The Economics of Automatic Milking Systems

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Introduction

Installation of Automatic Milking Systems (AMS) in Iowa continues to grow. It is probable that by 2025, up to 10% of dairy producers may be using AMS in their dairy operations. In order to assist dairy producers and their lenders make informed decisions on the economic variables associated with AMS consideration, these authors developed a partial budget spreadsheet tool. See Page three for assumptions and calculations.

There are two very important things to note when comparing AMS versus conventional parlor milking. First, many factors are "highly variable" meaning that slight changes in milk price or projected change in milk production, for instance, can significantly change the financial impact. Second, there is limited data to base various assumptions meaning producers and consultants will have limited research data for projecting costs and incomes with high confidence levels.

Herd and Financial Assumptions

Herd size is important in calculating the number of AMS needed. One AMS can handle an estimate 55-65 milking cows. An additional 10% to 12% herd size can be added when including dry cows. Thus, a 72 cow total herd per AMS can be feasible depending upon milk production.

Milk price should be estimated as a long term, projected average. Estimated cost per AMS should include new building or modifications to existing structures to house the robot and adequate alleys for cow flow. An estimation of $15,000 to $20,000 per AMS for housing can be expected. On average the estimated to cost is around $200,000 per AMS; multiple robot systems may provide for price discounts.

Many AMS installed in 2000 are still in operation. So, "years of useful life" is an unknown variable. Seven years of useful life is a very conservative estimate while more than 15 years may be risky, especially with the rapid development in AMS technology. The value of AMS after its useful life is also not clearly defined at this time.

Interest rate on money should display the rate which represents cost of interest paid or the opportunity cost of the owner's money, or, a combination of both. Insurance rate is the rate per $1,000 of value of AMS. Value of AMS used for interest and insurance is the full investment value less salvage value.

Bottom Line of AMS: Cows and People Like Them!

Labor Changes

One of the leading interest factors of AMS is the reduction of labor. Current hours of milking for the designated herd size in a conventional parlor needs to be compared to the anticipated hours of milking labor after the AMS is installed. Typically, the training period will last three months, labor rates after this period should be used in the assumptions. A reduction in time managing labor is probable.

The herd management software includes rumination, milk conductivity and cow activity. This information can lead to labor savings from heightened heat and mastitis detection and faster identification of sick cows. There will likely be an increase in records management with the AMS to utilize the software data that might utilized with conventional milking systems.

Milk Production and Quality Changes

Producers may experience losses in milk production six to nine % lower from 3x milking. From 2x milking, one could expect a three to five % increase or more. This is a huge variable of AMS financial impact. Somatic Cell Counts (SCC) and bacteria counts tend to increase in the first few months after adoption to the AMS but tends to drop to initial levels or even lower after the adoption period.

Feed Costs and Intake Changes

Feed cost per pound and intake level changes are seldom accounted for but can be significant. Milk production and feed intake have a positive correlation. AMS utilize a pelleted feed during milking which may increase feed cost depending on cost and current TMR. However, feed cost could decrease relative to previous feeding practices as cows are individually fed with AMS.

Culling and Herd Replacement Changes

Most producers report no change in culling percent. But, expected change in turnover rate should be accounted for in herds with poor feet and legs or possibly herds with genetic potential for lots of reverse tilt udders.

Utilities and Supply Changes for Milking

AMS systems may increase electrical usage up to 150 kWh per cow per year. Water usage may decrease 50 % or more for small herds using only one AMS, but water usage is more comparable for herds using two or three AMS. Chemical and supply costs may be higher in some instances but in most instances would slightly decrease.

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Sample 144 Cow Dairy Converting to AMS

A 144 cow herd and $17.50 per cwt milk price are used as a basis for installing two AMS at a cost of $220,000 per unit. The annual maintenance cost is $7,000 per robot. The producer expects a ten year useful life out of the AMS at which time he plans to retire and estimates the robots can be resold for $40,000 each. Using a combination of borrowed and own money, the interest cost is 5.5 %. And, the producer further insures the AMS at a value of $400,000 higher than the current system at a rate of $0.005 per $1,000 of valuation.

The producer is currently using 9 hours of labor for milking including set-up and clean-up and expects the time for fetching cows and clean-up of the AMS area will be 3 hours per day. Heat detection is projected to decrease from 40 to 15 minutes per day. The labor rate for the milking and heat detection is currently hired at $15 per hour, including benefits and employment taxes.

The producer recognizes that there will be an additional 0.6 hours per day of records management with the AMS but also estimates there will be a reduction of 0.6 hours per day in management of labor. The labor rate for record and labor management is valued at $18 per hour.

The herd has a current bulk tank average of 70 pounds per cow on 2x milking. A seven pound per cow (10%) increase in milk production is projected. The producer also expects the AMS to do a better job with pre and post milking sanitation, thus reducing his SCC by five %. The producer expects a gain of $35 per cow due to availability of cow production, reproduction and health information.

The Total Mixed Ration (TMR) fed to the herd currently costs $0.125 per pound of dry matter. The daily dry matter intake per cow will increase with the additional seven pounds of milk. Even though now using a pelleted feed in the AMS, a very small decrease of $0.002, one-tenth of one cent, is estimated as the change in cost per pound of dry matter due to individual cow feeding.

The producer expects a one % decrease in herd turnover rate. Replacement heifers are valued at $1,600 and cull cows sold for milk or dairy at an average of $750.

An increase of $8.25 per cow per year for electricity is anticipated with AMS. Due to neighbor's experiences, this producer estimated a $3 savings per cow for water use and a $1.50 increase in chemical or other supply use.

Partial Budget Analysis for 140 Cow Dairy

A partial budget considers changes to an operation due to AMS adoption including increased or decreased incomes or expenses. All costs are on an annual basis. At $17.50 per cwt milk price for 144 cows, an additional $58,212 of milk production income is generated. Reducing SCC by five % with a $0.003 per 1,000 ml change yielded $1,317 in premiums. A one % decrease in cow sales equaled -$1,080 in cull cow sales. Expected gain due to the herd software and related management records is $5,040. Total increased incomes equaled $63,489.

Decreased expenses that also created a positive impact include labor savings of 0.4 hours of heat detection, 6 hours of milking and 0.6 hour of labor management per day. This equates to financial savings of $2,190 in heat detection and $32,850 in milking labor. And reduction in labor management time for the owner was valued at $3,942. The total decreased expenses equaled $38,982 and when added to increased incomes gave a total positive impact of $102,471 by adopting AMS.

On the negative impact side only increased expenses are entered as no decreased incomes are expected. The capital recovery cost of the robots includes the depreciation and annual interest cost of owning the AMS. Depreciating the AMS out over ten years and charging 5.5 % interest against the purchase value yields a cost of $60,200 annually.

Increased repair and insurance costs stems from an annual maintenance contract on the AMS and the additional value to insure the AMS at total of $16,000. Additional feed costs of $22,270 come from the dry matter needed to produce the additional milk along with changes in total TMR costs due to pelleted feed and/or individual feeding of cows in the AMS. This producer expected a $0.002 cost reduction per pound of dry matter. Due to a one % decreased cull rate, heifer replacement costs decrease $2,304. Increased utilities, mainly from electricity, add $972 while increased records management labor adds $3,942. Total increased expenses and total negative impacts are $101,080.

Net financial impact, positive minus negative impacts, is calculated at $1,391 for this example. But, quality of life improvements from a flexible management schedule and a structured milking schedule is valued at $9,000. With quality of life included, the net impact becomes $10,391.

So, the adjusted value of the AMS depends heavily on the variables used and value of the quality of life gained from installing a system.

Economics of Robotic Milking Systems v2.0 Annual Partial Budget Analysis

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Positive Impacts

Increased Incomes	
Increased Milk Production	$58,212
Increased Milk Premiums	$1,317
Increased Cull Cow Sales	-$1,080
Software Value to Herd Production	$5,040
Total Increased Incomes	$63,489
Decreased Expenses	
Reduced Heat Detection Labor	$2,190
Reduced Milking Labor	$32,850
Reduced Labor Management	$3,942
Total Decreased Expenses	$38,982
Total Positive Impacts	**$102,471**
Annual Value to Quality of Life =	**$9,000**

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Negative Impacts

Increased Expenses	
Capital Recovery Cost of Robots (Dep & Int	$60,200
Increased Repair and Insurance Costs	$16,000
Increased Feed Costs	$22,270
Increased Cow Replacement Costs	-$2,304
Increased Utilities and Supplies	$972
Increased Records Management	$3,942
Total Increased Expenses	$101,080
Decreased Incomes Expected	
Total Decreased Incomes	$0
Total Negative Impacts	**$101,080**
NET ANNUAL FINANCIAL IMPACT =	**$1,391**
with Annual Value of Quality of Life =	**$10,391**

Herd and Financial Assumptions

		Units	Instructions or Reference Values
Herd Size -- both milking and dry	144	no. of cows	Typical herd size of 66-74 cows/robot
Mailbox Milk Price	$17.50	$ per cwt.	Typical range $13.00 - $20.00 / cwt
Estimated Cost per Robot -- include robot housing	$220,000	$ per robot	Typical range of $185,000 - $230,000
Estimated Annual Change in Milking System Repa	$7,000	$ per robot	Typical range from $5,000 - $9,000/robot
Number of Robots Needed	2	no. robots	Typical range of 55-65 milking cows/robot
Years of Useful Life	10	years	Typical rage is 7 - 15 years
Value per Robot after Useful Life	$40,000	$ per robot	Typical range of 10-30% of purchase price
Interest Rate of Money	5.50	% interest rate	Value of own or borrowed money
Insurance Rate per $1,000 Value	0.50	%	Typical rate is 0.5% per 1,000 investment
Increased Insurance Value of Robot vs. Current	$400,000	$ per farm	Value of robot(s) over current system
Labor Changes			
Current Hours of Milking Labor with setup&cleanu	9	hours per day	Range of 2 to 5 hours/day per 70 cows
Anticipated Hours of Milking Labor	3	hours per day	Range of 1 to 1.75 hours/day per 70 cows
Current Hours of Heat Detection	0.65	hours per day	Typical is 0.25 - .75 hours
Anticipated Hours of Heat Detection	0.25	hours per day	Typical is 0 - 0.5 hours
Labor Rate for Milking and Heat Detection	$15.00	$ per hour	Typical rate is $10 - $18 with benefits
Increased Hours for Records Management	0.6	hours per day	Include AMS management records
Reduced Hours for Labor Management	0.6	hours per day	Include hiring, training, overseeing, etc.
Labor Rate for Records and Labor Management	$18.00	$ per hour	Typical rate of $12 - $25
Milk Production, Herd Health, Reproduction and Milk Quality Changes			
Lbs of Milk per Cow per Day, Past Year	70	lbs/cow/day	Typcial range of 50 - 90 lbs
Projected Change in Milk Production	7	lbs/cow/day	Typical 5-15% more if 2x; 0-10% less if 3x
SCC Premium per 1,000 SCC Change	$0.003	$ per cwt	Typically $0.002 - $0.004/cwt
Current Annual Bulk Tank Average SCC	240,000	SCC per ml	Typical range of 100,000 - 400,000 SCC
Estimated Percent Change in SCC	-5.0	%	Typical range of -10 to +2%
Reproduction and Herd Health Value of Software	$35.00	$ per cow/year	Estimated range of $20 - $60 per cow/yr
Feed Costs and Intake Changes			
Lbs of TMR Dry Matter (DM) per lb of Milk	0.65	lb DM/lb Milk	Typical range of 0.55 - 0.8
Cost per lb of TMR Dry Matter	$0.125	$ per lb DM	Typical range of $0.8 - $0.15
Estimated Change in cost/lb Dry Matter	-$0.002	$ per lb DM	Typical range of -$0.005 to +$0.005
Culling and Herd Replacement Changes			
Cost of Replacement Heifer	$1,600	$ per heifer	Typical range of $1,300 - $2,200
Cull Price per Cow (or sold for milking purposes)	$750	$ per cow	Typcial range of $350 - $1,200
Expected Change in Annual Turnover Rate	-1	%	Typical change has been very small
Utilities and Supply Changes for Milking			
Anticipated Change in Electricity cost	$8.25	$/cow/year	Typical increase of 0 - 150 kWh
Anticipated Change in Water cost	-$3.00	$/cow/year	Typical range of -$5 to +$5
Anticipated Change in Chemicals Cost	$1.50	$/cow/year	Typical range of -$2 to +$2

Cash Flow Changes

The cash flow changes when evaluating AMS must be differentiated from the net financial impact. The net financial impact in the partial budget focuses on all changes in incomes and expenses, whether paid in cash or not. The cash flow change only focuses on the sources and uses of cash.

In the sample farm, the net financial impact was $1,391, not considering value to quality of life. Since depreciation is not a cash cost, the capital recovery cost of $60,200 needs to be added back and the principal and interest of the needed loan be deducted. In this example, a 7 year loan of $400,000 was needed with an interest rate of 5.5%. The annual payment on this loan would be $68,976 meaning the net cash flow would change by -$8,776.

A second cash flow change from the partial budget is the difference between paid and unpaid labor. The net financial impact showed a labor savings of $35,040. Subtracting paid labor from labor savings equals the amount of unpaid labor of $15,040 which is a non-cash expense. This non-cash difference needs to be subtracted from the net financial impact.

Time for increased records management was equal to reduced labor management resulting in a $0 gain. Both management costs are also unpaid. This also needs to be subtracted from the net financial impact.

So, the **net financial impact** of example was:	$1,391
Principal and interest payment over the **capital recovery cost** adds:	-$8,776
Adjustment for unpaid labor and management for: heat detection and milking adds	-$15,040
records and labor management adds	$0
Thus, the **total change in cash flow** using the net financial impact from the partial budget as a base is:	**-$22,425**

So, the net financial impact of $1,391 includes all changes of income and expenses including depreciation and unpaid labor. The change in cash flow considers principal and interest payments and subtracts out expenses such as unpaid labor that were not paid in cash.

In other words, the AMS, when balanced with quality of life concerns and other positive financial assumptions due to the herd management software can be a good investment. However, depending on labor, cost of capital and debt structure, AMS may result in negative cash flow.

Sensitivity Analysis of AMS

The following list depicts the change in net financial impact as a dollar value and percent change when the tested variable was changed by a positive ten percent with all other values held constant.

Increase Value by 10 Percent	$ Change
Herd Size	**$4,255**
Milk Price	**$5,821**
Cost per AMS	**-$6,820**
Change in Repair Cost	**-$1,400**
Years of Life	**$3,273**
Resale Value of AMS	$800
Interest Rate	**-$2,420**
Insurance Rate/$1,000 Value	-$200
Increased Insurance Value	-$200
Current Hours of Milking Labor	**$4,928**
Anticipated Hours of Milking Labor	**-$1,642**
Current Hours of Heat Detection	$356
Anticipated Hours of Heat Detection	-$137
Rate for Milking/Heat Detection	**$3,504**
Increased Hours Records Mgt	-$394
Reduced Hours Labor Mgt	$394
Rate for Records/Labor Mgt	**-$1,391**
Current Bulk Tank Average	$552
Projected Change in Milk Production	**$3,174**
SCC Premium/1,000 SCC Change	$132
Current Bulk Tank SCC	$132
Estimated Percent Change in SCC*	$132
Value of Software	$504
Lbs TMR Dry Matter/lb of Milk	**-$2,227**
Cost/lb of TMR Dry Matter	**-$2,703**
Change in cost/lb TMR Dry Matter*	$476
Cost of Replacement Heifer	$230
Cull Price per Cow	-$108
Change in Annual Turnover Rate*	$122
Change in Electricity cost	-$119
Change in Water cost*	$43
Change in Chemicals Cost	-$22

* means original input value was negative.

Users are cautioned that slight changes in input values can dramatically influence the net financial impact of an AMS analysis. The table above shows net financial impact when changing input values by 10 %. Change in Cost per AMS and Milk Price are the most significant variables at $6,820 and $5,821, respectively. Thirteen variables change the net financial impact by over $1,000. So, even robots are sensitive! ☺

In sum, AMS variables need careful discernment in order to confidently make decisions as to what financial and cash flow impact AMS will have on a dairy farm.