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InfoSheet

AUTOMATIC MILKING SYSTEMS

Key Points:

For a large herd AMS, extra consideration needs to be given to:

- Choice of equipment (boxes or robotic rotary).
- Milking in batches or voluntary milking.
- Handling milk that can't go into the bulk milk vat.
- Where to feed concentrates.

Automatic milking options for large herds

By Kendra Kerrisk and Lee-Ann Monks

AUTOMATIC MILKING is an option for large herds (more than 400 cows). The extra cows bring some challenges which can be dealt with through a combination of the milking system design and adjustments to the management system. This Info Sheet outlines some of the things to think through if you are considering investing in an automatic milking system (AMS) for a large herd (i.e. more than 400 cows).

If you are thinking about going down the automatic milking path for your large herd, five of the most important things to consider are:

- What robotic equipment will suit my farm: boxes or rotary?
- Do I want to manage the herd with batch milking or voluntary milking?
- What herd size will my AMS support?
- How do I handle milk that can't go in the bulk milk vat (from hospital or colostrum cows)?
- Where will concentrate feed be provided?

In all automatic milking systems cows wear an electronic identification collar or ear tag which is the communication path between the cow and the system. The system reports critical milking information to the farmer such as milk yield, milk quality and milk harvesting characteristics. The system also controls access through various electronic gates and to the feeding system if there is one.

Above: The electronic identification collar or ear tag is the communication path between the cow and the automatic milking system.

Boxes or rotary?

There are currently two milking equipment options for automatic milking large herds: a robotic rotary or a series of AMS box units. Their design, costs and management are quite different so it is important to consider the options and decide which is more suited to your situation.

Robotic rotary

The robotic rotary is a 24-bail internal herringbone rotary. Cows stand at a 30-degree angle with their heads facing out and their rumps facing in. The 30-degree angle enables the five centrally located robots to approach the cows from the side (between the front and back leg). Two robots are dedicated to teat preparation, two to cup attachment and the fifth robot disinfects teats after milking. The robotic rotary can milk about 90 cows an hour.

The robotic rotary was designed for Australia's large herds, managed in a pasture-based system.

However it is also suited to operate in a variety of farming systems including grazing, feedpads, and loose housing, or a combination of them.

The robotic rotary is suitable for batch or voluntary milking or a combination of the two. If necessary, the herd can be milked with manual cup attachment in a robotic rotary although most farmers use this only in the case of a breakdown.

The robotic rotary was designed without some of the capability of boxes to reduce the cost of the equipment. There are three key functionality differences between the robotic rotary and the boxes.

These capability differences require different routine practices:

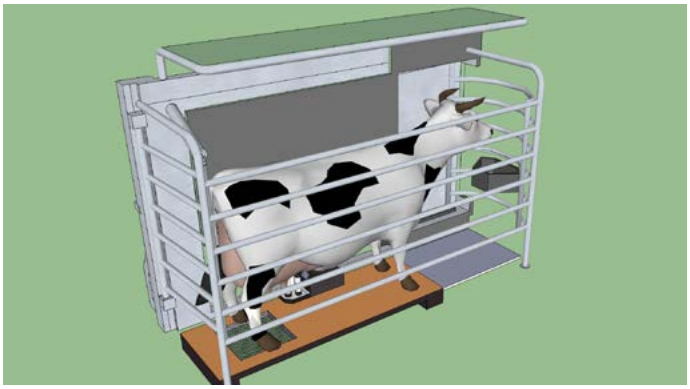
- The robotic rotary cannot reattach cups after kick offs.
- It does not divert milk of individual cows; so hospital and colostrum cows need to be managed separately (see later).
- It cannot perform automatic washes so the farmer must schedule and initiate them.
- The robotic rotary does not have in-bail feeding. Separate feed stations can be installed to provide the capacity for individual feeding of grain-based concentrates.
- There are a number of milk analyses (eg on line cell count) that cannot be done by the robotic rotary that are available on box AMS.

In mid-2014 there was one robotic rotary in operation in Australia – at Gala farm in Tasmania which milks up to 520 cows, depending on the time of the year. Two robotic rotaries were under construction in 2014 – at Sydney University's Corstorphine farm and at Retreat Creek in Victoria. Another four robotic rotaries were in operation in Europe with several more under construction.

For more information download the brochure: Robotic rotary: automatic milking for larger herds.

Box units

Automatic milking 'box units' have been used successfully overseas for more than 20 years. While the robotic rotary involves five robots, AMS boxes usually have a single robot which performs multiple tasks including washing of the teats, cup attachment and post-milking disinfection. Because the robot is idle while milking occurs, single box units have a lower milking throughput (8-10 cows per hour) than the robotic rotary. There are two styles of multi-box units available; which has a single robot servicing two parallel boxes (the robotic arm sits in between the two boxes); and another which has a single robot servicing up to five boxes in series (end to end).



Each single box AMS can perform about 150 milkings a day. If you are milking twice a day, a box unit will be sufficient for 60-75 cows. The multi-box robots can milk more cows per day because the robotic arm is able to spend a higher proportion of the time cupping cows (and less time idle). A number of AMS box units is needed to milk a large herd automatically. One advantage of AMS box units is that you can match the capital outlay with incremental increases in herd size.. With a little forward thinking, it is possible to start with a smaller herd and a couple of robots, and in the future add another robot to accommodate more cows.

Although originally designed for smaller herds, housed mostly indoors, AMS box units can be used in pasture-based systems. Given the high level of functionality they are generally used for voluntary rather than batch milking.

While most Australian box AMS are used for herds under about 400 cows, there are overseas AMS farms milking larger herds with multiple boxes (for example a 33 unit installation in Russia). As the number of boxes increases, the logistics of distance between robots and vat, etc start to create some challenges. Also, as the herd size increases, so does the walking distance for cows. Large herd AMS are often installed in modules with distinct groups of cows accessing 4-6 robots.

Very few large herd AMS farms overseas operate in a pasture-based system; most have a total mixed ration feeding system. Two of the largest pasture-based AMS farms is Camelot in NZ with 9 robots and about 580 cows and Gala Farm in Tasmania with a robotic rotary.

There is limited experience with milking large herds with multiple boxes under a pasture based system with voluntary cow movement. With a pasture based system, walking distances may limit voluntary cow movement to the dairy and around the farm. Once walking distances to the furthest paddock exceed 1.5km, there may be a need to modularise the operation; i.e. split the herd into two with two separate milk harvesting facilities. Walking distances may also be an issue with the robotic rotary but it also has management options. For example, the late lactation cows could be managed as a separate group grazing the further away paddocks while batch milking them.

Milking a large herd through multiple AMS box units creates some logistical challenges which need to be managed. Firstly, the sheer number of heifers in training, hospital and colostrum cows may slow down the milking process of the main herd, creating queues at the dairy yard.

For management tips see Info Sheet: Managing colostrum and hospital cows in large automatic milking herds.

Some (but not all) AMS brands have the option to attach cups manually to the odd cow (eg heifers in training) in AMS boxes. However it not feasible to milk the whole herd through boxes with manual cup attachment because of the logistics involved: moving between the boxes to attach cups; the slow throughput speed of the boxes and, in many cases, there is not a pit alongside the robots.

Batch or voluntary milking?

With a conventional milking system cows usually visit the dairy twice a day, in one or more groups. This is not feasible with a large herd and automatic milking because robots are slower than humans to attach cups and perform other milking tasks. Some cows would spend more than two hours in the holding yard waiting to be milked.

There are two options for handling this in an AMS: batch milking or voluntary milking. The decision you make about batch or voluntary milking will have a major influence on your farming system and daily routine, so it is important to consider it carefully. It is possible to change from batch to voluntary milking (or vice versa) but the change involves a significant adjustment period for the cows and the manager. It is not a change you can make routinely.

The management implications of batch and voluntary milking are summarised in the table on a following page.

Batch milking

Batch milking involves splitting a large herd into two or more groups which are managed and milked separately. The maximum size of each group is determined by the capacity of your milking equipment and the amount of time you are prepared to allow cows to spend at the holding yard waiting to be milked.

There is no difference (except labour efficiency) between batch milking with boxes or a robotic rotary. With a large herd you need to limit the group size to about two hours to prevent cows standing a long time on concrete.

For example the robotic rotary can milk up to 90 cows per hour, although this may be lower due to the farm environment and management practices. Running a group of more than 180 cows at once would result in the last cow waiting for more than two hours to be milked. To operate a robotic rotary with batch milking, cows should be fetched to the dairy in groups of no more than 180-200 cows. For a 600-cow herd this involves dividing the herd into three groups of 200 cows (and allocating separate paddocks for each group).

Each group should be fetched regularly to achieve the desired milking frequency. Typically we would think this would be twice a day but this is not necessarily the case. You may decide to have early lactation cows and high producing cows in one of the groups and milk these cows three times a day. Another group may have late lactation and low producing cows which are milked just once a day. The different milking frequencies should optimise milk harvesting efficiency.

Consider how many cows you plan to milk and calculate how many times per day you would be fetching cows to the dairy. For example, a herd of 500 cows, managed in three groups of 160-170 cows each milked twice a day would involve six fetchings. What impact would this have on your working routines? You could be fetching cows at 4am, 6am, 8am and again at 2pm, 4pm and 6pm. Regardless of whether you have boxes or a robotic rotary, you could require cows to be fetched as nine groups (say three groups twice a day and one three times a day) if you are to operate the system for 18 hours/day.

Both technology and farming practices are continuously improving. When planning the farm layout, consider allowing for higher robotic throughput in the future.

The same principles apply to batch milking with box units. Determine the technical capacity of the equipment (this varies between single, double and multibox technology) and set group sizes that can be milked within two hours or less.

Above: If batch milking with a robotic rotary, limit group sizes to 180-200 cows so that they spend no more than two hours at the holding yard waiting to be milked.

Situations suited to batch milking

Batch milking is likely to suit farmers who:

- Do not want to be on call 24 hours a day as is the case with voluntary cow movement.
- May be uncomfortable with the concept of voluntary cow movement.
- Want absolute control over milking frequency of individual cows.
- May be daunted by the need for highly accurate pasture allocation.
- Have labour available or semi-automatic systems to fetch cows.
- Want to reduce the physical demands of their work rather than the number of hours worked (batch milking probably doesn't save much time over conventional milking but it is less strenuous than standing in the milking shed putting on cups).

Voluntary milking

Most Australian, pasture-based AMS use controlled voluntary cow movement, where the cows move from the paddock to the dairy and back again on their own. Smart gates are programmed to direct cows to different parts of the farm, depending when they were last milked and other criteria set by the manager. One-way gates ensure cows continue to progress through the system rather than back track.

This is a flexible option in terms of labour and lifestyle because milking can occur any time of the day or night without human involvement.

However it is reliant on accurate pasture and feed allocation to achieve high levels of milking unit utilisation and evenly distributed milkings across a 24 hour period. Some successful AMS farmers don't measure the quantity of feed they are allocating. Instead, over time they have become very tuned in to knowing how much is too much or too little. They monitor cow traffic very closely to identify when they are not getting pasture and feed allocation right, and make adjustments accordingly.

The principles of feed allocation for AMS herds (not specifically large herds) are covered in page 13-23 of Management Guidelines for AMS farms.

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Left: With a voluntary milking system, cows move from the paddock to the dairy and back again on their own.

For more information about voluntary cow milking, refer to FutureDairy's Information Sheet - Voluntary cow movement in automatic milking systems.

For more information on voluntary and batch milking refer to FutureDairy info sheet: Cow movement in an AMS.

Management implications of batch and voluntary milking

Batch milking	Voluntary milking
HOW COWS GET TO THE DAIRY	
Staff fetch cows to the dairy at scheduled times. **Pros:** Allows strict control of milking frequency and milking intervals. **Cons:** The time involved in fetching cows has a significant impact on labour needs and daily routine. No opportunity for high producing cows to choose to be milked more frequently.	***Cows walk on their own to the dairy throughout the day and night.*** **Pros:** Low labour requirement. Only a small group of non-complier cows need to be fetched. High production cows can choose to be milked more frequently eg 2½ times a day may be more efficient than 2 or 3 times a day. Farmer has some control over this frequency through the system and automatic drafting gate settings. **Cons:** Variable milking frequency and interval requires attention to ensure these are not extreme and that they don't reduce milk production.
TECHNICAL ALARMS, NEED TO BE ON CALL	
Technical alarms are limited to the scheduled milking times. **Pros:** Lifestyle: no need to be on call 24 hours a day. **Cons:** The lifestyle benefit of not needing to be on call 24 hours a day may not outweigh the impact of having to fetch many mobs of cows each day.	***Technical alarms can occur throughout the day and night.*** **Cons:** Someone needs to be on call 24 hours a day. Lifestyle impact of occasional callouts during the night.
COW MOTIVATION FOR WALKING TO THE DAIRY	
Cows may be sluggish moving to and through the dairy if they are full bellied and cudding. **Cons:** There is a risk of lameness due to cows spending more time on concrete and being fetched/herded.	***Cows will move around the farm and through the dairy routinely when pasture and other feed allocations are well managed.*** **Pros:** Cows spend minimal time on concrete and off pasture. There is less shuffling on concrete and therefore less lameness.
BACKING GATE	
An automated backing gate may be needed to ensure a 2-hour milking session doesn't extend significantly and affect the next mob to be milked. **Pros:** Backing gate can encourage consistent cow traffic and ensure cows don't spend too long in the yard. **Cons:** Abrasion on hooves through scuffing on concrete. Forced interactions may affect cows lower in the pecking order.	***No need to use a backing gate.*** **Pros:** Very relaxed dairy facility, calm and orderly environment; good for animal welfare. **Cons:** A cow may choose to spend a long time in the yard if she chooses (rare in a well-managed system).
MILKING FREQUENCY	
Miking frequency is controlled by the farmer and there is little variation within a given group. **Pros:** Can have a positive impact on milk production for some cows, especially those that would otherwise choose to milk less frequently.	***Different cows will have different milking frequency and the interval between milkings will vary.*** This is OK, as long as management routines prevent extremely long or short intervals. Very long milking intervals reduce milk production and increase the risk of mastitis. Very short milking intervals reduce machine efficiency. Lots of very short intervals will negatively affect the time spent on pasture and total cups on time per day which can create poor teat condition.
PRODUCTION POTENTIAL	
The opportunity to increase production potential through higher milking frequency is capped by the scheduled milking frequency set by the farmer (and the associated labour needed).	***If desired, increased milk production can be achieved by allowing cows in early lactation to milk themselves more frequently.*** Of course, targeted increases in production will be limited by nutrition and the cows' genetic merit.
IDLE TIME	
There is very little, or no, idle time during milking sessions. **Pros:** Potential to conduct more milkings per day; either with more cows or a higher milking frequency.	***You need to allow for idle time during milking times. This can vary from 10-20% with AMS box units.*** **Cons:** Allow for lower throughput potential; ie less milkings per day. This does not necessarily mean less milk as other benefits of voluntary cow movement are likely to counteract it such as less lameness and more relaxed cows.

Herd size

With both the robotic rotary and AMS box units, the herd size that the milking system supports depends on milking frequency. It is up to the farmer to decide the most profitable way to harvest milk within the number of milkings available in a day. The number of milkings available per day will depend on whether you plan to batch or voluntary milk (see table – Idle time).

Robotic rotary

The Robotic Rotary offers approximately 1400-1600 milking opportunities per day, depending on farm system type, management style, voluntary or batch milking. With an operating time of approximately 18 hours per day, this allows time to conduct up to three washes a day and allows additional time opportunities to perform preventative maintenance and servicing routines.

The herd size that this system will support depends in the milking frequency and it is up to the farmer to consider how to make best use of the available 1600 milkings. For example, if you aim to average twice a day milking, a robotic rotary could milk up to 800 cows. But some farmers prefer to milk fewer cows, more frequently for higher production. The system could support a herd of about 530 cows milking three times a day.

The robotic rotary at Gala in Tasmania successfully milked a a herd of 520 cows with a pasture-based, voluntary cow movement system. The herd size will increase further in Spring 2014. A new installation at Retreat Creek, Victoria has been designed for a 600-800 cow herd. FutureDairy will monitor the impact of herd dynamics and cow traffic on the full farm system performance with these larger herds.

Managing milk that can't go in the vat

Every dairy operation must have a reliable system for managing milk that can't go in the vat such as milk from hospital or colostrum cows. The robotic rotary and AMS box units have very different ways of handling this milk.

With any AMS you will also need to build time into your daily routine to attend to cows which are drafted by the system to a holding yard awaiting treatment, AI or other attention.

Robotic rotary

The robotic rotary cannot divert milk from individual cows from the main bulk milk vat. Colostrum and hospital cows need to be managed and milked separately.

One option is to set the system to hold these cows; so that they can be milked together followed by a system wash. With a large herd this interruption twice a day can significantly reduce the utilisation of robots and disrupt cow flow of the main milking herd.

Another option is to have a separate facility such as a single sided herringbone for milking and treating hospital cows or those whose milk needs to be diverted from the bulk milk vat. This approach has been used successfully at Gala Farm in Tasmania and plans for the robotic rotary installations at Sydney University and Retreat Creek include a single-sided herringbone facility.

It may be possible to retain a single side of an existing herring bone for this purpose, or it could be built using second hand equipment. A well designed facility may only have 6-12 clusters, but may cater for a larger number of cows so it can be used for other husbandry practices such as vaccinations, AI, pregnancy testing, udder singeing etc.

Having a separate facility enables staff to milk, observe and treat hospital or colostrum cows without the pressure of fitting around the main milking herd. It also means that system washes on the robotic rotary can be scheduled at more convenient times rather than having to be conducted immediately after the hospital herd.

For example, it may be convenient to set the system wash to occur at a time of day that has typically fewer cows arriving at the dairy. Other advantages of a separate facility include reduced risk of antibiotics entering the main vat, a safer working environment for staff, more time available to spend with those cows that require attention and more flexibility on when those cows are milked.

Above: Single sided herringbone for processing hospital cows.

Benefits of no automatic divert

Although not having the capacity to automatically divert milk in the robotic rotary may be considered a limitation, there are some definite advantages.

Firstly, the risk of antibiotic milk going into the vat is minimised. The only reason antibiotic milk could end up in the vat is if the treatment was not entered into the computer system. Once the information is entered into the system it will not allow automatic cup attachment to a treated cow. If you choose not to enter the information into the system you'll need to keep the cow geographically separated to reduce the risk.

Secondly, the fact that the colostrum and hospital cows are milked manually provides the opportunity to give focussed attention to individual cows that need it. It also gives the farmer absolute control of the milking frequency of these cows so they can be treated at regular intervals. Milking these cows twice a day is likely to result in a higher cure rate and lower re-infection rate.

Downside of separate treatment facility

The downside of a separate treatment facility is that time needs to be allocated to milk hospital and colostrum cows twice a day. However, having to spend 20 minutes a day dealing with these cows is a big improvement to milking more than 500 cows in a conventional milking system!

AMS box units

Most AMS box units can divert milk from individual cows to a number of destinations such as the bulk milk vat, drain, bucket or colostrum vat. After these cows have been milked, an automatic wash may be required. With a large herd, particularly if seasonal calving, there may be times when the number of system washes significantly slows down the system. In this situation consider designating one of the boxes only to milk cows whose milk is not going into the bulk milk vat. This will mean that you will be able to minimise the rinses by only rinsing after milking infected cows (to prevent cross-infection) rather than all dump cows as the bulk milk is not going to be compromised. Only one box is slowed down, keeping the others running at normal throughput.

Although most AMS boxes have a divert function, colostrum and hospital cows will trickle through the system all day. To treat them someone either needs to attend them as they trickle through, or the divert cows have to be drafted and held near the dairy to be

treated as a group at the next convenient time. By then, some may need re-milking to make sure the mammary gland is empty for treatment. This is likely to be a much more onerous task with a large herd. Smaller herd farmers develop systems and routines that work for them, their daily routine and that are suited to their infrastructure. Larger herds that are in operation with a large number of single box robots may wish to consider a separate treatment facility such as a single sided herringbone.

Feeding concentrates

Robotic rotary

As the robotic rotary doesn't have in-bail feeding functions, consider incorporating feed stations into your design. Although this is an additional cost, feed stations allow you to allocate grain-based concentrates to individual cows (or groups of cows), based on production, stage of lactation, body condition or other parameters that you set. They also have the spin off benefits of encouraging cows to exit the dairy and a cleaner environment in the dairy i.e. less dust and less risk of rodents (and the associated damage to wiring etc). The downside is there is no feed incentive to encourage cows to move onto the milking platform.

Feed stations are usually installed at the exit area of the dairy. This provides a reward for cows moving through the milking facility. Different feedstuffs can be allocated in different proportions to individuals if the necessary feed storage and delivery systems (silos, augers) are installed. Individual cows can receive a diet customised to different nutritional specifications such as protein or energy levels.

At the planning stage, make sure you allow for enough feed stations to prevent competition affecting each cow's ability to eat her allocated portion of concentrates. A large herd is likely to require 10 to 20 feed stations; the exact number will depend on herd size, typical feeding levels and likely milkings per hour.

AMS box units

All AMS box units have the ability to provide feed to cows in the robotic milking unit. They work on a trickle feeding process: feed is supplied at a rate that is similar to the cow's eating rate. The default feeding rate can be adjusted to suit a particular herd. This is usually done in the first few weeks of operation.

Experience has shown that it is quite challenging to encourage pasture-fed cows to consume an average of more than about 4.5kg/concentrate/day through AMS feeders. This depends slightly on the type of feed offered but the key limitation is the amount of time cows spend in the robotic milking units each day. This is influenced by the duration of each visit and the number of visits made to the AMS each day.

On average a milking through an AMS box unit takes 6½ -7 minutes, although this depends on the milking speed of the cow, amount of milk to be harvested and the time it takes to prepare and attach the cups. Cows that are milked more often may have more time in the robots each day but this is not usually a significant increase in time as milk harvesting efficiency often drops as milking frequency increases.

If you want to feed more than 4.5kg grain or concentrates/cow/day, it is important to consider how best to deliver this. If you feed a mixed ration for most of the year you have the option of putting a blanket allocation of concentrates in the ration. Then you can use the robotic milking units to lift the intakes of individual cows. Another, common option for pasture based systems is to install additional feed stations at the exit area of the diary, so that cows can consume any 'left over' allocation before heading to the paddock. The ratio of feed stations to robotic milking units will depend on your needs but should be discussed with the equipment manufacturer.

Above: Feed stations allow you to allocate grain-based concentrates to individual cows (or groups of cows), based on production or other parameters that you set. They also have the spin off benefits of encouraging cows to exit the dairy and a cleaner environment in the dairy.

FOR MORE INFORMATION

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