The Economics of Automatic Milking Systems 2.1

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Introduction
Installation of Automatic Milking Systems (AMS) in Iowa continues to grow. Approximately 5% of Iowa dairy producers currently use AMS. In order to assist dairy producers and lenders make informed decisions on the economic variables associated with AMS consideration, a partial budget spreadsheet tool was developed. (Pg.3)

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 a wide variation in results from producers implementing AMS in terms of milk production and other responses.

Herd and Financial Assumptions
Herd size is important in calculating the number of AMS needed. One AMS can handle an estimate 55-70 milking cows. An additional 10% to 12% herd size can be added when including dry cows. Thus, a 72 cow total herd per AMS is typical, depending upon milk production system.

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. Area to house the AMS averages $25,000 per AMS. On average, each AMS costs around $225,000.

AMS installed in the early 2000's are still in operation. So, "years of useful life" is an unknown variable. Ten 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 represent the cost of interest paid to a bank; or the opportunity cost of the owner's money; or a combination of both over the life of the loan and/or AMS. 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.

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 current milking system need to be compared to the anticipated hours of milking labor after the AMS is installed. Management of labor tends to decrease, too.

Herd Management Software
The herd management software includes rumination data, milk conductivity, and cow activity. This information can lead to savings from heightened heat and mastitis detection and faster identification of sick cows. Pregnancy rates tend to increase. There will likely be an increase in records management with the AMS to utilize data that might not be available with other milking systems.

Milk Production, Fat, Protein and Quality Changes
Producers may experience losses in milk production six to nine percent lower from 3x milking. From 2x milking, one could expect a three to five percent increase or more. Iowa surveys show a 10% increase on herds not building new facilities. 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 20% lower after the adoption period. Milk fat and protein tends to increase.

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 but dependent on current TMR. However, feed costs could decrease relative to previous feeding practices since cows are fed more individually with AMS. Producers feeding both a parlor herd and an AMS herd, share feed cost at about $0.005 higher per lb. DM for the AMS herd.

Culling and Herd Replacement Changes
Producers report a 0-2% decrease in culling percent on average. Higher changes in turnover rate should be expected for 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 300 kWh per cow per year. Water usage may decrease for small herds using only one AMS, but water usage is more comparable or higher for herds using two or three AMS. Chemical, teat dip and supply costs tend to be higher.

Bottom Line of AMS: Cows and People Like Them!

216 Cow Dairy Converting to 3 AMS using Iowa data

A 216 cow herd and a $17.81 per cwt milk price is used as a basis for installing three AMS at a cost of $250,000 per unit, including AMS housing. The AMS maintenance cost over current parlor maintenance cost is $7,000 per robot annually. The producer expects a 15 year useful life out of the AMS and estimates the robots can be resold for $35,000 each. Using a combination of borrowed and own money, the interest rate is 5.5 %. The producer further insures the three AMS at a value of $750,000 higher than the current system at a rate of $0.005 per $1,000 of valuation.

The producer is currently using 14 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 5.3 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 expected to be $14 per hour, including benefits and employment taxes.

The producer recognizes that there will be an additional 0.85 hours per day of records management with the AMS but also estimates there will be a reduction of 1.25 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. Milk fat percentage is expected to increase 0.114% and protein 0.06% with fat valued at $2.43/lb. and protein at $1.81/lb. The producer also expects the AMS to do a better job with pre and post milking sanitation, thus reducing his SCC by 5%. The producer expects a gain of $50 per cow due to availability of cow production, reproduction and health information.

The Total Mixed Ration (TMR) fed to the herd currently costs $0.101 per pound of dry matter. The daily dry matter intake per cow will increase with the additional seven pounds of milk. Using a pelleted feed with the AMS, a very small increase of $0.0053 is estimated as the change in cost per pound of dry matter.

The producer expects a 1.7 % decrease in herd turnover rate. Replacement heifers are valued at $1,500 and cull cows sold for milk or dairy at an average of $750.

An increase of $40 per cow per year for electricity is anticipated with AMS. An estimated increase $0.35 per cow per year for water use, chemical or other supply use is anticipated along with a $15 per cow increase for teat tip. The changes in electrical, water, chemical, supplies and teat dip vary greatly from farm to farm so user beware.

Partial Budget Analysis for 216 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 $17.81 per cwt milk price for 216 cows, an additional $88,865 of milk production income is generated. Reducing SCC by 5% with a $0.0023 per 1,000 ml change; increasing butterfat 0.114%; and increasing protein 0.06% yielded $22,544 in additional income. A 1.7 % decrease in cull cow sales equaled -$2,754 due to lower cull rate. Expected gain due to the herd software and related management records is $10,800. Total increased incomes equaled $119,455.

Decreased expenses that also created a positive impact include labor savings of 0.4 hours of heat detection, 8.7 hours of milking and 1.25 hours of labor management per day. This equates to financial savings of $2,044 in heat detection and $44,457 in milking labor. Reduction in labor management time for the owner was valued at $8,213. The total decreased expenses equaled $54,714 and when added to increased incomes gave a total positive impact of $174,169 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 over 15 years with a 5.5% interest charge yields a cost of $84,250 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 $24,750. Additional feed costs of $51,665 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. Due to a 1.7 % decreased cull rate, heifer replacement costs decrease $5,508. Increased utilities, mainly from electricity, add $11,956 while increased records management labor adds $5,585. Total increased expenses and total negative impacts are $172,697.

Net financial impact, using positive minus negative impacts, is $1,472 for this example. Quality of life improvements from a flexible management schedule is valued at $15,000. With quality of life included, the net impact becomes $16,472.

In sum, the decision to employ AMS depends heavily on the variables used and value of the quality of life gained from installing a system. In addition, consider the system the AMS is being compared to as there are other options, including low cost parlors, that yield different results.

Economics of Robotic Milking Systems v2.1 Annual Partial Budget Analysis

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Positive Impacts

Increased Incomes	
Increased Milk Production	$88,865
Increased Milk Premium/Fat/Protein	$22,544
Increased Cull Cow Sales	-$2,754
Software Value to Herd Production	$10,800
Total Increased Incomes	$119,455
Decreased Expenses	
Reduced Heat Detection Labor	$2,044
Reduced Milking Labor	$44,457
Reduced Labor Management	$8,213
Total Decreased Expenses	$54,714
Total Positive Impacts	**$174,169**
Annual Value to Quality of Life =	**$15,000**

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Negative Impacts

Increased Expenses	
Capital Recovery Cost of Robots (Dep & Int)	$84,250
Increased Repair and Insurance Costs	$24,750
Increased Feed Costs	$51,665
Increased Cow Replacement Costs	-$5,508
Increased Utilities and Supplies	$11,956
Increased Records Management	$5,585
Total Increased Expenses	$172,697
Decreased Incomes Expected	
Total Decreased Incomes	$0
Total Negative Impacts	**$172,697**
NET ANNUAL FINANCIAL IMPACT =	**$1,472**
with Annual Value of Quality of Life =	**$16,472**

Herd and Financial Assumptions

		Units	Instructions or Reference Values
Herd Size -- both milking and dry	216	no. of cows	Typical herd size of 66-74 cows/robot
Mailbox Milk Price	$17.81	$ per cwt.	Typical range $13.00 - $20.00 / cwt
Estimated Cost per Robot -- include robot housing	$250,000	$ per robot	Typical range of $220,000 - $280,000
Estimated Annual ***Change*** in Milking System Repair	$7,000	$ per robot	Typical range from $5,000 - $15,000/robot
Number of Robots Needed	3	no. robots	Typical range of 55-65 milking cows/robot
Years of Useful Life	15	years	Typical range is 13 - 17 years
Value per Robot after Useful Life	$35,000	$ per robot	Estimated range of $25,000 - $50,000
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	$750,000	$ per farm	Value of robot(s) over current system
Labor Changes			
Current Hours of Milking Labor with setup&cleanup	14.0	hours per day	Range of 2 to 5 hours/day per 70 cows
Anticipated Hours of Milking Labor	5.3	hours per day	Range of 1 to 2 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
Future Labor Rate for Milking and Heat Detection	$14.00	$ per hour	Typical rate is $10 - $18 with benefits
Increased Hours for Records Management	0.85	hours per day	Include AMS management records
Reduced Hours for Labor Management	1.25	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	70.0	lbs/cow/day	Typcial range of 50 - 90 lbs
Projected Increase in Milk Production 10.00%	7.0	lbs/cow/day	Typical 5-15% more if 2x; 0-10% less if 3x
Projected Increase in Milk Fat %	0.114	Typical = .05%-.2%	*Milk Fat Value/lb.* $2.43
Projected Increase in Milk Protein %	0.06	Typical = 025-.1%	*Milk Protein Value/lb.* $1.81
SCC Premium per 1,000 SCC Change	$0.0023	$ per cwt	Typically $0.001 - $0.004/cwt
Current Annual Bulk Tank Average SCC	223,000	SCC per ml	Typical range of 100,000 - 400,000 SCC
Estimated Percent Change in SCC	-5.0	%	Typical range of -10 to +2% unless new facilities
Reproduction and Herd Health Value of Software	$50.00	$ 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	$0.101	$ per lb DM	Typical range of $0.8 - $0.15
Estimated Change in cost/lb Dry Matter	$0.0053	$ per lb DM	Typical range of -$0.01 to +$0.01
Culling and Herd Replacement Changes			
Cost of Replacement Heifer	$1,500	$ 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	-1.7	%	Typical change has been very small
Utilities and Supply Changes for Milking			
Anticipated Change in Electricity cost	$40.00	$/cow/year	Typical increase of 0 - 300 kWh
Anticipated Change in Water/Chemical Cost	$0.35	$/cow/year	Typical range of -$5 to +$5
Anticipated Change in Teat Dip Cost	$15.00	$/cow/year	Typical range of $5 to +$20

Cash Flow Analysis Versus Profit (Net Financial Impact)

The "cash flow" analysis when evaluating AMS must be differentiated from the profit analysis or 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 $1,472, not considering value to quality of life. Since depreciation is not a cash cost, the capital recovery cost of $84,250 needs to be added back and the principal and interest of the needed loan be deducted. In this example, a 7 year loan of $675,000 was needed with an interest rate of 5.5%. The annual payment on this loan would be $116,397 meaning the cash flow would change by -$32,147.

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 $46,501. Subtracting paid labor from labor savings equals the amount of unpaid labor of $11,501 which is a non-cash expense. This non-cash difference needs to be subtracted from the net financial impact because labor that was previously not paid in the cash flow, now needs to paid in cash towards paying back the AMS.

Labor management and records management changes was $2,628. This was previously unpaid and will continue being an expense that does not need a cash payment. This results in a zero dollar effect to the cash flow. If it would need a cash payment, this would also needs to be subtracted from the net financial impact. With everything considered, the Total Change in Cash Flow ends up at -$42,177 compared to the current system.

Below is the Cash Flow Analysis for the sample farm. Bottom line is that there is and can be substantial differences in profit (net financial impact) and cash flow. Thus, even though the AMS has a net financial impact of $1,472, the cash flow analysis is -$42,177. The net financial impact of $1,472 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.

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

Even slight changes to the variables can drastically change the net financial impact. The milk price and milk production increase has a very sensitive impact. 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 particular dairy farm.

AMS Loan Amortization for 3 Robots

7 Years of Loan	Annual Interest		Principal Amount
12 Annual Payment(s)	Rate	5.50%	$675,000
84 Total Payments			

First Month	Interest	Prinicpal	Total Payment
Payment	$3,094	$6,606	$9,700

First Year	Interest	Prinicpal	Total Payment
Payment	$37,125	$79,272	$116,397

Net Cash Flow Analysis of AMS

		Totals
Net Annual Financial Impact from Partial Budget Analysis		**$1,472**
Capital Recovery Cost of Robots	$84,250	
Annual Payment on Robot Investment	$116,397	
Cash Flow Difference of Capital Recovery vs Annual Payment		**-$32,147**
Cash Flow Adjustment for Unpaid Labor and Management		
Heat Detection & Milking Labor Saved	$46,501	
Amount Hired	$35,000	-$11,501
Labor Mgt & Records Mgt Changes	$2,628	
Amount Needing Cash Payment	$0	$0
Total Change in AMS Cash Flow		**-$42,177**