Economics of Automatic Milking Systems

LLOYD DAVIES

Agricultural Consultant Stockton NSW

ANDREW ALFORD

Livestock *Research Officer Industry and Investment NSW*

KENDRA KERRISK

AMS Research Leader, University of Sydney

SERGIO GARCIA

Science Leader – FutureDairy, University of Sydney

Contents

KEY MESSAGES TO INDUSTRY

- An automatic milking system (AMS) can be sometimes be justified when:
    - There is a large saving in time compared to the alternative system conventional milking system (CMS).
    - The value placed on that labour is relatively high.
    - The initial capital cost of an AMS is only approximately a maximum 50% greater than the CMS.
    - The life expectancies of the two systems are similar.
    - The increased repair and maintenance costs for the AMS (likely to be higher than for a CMS) do not erode most of the labour saving benefits.
- The partial budget worksheet available on Future Dairy's website is suggested as a tool to assess the merits of an AMS. The alerts the user to the key inputs that are likely to change allowing the farmer to conduct an initial investigation into the merits of AMS prior to conducting a detailed economic analysis (most likely with an accountant or consultant).
- Investment in any milking facilities is generally a low returning investment but from time to time they must be updated, especially if lifestyle factors are taken into consideration.

BACKGROUND

The main purpose of this document is to:

- Summarise a detailed economic evaluation comparing Automatic Milking Systems (AMS) with alternative conventional milking systems. (CMS).
- Discuss the key factors that will drive the economic differences between the AMS and alternative systems.

The document is a brief and "easy read" version of a detailed economic evaluation that was carried out by Andrew Alford (then at Industry and Investment, NSW) which drew on other research carried out up to February 2010. Readers can access the more detailed evaluation by contacting the FutureDairy team. Note the information contained in all tables of this document (excluding those in the example evaluation – section 6) have been taken from the detailed evaluation.

A lot of the information about AMS originates from the Northern Hemisphere, where cattle are housed during winter. This information will not be directly comparable. Over time more Australian information will become available to allow farmers and consultants to fine tune the key variables and thus make a more accurate budgeting projection about the merits of different milking systems.

Older milking facilities may be reaching the end of their useful life for a number of reasons including:

- Labour efficiency is not as high as in modern dairies.
- These facilities are often too small for an expanding herd.
- The repair and maintenance costs for such facilities are increasing and reliability is declining.

In these circumstances the farm manager must question whether they persist with the present milking facility or invest in a new facility. Unfortunately, an analysis on purely economic grounds often shows a low return on extra capital, indicating the farmer should persist with the existing facility. But there are non-economic (lifestyle) factors that only the farmers themselves can evaluate.

If the decision to invest in new facilities is still to be made, there is then a question of which technology the farmer should adopt in the new milking shed. For herds less than 250 cows, the conventional swing over system would be the most common. As herd size increases a rotary dairy may be considered. Automatic systems are also available and some farmers are adopting them in Australia, as well as overseas. Each unit of an AMS currently has the capacity to milk around 80 cows (dependent on production level and desired targets). In the future the available technology will change and higher throughput systems will become available (e.g. DeLaval Automatic Milking Rotary - AMR^{TM}).

1. COMPARISON OF SYSTEMS

In this summary, we will only discuss variables where there is a difference between the AMS and the CMS. The systems covered are included in Table 1.

Here the assumption is made that for every 80 milking cows, one AMS is currently required[1]. Herd sizes of 160, 240, 320 and 400 milking cows were analysed with the following installations:

Table 1 Incremental increase in AMS units and suggested alternate CMS designs as herd size increases and associated farm areas

No. of cows	**160**	**240**	**320**	**320**	**400**
CMS	18 Swing-over	24 Swing-over	30 Swing-over	40 Unit Rotary	50 Unit Rotary
AMS (80 cows per unit)	2 Units	3 Units	4 Units	4 Units	5 Units
Milking area	43 ha	65 ha	87 ha	87 ha	108 ha
Dry stock area	64 ha	96 ha	128 ha	128 ha	160 ha

[1] With improvement in the technology and faster throughput, it may be possible that AMS systems may handle more than 80 cows. If this is the case, the future AMS capital required per milking cow may reduce.

2. KEY VARIABLES TO CONSIDER

2.1 Capital costs

The estimates in Table 2 show that the total capital cost for a 160 cow unit CMS is almost $825,000, which increases to $1,330,000 for a rotary dairy to handle 400 cows. This is an increase of 62%. In comparison, the two-unit AMS for 160 cows costs around $946,000 and the 5 unit system for 400 cows costs $1,920,000, just over double the cost of the smaller unit. To put this another way the 2 unit AMS costs just 15% more than the 18 aside swing over system but the 5 unit AMS costs 46% more than a 50 unit rotary. The main reason for this difference is there are more savings in economies of scale in some of the conventional systems. Automatic milking systems are deployed as discrete units, meaning there is less scope for savings in concrete and plant and equipment. For each additional AMS unit, the plant and equipment costs remain virtually the same.

Let's look at this from another angle – capital investment required per cow per year over the assumed life of both systems (AMS and CMS) of 15 years. With an 18 swing over milking system servicing 160 cows, the capital cost $/cow per year is $310. This decreases to $200 for a 50 cow rotary milking 400 cows, a reduction of 35%. In comparison, the reduction in costs between a two unit AMS milking 160 cows and five unit AMS milking 400 cows is only 19%. (Figure 1).

For farmers who are considering both systems, the quotes obtained for each system can be used as the basis for further analysis. One key assumption that farmers will need to make is the relative life of each system.

Table 2. Milking system capital cost assumptions

	Conventional Milking Systems			Automatic Milking Systems		
Dairy Shed Capital Costs						
160 Cow		**GST**	**Total**		**GST**	**Total**
Plant & equipment installed[1]	292,806	29,281	322,087	594,621	59,462	654,083
Shed, concrete, yarding etc	455,600	45,560	501,160	265,000	26,500	291,500
Total ($)	**748,406**	**74,841**	**823,247**	**859,621**	**85,962**	**945,583**
Ave MS Capital Invested $ /cow/year[2]	**312**			**358**		
240 Cow		**GST**	**Total**		**GST**	**Total**
Plant & equipment installed[1]	337,905	33,791	371,696	839,119	83,912	923,031
Shed, concrete, yarding etc	518,650	51,865	570,515	366,000	36,600	402,600
Total ($)	**856,555**	**85,656**	**942,211**	**1,205,119**	**120,512**	**1,325,631**
Ave MS Capital Invested $ /cow/year[2]	**238**			**335**		
320 Cow – 30 unit swing over		**GST**	**Total**		**GST**	**Total**
Plant & equipment installed[1]	372,823	37,282	410,105	1,068,505	106,851	1,175,356
Shed, concrete, yarding etc	570,000	57,000	627,000	399,000	39,900	438,900
Total ($)	**942,823**	**94,282**	**1,037,105**	**1,467,505**	**146,751**	**1,614,256**
Ave MS Capital Invested $ /cow/year[2]	**196**			**306**		

	Conventional Milking Systems			Automatic Milking Systems		
Dairy Shed Capital Costs						
320 Cow – 40 unit rotary		**GST**	**Total**			
Plant & equipment installed[1]	411,143	41,114	452,257			
Shed, concrete, yarding etc	680,000	68,000	748,000			
Total ($)	**1,091,143**	**109,114**	**1,200,257**			
Ave MS Capital Invested $ /cow/year[2]	**227**					
400 Cow		**GST**	**Total**		**GST**	**Total**
Plant & equipment installed[1]	476,058	47,606	523,664	1,311,560	131,156	1,442,716
Shed, concrete, yarding etc	735,000	73,500	808,500	433,000	43,300	476,300
Total ($)	**1,211,058**	**121,106**	**1,332,164**	**1,744,560**	**174,456**	**1,919,016**
Ave MS Capital Invested $ /cow/year[2]	**202**			**291**		

[1] *Includes milk vat, cooling system, auto cleaning, plant and equipment installed.*

[2]*Average milking system (MS) capital invested/cow/year is calculated by dividing the total capital cost by the specified herd size and then divided by the effective life of the MS used in this study; 15 years for CMS and 15years for AMS.*

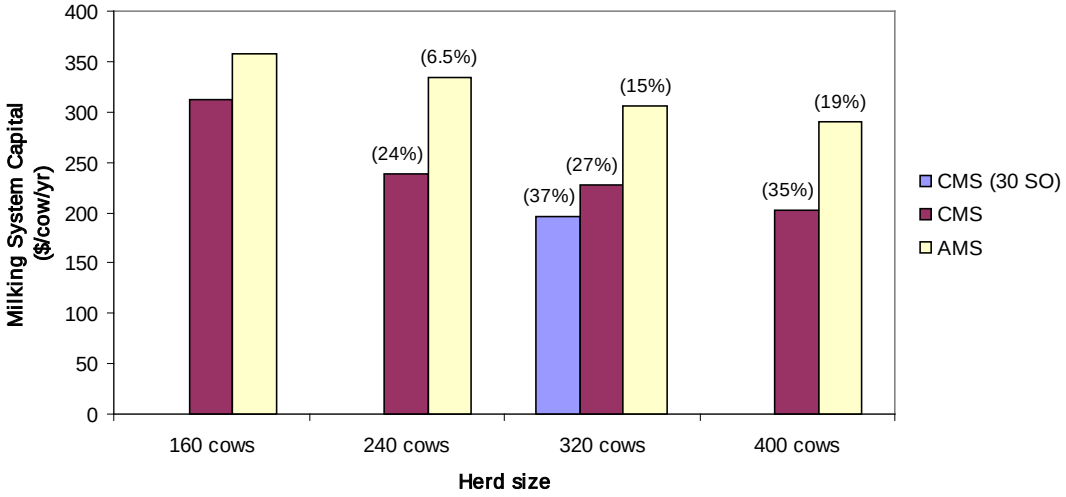

Figure 1 Milking system capital costs ($/cow/year) for the automatic and conventional milking systems, and relative savings (compared to 160 cow installation) achieved with scale (%)

2.2 Life of the milking equipment

Depreciation is a significant cost because milking facilities have a finite life. Systems become unreliable in time or new technology makes it necessary to reinvest in the latest systems to remain competitive. In the original detailed economic evaluation the assumed lifespan of both the CMS and the AMS was 15 years. The longer the expected usage period, the higher the annual running costs will be, as the repair and maintenance bill will likely increase with time.

2.3 Salvage value of equipment

There is likely to be some salvage value of the equipment at the end of its use. The assumption is made here that the salvage value at the end of the 15 year life was 10% of the original value for both AMS and CMS. However, a possible advantage for the AMS is that the unit itself is transferrable and could have a much higher salvage value, especially in early years after installation.

3.3 Labour

A conservative assumption is made that on the smaller 160 cow dairy two labour units would be used regardless of whether an AMS or a CMS was used. The nature of dairy tasks varies substantially between the systems and the AMS offers significant lifestyle gains. While there will be some labour required in cleaning and monitoring, there is a labour saving that many farmers will value. A secondary advantage is the health benefits (such as fewer back problems) from having less time in the dairy. The assumptions shown in Table 3 indicate an increasing labour saving with the larger units meaning that hired labour is replaced with AMS capital.

Table 3. Labour productivity assumptions used in the economic analysis for both the CMS and AMS

	CMS cows/l.u.	AMS cows/l.u.	Increase in labour productivity relative to CMS[1] (%)
Cow herd size			
160	80	80	0
240	95	109	15
320	110	132	20
400	125	156	25

[1] *% increase in labour productivity relative to CMS at same herd size.*

Farmers will have to place a value on the labour they save themselves. Some may like working with the cows and feel they identify cow health problems more easily in a batch milking situation. These farmers may put a lower value on the labour savings, compared to someone who finds milking a chore and wants more time for other management tasks or leisure time.

For individual farmers to place a value on labour savings, they will need to estimate the yearly amount of labour required to operate each system and place a value on the hours saved (and/or value added through more attention to the whole farm) if they opt for an AMS.

2.4 Milking system annual running costs

Due to the complexity of the AMS, it is assumed that an annual service contract is part of the running costs. The annual servicing costs reduce slightly on a per unit basis as more units are purchased. Servicing and running costs of CMS systems in Table 4 were provided by an industry consultative group and commercial suppliers but it is recognised that these costs will vary depending on brand of machine.

If automatic systems are adopted more widely, there will likely be savings on technician travelling costs, as technicians will not have to travel so far between farms that use AMS units. Also costs of replacement parts may reduce due to economies of scale. When farmers prepare their situation using the template provided they should use the quote they receive for annual servicing costs at the time of purchase. If the annual service cost increases over time, the farmer should use the average annual service costs over the life of the unit.

Table 4. Service and running costs for the various milking systems[1]

	Conventional Milking Systems	Automatic Milking Systems
160 Cow	18 Swing Over	2 AMS
Service and Running Costs	$16,350	$21,563
240 Cow	24 Swing Over	3 AMS
Service and Running Costs	$24,000	$30,588
320 Cow[2]	30 Swing Over / 40 Rotary	4 AMS
Service and Running Costs	$36,000	$40,763
400 Cow	50 Rotary	5 AMS
Service and Running Costs	$44,000	$50,998

[1] *Estimates provided by industry consultative group and commercial suppliers.*

[2] *For the purpose of these analyses both alternate conventional systems applicable to the 320 cow herd*

2.5 Milk production

There are two aspects to consider here:

1. Cows must adapt to a new system and there is likely to be an adaption phase where less milk is given (the extent of this will depend on managerial competence). The same is likely to apply when cows have to adapt from a swing over system to a rotary system. Despite the experience at Elizabeth Macarthur Agricultural Institute indicating there were negligible adaptation losses, the detailed economic evaluation assumes that milk yield in the first year from cows adapting to an AMS is 90% and 95% in the second year.
2. There is some evidence that cows, particularly early in lactation, may elect to be milked more than twice per day, which in turn has the potential to increase milk yields, but any additional feed costs would also have to be accounted for. The detailed economic evaluation assumed that there weren't any milk yield benefits.

Over time there will be further information on milk yields from farms that use the AMS. It is important that case studies be made of some of the early adopters of AMS technology so that there is fine tuning of potential benefits and costs of the new system. The budget tool has been designed to allow for farmers to include their own estimates of variations in milk production expected from the two systems.

2.6 Other Factors

As mentioned in 3.3 above, an AMS should result in additional quality of life benefits for the manager and also for staff.

Other issues to consider are:

- The reliability of each system and should either system fail, questions such as what is the likely repair time and what are the alternative milking options should something go wrong.
- If less time is spent on milking with an AMS, what are the management benefits that could occur on the rest of the farm? For example, outstanding jobs such as completion of laneways adding to the overall efficiency of the farm. Another possibility is there is more time for pasture management which could increase per head production or reduce per head purchase feed costs through a focus on increasing milk produced from home-grown feed. Of course if more time is required to achieve these productivity improvements, it must be accounted for.

These factors are impossible for an outsider to value and may also be very difficult for a farmer to estimate. Remember if you place a value on the family labour savings by using an AMS, this value is not a cash benefit unless it results in higher productivity elsewhere.

3. OUTCOMES

One criteria used to evaluate the merits of each of the systems in the detailed economic analysis is an internal rate of return (IRR). It is basically the interest rate that can be charged on the initial capital outlay that would cause the project to break-even or just pay for itself at the end of the time that the equipment is used and the salvage value of the equipment has been received. As discussed earlier both the AMS and CMS assumed to have a useful life of 15 years in the detailed economic evaluation. The equipment was then salvaged for 10% of the original value. In the results in Table 5 the internal rate of return for the 400 cow AMS was 5.2% and 5.6% for the CMS. This means that based on the assumptions about the cost, and income flows, an interest rate of 5.2% could have been charged for the AMS and this would have just paid back all the principal and interest from the cost savings and the benefits that the AMS is expected to give. 5.2% is not a very good result because we would be looking for a return exceeding bank interest rates to make the investment attractive. When other results in Table 5 are examined (for both the AMS and the CMS), the IRR for the smaller scale operations is even lower.

Table 5. Economic analysis of the AMS and CMS, internal rates of return (IRR) of the businesses at different farm scales

Herd size	160 cow	240 cow	320 cow[1]	320 cow[2]	400 cow
CMS IRR %	1.0	3.4	4.7	4.4	5.6
AMS IRR %	0.3	2.8	4.1	4.1	5.2

[1] *CMS 30 unit swing over*

[2] *CMS 40 unit rotary*

4. INTERPRETING THE OUTCOMES

The economic results presented are rightly based on quite conservative assumptions. Researchers will err on conservative estimates about performance in making initial comparisons but in time there will be more commercial information about actual performance and farmers will be able to fine tune their estimates in making a decision about the choice of a CMS or an AMS. In addition some farmers that have few cash flow problems are likely to place a higher value on labour savings than a farmer who has greater cash flow difficulties.

There is excellent information available about the current knowledge of factors that impact on the economic performance on an AMS. But most AMS experience is from the Northern Hemisphere, and their results are not directly comparable to our year round pasture based systems. New local information will quite quickly become available, from the early adopters, and there is a significant likelihood that revised estimates will alter the present "best guess" figures. Most farmers will not be able to calculate their own IRR with new information that they obtain so to help in making a decision a partial budget worksheet has been developed to give the user an indication of how investment in one or two possible systems compares. The partial budget worksheet is named because it only looks at what changes between the two systems. The use of it to evaluate milking system purchases is not ideal because it is not good at handling cash flows that vary between systems from one year to the next. For example milk production may be expected to decrease as cows adapt to the AMS but then could increase later with more early lactating cows opting to be milked more than twice per day. If annual differences do in fact exist, averages are used and some accuracy is sacrificed when compared to other more elaborate techniques. The partial budget worksheet is developed to help farmers to think about inputs and outputs that are likely to change allowing a farmer to determine the scale of difference for the following two types of comparisons:

1. Comparison of the purchase of a new milking system against the alternative of retaining the old system or
2. If the old milking facility has to be scrapped, it can be used to compare the more expensive system against a cheaper conventional system.

The figures compiled by working through the worksheet should then be taken to a consultant or accountant to develop a detailed full economic evaluation of the systems being considered.

5. SUMMARY

Automatic milking systems (AMS) are generally more expensive than conventional milking systems (CMS) of the same capacity. The decision to choose a system that involves a greater capital outlay is predominantly based on the estimate of the amount of labour an AMS will save and the value they place on that labour. The question of the value that is placed on saved family labour in particular will be critical in the evaluation of whether the extra capital required for an AMS is saving sufficient labour costs to give an adequate return on the additional investment.

Factors other than labour could also be important. Key factors could be:

- The anticipated life of the equipment which drives depreciation costs.
- The difference in the capital costs between the systems.
- Whether there is an expected difference in milk production per cow using different milking systems.
- Lifestyle issues
- The annual repair and maintenance bill for different milking systems.
- The cost of borrowing and the possibility of any significant increase in interest rates.
- Attitude or risk associated with an aversion to technology

As more AMS systems are operational in Australian conditions, there will be a degree of fine tuning of the economic benefits that are likely. However some of the factors such as the value that a business puts on the family labour is a very personal thing and there is no right or wrong answer. As a result a partial budgeting worksheet has been developed to allow individual farm businesses to insert their own estimates and generate their own comparisons. Taxation issues have not been built into the template and these will need to be discussed independently with financial advisors.