still, it was not until the 1970s—amid rising labor costs in developed nations—that practical initiatives for AMS gained traction. During the 1970–1990 period, various

Figure 3. Milking Steps Using AMS

Source: Designed by the authors.

European institutions undertook endeavors focused on teat position determination as well as developing the apparatus for the automatic attachment of milking clusters (Rossing and Hogewerf 1997; Sharipov et al. 2021). The first Gascoigne Melotte's experimental milking robot was debuted in 1986 at the De Waiboerhoeve research farm in Lelystad, Netherlands (Sharipov et al. 2021). However, it was not until 1992 that the practical adoption of AMS occurred, marked by the inaugural adoption of four milking robots, named the *Astronaut*, by Lely Industries (Sharipov et al. 2021). By 1998, approximately 100 Astronaut systems were operational on Dutch farms, with similar expansions in northern Europe, Italy, and Japan (John et al. 2016; Sharipov et al. 2021). By 2010, AMS accounted for a substantial percentage of new milking equipment installations in several European countries, particularly Denmark and the Netherlands. Subsequent years witnessed a significant surge in global AMS deployment, with installations surpassing 35,000 units by 2017 (Sharipov et al. 2021).

Few studies have examined North American dairies in conjunction with European farms. An exploratory case study (Schewe and Stuart 2015) on 15 Danish, 5 Dutch, and 15 U.S. Midwest farms found that differences in herd management, herd health, and milk quality are relevant factors when assessing the advantages of AMS. Tse et al. (2018) found that Canadian farmers with experience using AMS credit this technology with increased profitability, enhanced quality of life, and improved cows' health. Interestingly, Heikkilä, Nousiainen, and Pyörälä (2012) study on Finish dairies concludes that animal welfare and producer profits are more important as factors influencing AMS adoption than market and sociodemographic conditions.

However, Jacobs and Siegford (2012) argue mixed results regarding AMS benefits, citing changes in management practices and facility design as major sources of variation. Specifically, implementing AMS may require operators to acquire new skills for overseeing the technology, analyzing data outputs, and readjusting equipment issues (Driessen and Heutinck 2015). In addition, Steeneveld et al. (2012), found insignificant differences in labor costs, net output, or technical efficiency between farms with and without AMS. This suggests that more research is needed on this topic as the results may signal a transformative impact on labor dynamics and managerial roles within dairy operations.

Research on animal health—a crucial variable associated with veterinary cost—also provided mixed results when analyzing somatic cell count in U.S. and European milking systems (Helgren and Reinemann 2006; Hovinen, Rasmussen, and Pyörälä 2009). **Thus, whether this technology's net benefits outweigh implementation and maintenance costs for Pioneer Farms is not entirely clear.**

In summary, while AMS adoption in the United States is still in its infancy, with limited economic literature (Barkema et al. 2015; Marques et al. 2023), European countries and New Zealand have made significant progress in integrating this technology into their dairy operations, and understanding the downsides surrounding its adoption. The experiences of these nations provide valuable case studies and lessons to shed light on both benefits and challenges associated with AMS.

7 Financial Profile of Pioneer

Pioneer Farm's current financial position is stable, but nothing to brag about. The farm owners have done an excellent job of keeping the farm profitable, especially during the volatility of milk prices from 2012 to 2024. However, farm growth has stagnated, and the farm has trailed behind the average Wisconsin dairy across several dimensions including yields.

The farm currently has two enterprises: dairy and cash crops. Pioneer Farm markets its milk through a regional dairy cooperative, a typical arrangement for Wisconsin small- and medium-sized dairy farms (Brock and Barham 2009). The regional cooperative manages milk collection, processing, and distribution. The dairy enterprise includes 175 milking cows, all Holsteins, with about 60 replacement heifers. The herd is in good health, and instances of mastitis and other diseases are at or below industry standards. Milk produced per cow equals approximately 25,400 pounds (lbs.) per year. For cash crops, corn and soybeans are grown on 1,033 acres, 430 of which are owned by Pioneer Farms,

2023 Balance Sheet

PIONEER FARM, LLC
BALANCE SHEET
January 1, 2023

ASSETS

Current Assets	Value
Cash and checking	$ 79,876
Prepaid exp. & supplies	100,883
Growing crops	-
Accounts receivable	104,883
Hedging accounts	-
Other current assets	

Crops	Quantity	Value/Unit	Value
Alfalfa Hay	368	125.00/ton	46,000
Corn Silage	1,365	25.00/ton	34,125
Grass Hay	95	40.00/ton	3,800
Barley Silage	200	15.00/ton	3,000
Additional crops			247,925
Livestock held for sale			-
Total Current Assets			$ 620,492

Current Liabilities	
Accrued interest	$ 1,027
Payables & accrued expenses	16,345

Current loans	Principal Balance
Jannik Bank-LOC	-
Joze Bank-Credit Card	3,273
Betty Bank-Credit Card	32,055
Alberto Bank-Credit Card	1,693

Principal due within 12 months on term liabilities	43,620
Total Current Liabilities	$ 98,013

Intermediate Assets

Breeding livestock	No.	Value/Unit	Value
Holstein Cows	165	1,000	165,000
Springing Heifers	10	1,250	12,500
Heifers 16-23 months	26	1,000	26,000
Add. Breeding livestock			73,000
Machinery			620,910
Titled vehicles			63,120
Other intermediates			25,125
Total Intermediate Assets			$ 985,655

Intermediate Liabilities

Loan	Balance
SAP - '09 Chattel	129,993
Rising Star - TMR	-
Manit - '14 4240	2,279
ASB - #90175	49,277
Total Intermediate Liabilities	$ 181,549

Long Term Liabilities

Loan	Balance
ASB-ASB '05 RE	344,165
Total Long-Term Liabilities	$ 344,165

Long Term Assets

	Acres	Value
Land Tillable	300	149,980
'96 TILE 45A.2500'	-	500
ARLINGTON BANK	126	64,875
Additional Land		49,519
Buildings		259,311
Other long-term assets		211,091
Total Long-Term Assets		$ 735,276
Total Farm Assets		$ 2,341,423
Personal Assets		154,177

Total Farm Liabilities	$ 623,727
Personal Liabilities	10,864
Total Liabilities	$ 634,591
Equity	
Retained Earnings/Contributed Capital	$1,861,009
Total Equity	$1,861,009

Total Assets	$ 2,495,600
Net worth	$ 2,495,600

Figure 4: Pioneer's Balance Sheet (January 1, 2023)

2024 Balance Sheet

PIONEER FARM, LLC
BALANCE SHEET
January 1, 2024

ASSETS

Current Assets	Value
Cash and checking	$ 5,330
Prepaid exp. & supplies	12,750
Growing crops	-
Accounts receivable	105,046
Hedging accounts	-
Other current assets	-

Crops	Quantity	Value/Unit	Value
Alfalfa Hay	264	117.95/ton	31,080
Corn Silage	2,300	27.00/ton	62,100
Soybeans	5,855	9.37/bu.	54,855
Corn	69,019	3.47/bu.	239,300
Livestock held for sale			-
Total Current Assets			$ 510,461

Current Liabilities	
Accrued interest	$ 2,799
Payables & accrued expenses	12,625

Current loans	Balance
Jannik Bank-LOC	20,000
Joza Bank-Credit Card	2,698
Betty Bank-Credit Card	1,309
Alberto Bank-Credit Card	16

Principal due within 12 months on term liabilities	67,264
Total Current Liabilities	$ 106,713

Intermediate Assets

Breeding livestock	No.	Value/Unit	Value
Holstein Cows	180	1,000	180,000
Springing Heifers	15	1,250	18,750
Heifers 16-23 months	25	1,000	25,000
Heifers 12-15 months	34	800	27,200
Add. Breeding livestock			50,400
Machinery			766,510
Titled vehicles			66,768
Other intermediates			25,125
Total Intermediate Assets			$ 1,159,753

Intermediate Liabilities (Schd V)

Loan	Balance
SAP-'09 Chattel	121,081
Manit-'14 4240	-
ASB-#90175	34,789
CLASS Financial-Combine	102,740
Total Intermediate Liabilities	$ 258,610

Long Term Assets

	Acres	Value
Land Tillable	300	149,980
'96 TILE 45A 2500'	-	500
ARLINGTON BANK	126	64,875
Additional Land		49,519
Buildings		445,844
Other long-term assets		216,122
Total Long-Term Assets		$ 926,840

Total Farm Assets	$ 2,597,054
Personal Assets	154,177
Total Assets	$ 2,751,230

Long Term Liabilities

Loan	Balance
ASB-ASB '05 RE	331,959
ASB-Barn#90495	191,223
Total Long-Term Liabilities	$ 523,182

Total Farm Liabilities	$ 888,505
Personal Liabilities	3,000
Total Liabilities	$ 891,505

Equity

Retained Earnings/Contributed Capital	1,859,726
Total Equity	$1,859,726
Net Worth	$ 2,751,230

Figure 5: Pioneer's Balance Sheet (January 1, 2024)

and another 603 are rented. Yields of both commodities have been modest, falling under the county average the past couple of years.

The balance sheet is quite typical of a small Wisconsin dairy farm (Figures 4 and 5). Assets are valued at about $2.75 million, with land (including tillable land) valued at $264,874, and buildings and improvements (barns and other structures) valued at about $661,966. Intermediate assets such as breeding livestock, machinery, equipment, and vehicles are valued at $1.16 million, and current assets equal $0.51 million. While current assets comfortably exceed current liabilities, a major proportion is attributed to unsold inventory of forage and cash crops. It is not certain how quickly this inventory can be sold or will be utilized in production. The Pioneer Farm ended the last fiscal year with only $5,330 in cash and about $105,046 in accounts receivable.

The Pioneer Farm has relatively low debt. Short-term liabilities include a couple of operating loans and a credit card balance. These liabilities equal about $106,713. Long-term liabilities include several small low-interest loans that the owners have been consistently paying off over the last decade. The largest long-term liability is a real-estate loan with a balance of $331,959 at an interest rate of 5 percent, and 9 years left on the payment schedule. Total liabilities equal $891,505, and the owners' net worth equals about $2,751,230.

The Profit and Loss Statement (Figure 6) shows the profitability challenges that the farm has been facing over the past few years. The farm ended the last fiscal year with a net income of -$121,582. The year before that, the net income was $35,792. The farm is on track to end the current fiscal year with a net income of $34,461. The three-year average net income is $17,160. Gross crop income has been about 33 percent of overall gross revenue, whereas milk sales are about 56 percent.

In 2023, operating expenses have hovered between 90 percent and 98 percent of total revenues. Major operating expenses include purchased feed of $273,500, land rent of $150,800, and hired labor of $179,650. The owners have several employees that help with cow care, do the milking, help with field work, etc. Total labor for the current year includes 12,000 hired labor hours with an estimated 5,000 hours from owners and family. The average hourly rate paid to hired employees is $14.97. Repair expenses are a relatively small percentage of total expenses, and the farm relies mostly on the owners and family members to conduct repairs and maintenance. Both Joe and Jack have basic mechanic and electrician skills, and Erika is quickly learning from her dad and grandpa.

The cash crop enterprise leads to a substantial amount of seasonality in the farm's cash flow. The farm typically starts the calendar year strapped for cash, as a major portion of the cash reserves are used to purchase operating inputs to prepare for planting. The monthly milk checks and short-term operating loans help the farm's liquidity during this time. The bulk of the farm's cash is generated in the last quarter of the year, coinciding with corn and soybean harvest seasons. Despite this seasonality, net cash from operating activities has been safely in the positive for the past several years.

The farm's liquidity has been most impacted by capital investments, particularly the purchase of a new combine last year. The previous model had become costly to maintain, making the replacement a necessary investment to sustain operational capacity. Although part of the purchase was financed through a loan, a significant portion of the farm's available cash was used, putting additional strain on liquidity. The year before, multiple other investments were made, including purchasing a skid steer and a new milk bulk tank. The skid steer was primarily intended to maintain current farm operations by improving efficiency in routine tasks such as manure management and feed handling. The new milk bulk tank was a forward-looking investment designed to accommodate potential increases in milk production, aligning with the farm's long-term capacity expansion goals. While necessary, these one-time purchases made consistently over the last few years have significantly impacted the farm's liquidity position.

Lastly, adopting AMS at Pioneer Farm may require infrastructure investments. Retrofitting the barn for robotic milking units could cost $100,000 to $200,000—including cow flow redesign, rubber flooring installation, and expanded space for robot access (Tranel 2017). Upgrades to electrical and

December 31, 2023 Income Statement

Income Statement

Crop sales	425,730	
Crop inventory change	-1,258	
Gross crop income	$ 424,472	
Livestock sales	738,226	
Livestock inventory change	50	
Gross livestock income	$ 738,276	
Government payments		97,248
Other cash farm income		85,753
Change in accounts receivable		-31,051
Gain or loss on hedging accts		-1
Change in other assets		-19,946
Gain or loss on breeding livestock		18,050
Gross farm income		1,312,801
Cash operating expense	1,310,922	
Change in prepaid exp and supplies	-4,365	
Change in growing crops	-	
Change in accounts payable	-8,323	
Depreciation	74,969	
Total operating expense	$ 1,373,203	
Interest paid	57,567	
Change in accrued interest	3,613	
Total interest expense	$ 61,180	
Total expenses		$ 1,434,383
Net farm income		-$121,582

Farm summary

Total crop acres	1,033
Dairy Cows	175
Cows Replaced or Transferred out	59

Figure 6: Pioneer's Income Statement

plumbing systems—estimated at $50,000 to $75,000—are also essential to meet AMS's power and water needs. Additional costs of $40,000 to $60,000 may arise from improved ventilation, internet connectivity for monitoring, and manure management (Jacobs and Siegford 2012).

8 Friday July 12, 2024: Meeting at the Pioneer Farm

The morning of Friday, July 12, has arrived. As the meeting commences with Grandpa Joe, Jack, and Erika, introductions of both your team and theirs are exchanged. Here, we present parts of the conversation, focusing on additional information about the dairy farm and AMS:

Luis: Thanks for having us and for providing us with your financial statements in advance. I'm glad we could sit down today to discuss the potential of adopting robotic milking on your farm.
Jack: Thanks for coming today. We have been debating whether to install milking robots for some time. It's intriguing, but I'm not sure if it's the right move for our farm.
Luis: Absolutely, it's a large financial investment. How many cows do you have, and what's your average milk production?
*Jack: We have about **175** cows that are being milked, and we sell around 25,400 lb. of milk per cow annually.*
Erika: For the current herd size, how many robots would we need?
Shaheer: About three robots, as each box is able to milk about 60 cows per day.
Luis: Do you hire part-time or full-time workers?
Joe: We usually hire workers to help with milking the cows, but this ends up being a lot of labor. Last year's records show that we paid about 12,000 hours in wages. During 2022 and 2023, we hired the kids of our friends that live nearby, but it has been difficult to retain them, as many of them go to high school and have homework, are involved in after-school activities, and will be going to college next year.
Jack: We've tried to hire full-time employees but that has been a challenge. They often don't show up on time, and on some days, they don't show up at all. We are afraid to let them go because we need the help, and it is difficult to find new employees.
Luis: I see. How many hours per year does your family work on the farm?
Joe: Jack and I spend most of our time at the farm. However, now that Erika has graduated from college two weeks ago, and I am retiring, she will help Jack run the farm. I estimate that last year we spent about 5,000 hours on the farm as a family.
Shaheer: Apart from labor, what other costs and risks are you concerned about?
Jack: We are definitely worried about feed cost and price variability.
Shaheer: What are your expectations on milk prices?
Joe: We are not entirely sure. The milk price has fluctuated a lot over the last five years. Some months we have received as low as $15/cwt, while other months, such as in May 2022, we got an all-time-high of $23/cwt.
Shaheer: Thanks for the insights. Do you have any questions for us?
Jack: Yes, first off, how much of an investment are we talking about here? I've heard it can be pretty steep.
*Shaheer: It can vary depending on the size of your operation. Typically, you're looking at an initial investment ranging from **$185,000 to $250,000 per robot** for brand new robots. This does not include the cost of the new barn or retrofits. Robots also have higher ongoing maintenance costs than conventional milking systems.*

The conversation continues for thirty more minutes. Dr. Shaheer and Dr. Luis take notes of all the farmers' concerns regarding automation in order to help you have a better idea of where to focus on your consultancy task. The conversation ends with Jack's remark:

Jack: I really appreciate your input and thoughts. I am looking forward to your recommendation of the best option to position our farm for the future.

9 Your Role: Assess the Feasibility of Adopting AMS on the Pioneer Farm

Dr. Luis and Dr. Shaheer have summarized the questions raised by the Schmidt family. Your consultancy is expected to provide a thorough analysis addressing the following questions:

a. *Marketing Analysis*

- What are the opportunities and challenges of adopting robotic milking systems?
- What considerations and costs should be taken into account when adopting AMS? What assumptions need to be made when making these types of decisions?
- What is the outlook for the dairy sector in 5 years? How does this may influence Pioneer's decision to invest in AMS?

b. *Financial Analysis*

- Analyze liquidity, profitability, solvency, and repayment capacity to determine the financial feasibility. Does the current financial position support the investment in AMS?
- What information is needed to calculate the feasibility of investing in AMS?
- Under your assumptions, is it financially profitable for the Pioneer Farm to invest in AMS? If so, which type of robots would you recommend, new or used robots?
- If AMS is not recommended, what would you advise the Pioneer farm do to position their farm for future success?

c. *Farm Labor*

- What tasks would AMS likely replace and create? How would this impact labor costs and efficiency?
- How can Pioneer Farm ensure workers adapt to their new roles post-AMS adoption?

d. *Management Practices and Labor Demand*

- How might adopting AMS alter management practices on the Pioneer Farm, particularly in monitoring, decision-making, and operational oversight?
- What strategies should be implemented to effectively reallocate labor and train workers to manage and maintain AMS, ensuring optimal integration with existing farm operations?

e. *Animal Welfare and Farmer's Quality of Life*

- Should the owners of non-traditional milking systems such as AMS be concerned about consumers' concern for animal welfare and health issues?
- How could adopting AMS affect the farmers' quality of life?

f. *Environment*

- How might environmental stewardship impact the market considerations for owners using AMS?
- What role does traceability play in the non-financial market considerations for products from non-traditional milking systems such as AMS?
- Can you identify and discuss any other non-financial market considerations that should be considered when adopting and using AMS?

g. *Economic and Financial Performance*

- How would you allocate labor and shared costs between the crop and dairy enterprises to assess their profitability, and what assumptions would you make without more enterprise specific data?
- What additional recommendations would you provide to the Pioneer Farm to improve its financial resilience in the long term?
- If AMS is financially profitable, do you think Pioneer would take your advice? Why or why not?

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