# AUTOMATIC MILKING SYSTEMS IN NORTH AMERICA: ISSUES AND CHALLENGES UNIQUE TO ONTARIO

Jack Rodenburg[1] and David F. Kelton[2]
[1]Ontario Ministry of Agriculture, Food and Rural Affairs, Woodstock, Ontario, Canada
[2]University of Guelph, Guelph, Ontario, Canada

## Introduction

In Europe, automatic milking systems (AMS), available commercially since 1992, have gained rapid acceptance. More than 400 systems were in operation in 1999, including over 200 systems in the Netherlands (Schukken 1999). While more than 1000 installations are projected in Europe by the end of 2000 (Lind 2000), North American adoption of this technology is in its infancy. The first commercial robotic milking system on this continent was installed in Ontario, Canada in March 1999. Ontario now has 15 dairy farms with AMS experience consisting of 20 Lely Astronaut stalls on 13 farms. and 3, 4-box AMS Liberty systems on 2 farms. While this is too small a number to permit formal field studies, early observations gained from working with these herds, may be helpful in identifying issues relevant to the adoption of robotic milking in the United States and Canada.

The 15 robotic milking herds were visited in December 2000 to collect basic herd information and conduct brief interviews with the operators. In addition, monthly milk quality records for robotic milking herds were compared to dairy herds not using AMS technology.

## Why Automatic Milking?

The Ontario dairy industry is well suited to be the first in North America to adopt robotic milking. The typical Ontario dairy herd consists of 58 cows with the majority of herds housed in tiestalls. Many producers are now expanding into their first freestall barn for 60 to 200 cows. Most herds are milked 2X and involve exclusively family labor. Herds in this size range, also common in the northeastern United States, have difficulty making efficient use of modern milking parlor technology. They are faced with a "trade off" between investing too much capital in a labor efficient parlor that is under utilized, or spending too many hours milking with low cost but inefficient equipment (Steevens 1992). A preliminary economic analysis, using costs typical for the Midwestern US (Reinemann 2000) estimates the labor and equipment cost for parlor milking 70 to 140 cows at $2.15 to $3.65 per hundredweight, three times as much as for a 400 cow herd. The same study estimates milking costs with AMS at $1.30 to $2.00 per hundredweight. AMS technology has the potential to permit a "family farm" to expand to 100 to 150 cows without hiring outside labor. It also has potential to make this size of operation economically viable and competitive with larger dairies. In southern Ontario, growing friction between an increasing non-farm rural population and shrinking numbers of ever-larger farms threatens the future of livestock agriculture. AMS technology appears to enhance the economic sustainability of smaller, land based, family-run dairy operations. Although the real environmental and rural economic impact of AMS has not been studied, current public sentiment in Ontario strongly supports this style of agricultural production.

Addressing whether or not automatic milking systems can benefit the larger dairy herds in the USA, is one of the issues facing the industry in North America. Ontario herds using AMS systems average 94 cows. It is doubtful our experience will contribute much to this discussion.

Over the last decade, numerous dairy producers from the Netherlands have immigrated to Ontario. Prior exposure has made this group familiar and comfortable with AMS technology. Of the 15 farms with robots, 7 are operated by recent Dutch immigrants.

In interviews 13 of the 15 owners of robotic milking systems ranked "avoiding the frustrations of dealing with hired labor" as either their first or second reason for choosing AMS. With an average herd size of 94 cows, AMS owners feel that hired labor is difficult to schedule, requires multi-skilled employees and would require them to learn new skills in people management and employee training. Robotic milking allows them to milk more cows while continuing to work with family labor only. The second ranked reason for choosing AMS, listed by 9 of the producers, is the opportunity for more milk frequent milking, with its benefits of higher milk production, lower SCC, lower incidence of clinical mastitis and reduced stress on udders. In their experience 3X parlor milking for a herd of 100 cows is impractical because of major scheduling problems for the 1 to 2 hours of midnight labor, 7 days per week. Other reasons given include the flexibility and lifestyle advantages (6 producers) of not being tied to a fixed milking schedule, and the desire to be innovative (3 producers). Four of the herd owners interviewed also pointed out that when the cost of building space was included, capital cost of AMS technology at this herd size was comparable to large milking parlors. Faced with the need to invest in a new milking system these producers are confident that, for them, robotic milking will be economically advantageous compared to a new parlor.

Most aspects of robotic milking will be subjected to extensive research involving many systems in Europe. In Ontario, data was collected on the 15 farms on barn layout, freestall design and management, milking system cleaning practices, length of milk lines, and milk storage and handling, including the size and configuration of bulk tanks and "buffer tanks". While it is our long term goal to correlate these parameters to milk quality, insufficient data prevents useful analysis at this time. Interviews with producers also provide commentary on cow traffic and behavior, estimated labor savings, and incidence of and reasons for system alarms. In general these observations agree with those reported in the European literature. While most questions will be better answered by more experienced European experts, a few specific issues of special interest in Ontario have come to our attention and warrant further discussion.

## Cold Housing and AMS

Although cold environments for dairy cattle undoubtedly exist in Europe, published reports have not addressed operation of robotic milkers in freezing conditions. Freestall barns in Ontario are constructed with a wide range in the amount of insulation, and operated at a wide range of winter temperatures. Among the 15 robotic milking facilities 10 are located in insulated barns which include a ceiling liner attached to the underside of the "scissors truss", covered with a vapor barrier and R15 to R25 blown in insulation. These barns are operated at above freezing temperatures and report no cold related problems with robotic milking. Four of the barns are constructed with a minimal amount of insulation as a drip barrier under the roof, and one barn is uninsulated. Despite mild winters in recent years, these producers have found that robotic milkers cannot operate in freezing conditions. Reports of ice on lasers and rollers on Lely systems and frozen tracks and mechanical components on the AMS Liberty demonstrate that the immediate environment of the robot must be maintained frost-free. In these barns, Ontario producers have successfully alleviated the problem by enclosing the working area on the clean side of the robot with walls and a ceiling, and adding a small space heater and positive ventilation in this "room."

## Stray Voltage

The most common source of stray voltage is neutral current generated by normal power consumption in the grounded neutral electrical distribution system used throughout Canada and the USA. Electrical distribution in Europe is phase to phase and with the rare exception of electric shock from ground faults, stray voltage as we know it does not exist on European farms.

Although most recent research suggests that the practical significance of low levels of stray voltage is minimal, a behavioral, "avoidance" response is recognized to be the most likely first effect of exposure (Southwick 1995). This effect has been observed in farm situations involving refusal to use computer feeders in which cows were exposed to shocks of 2 to 3 milliamps, or 1 to 1.5 volts in a mouth to hooves pathway. Robotic milking systems are highly dependant on voluntary visits by cows to the milking stall (Lind 2000). If cows experience electric shocks when visiting the milking stall, it is predictable that they will reduce their voluntary visits. Measurements taken from cow contact points on both types of robotic milking systems in Ontario indicate the metal equipment is case grounded and provides a potential cow contact for stray voltage. Since the metal floor is an integral part of the milking box, the cow is on an equi-potential plane while in the stall and therefore protected from stray voltage during milking. Cows are exposed to a "step potential" when entering and leaving the box. While measurements on Ontario robot farms demonstrate the potential for stray voltage problems, limited testing on 8 of the farms found voltage ranging from 0 to 0.4 volts. In all probability this level is too low to be of concern. On several of the farms the area beside the milking stall is slatted and provides minimal grounding to the cows thereby alleviating any risk of stray voltage. In solid floor barns, installation of transition gradients (Gustafson 1984) at the time of construction may be a worthwhile preventative measure. Since the stray voltage issue is unique to North America, proper monitoring of stray voltage and mitigation when required may be important to robotic milking installations.

## Feeding Management

Automated milking systems rely on the use of feed offered in the box, or provided by way of restricted access and "one way cow flow" to motivate cows to visit the milking box. European dairy herds often make extensive use of pasture. Perhaps because of this, computer feeders, and other means of feeding grain separate from forage remain popular. While total mixed rations are used they are by no means predominant. It can be predicted that much of the European research on feeding strategies with AMS will remain focussed on pasture, and on separate grain feeding. Of the 15 AMS herds in Ontario, 14 feed a mixed ration in the bunk. All of these herds also feed a pelleted grain ration in the milking box. The average quantity fed ranged from 1 to 3.5 Kg and averaged 2.5 Kg. The maximum fed ranged from 1 to 6 Kg with an average of 4 Kg. Several producers speculated that long milking intervals for stale cows may be correlated with reduced grain feeding in the milking box. Farms which fed less grain at milking also tended to report more cows with long milking intervals. Several of these producers are experimenting with custom formulated, pelleted feeds containing only the most palatable ingredients and no minerals. Eight of the 15 herds currently use one way cow flow to force cows through or past the milking box on the way to the feed manger, but in most cases this is viewed as a training regimen which will be discontinued when cows have more robot experience. The use of TMR feeding is nearly universal in Canada and the United States. Feeding up to 6 Kg of grain outside of the mixed ration will not be popular with North American dairy producers and may negate many of the benefits associated with TMR feeding. Thorough research to define optimum feeding strategies for systems that combine AMS with TMR will be important to the management of AMS systems in North America.

Water Quality

Unlike dairy farms in the Netherlands, which are supplied with municipal treated water, Ontario dairy farms rely on on-farm wells. Field studies have shown that many farm wells are contaminated with bacteria. While use of contaminated water for washing milking equipment is ill advised, use in robotic milking systems is thought to involve even greater risk. Dutch investigations of milk quality report an increase in freezing point with robotic milking and suggest that frequent cleaning and rinsing cycles which leave remnants of water behind, may be responsible (Van der Vorst 2000). If this “remnant of water” is contaminated there is a clear risk of reduced milk quality, in terms of increased bacteria counts. High bacteria counts on one robotic milking farm in Ontario have been directly linked to use of contaminated water. Thorough testing of the water supply used to clean and rinse milking robots, and treatment if required are advised for AMS farms.

Milk Quality

Dutch studies have reported decreased milk quality, particularly increased bacteria counts and elevated freezing points for farms, which have switched to robotic milking. In a ently published report, first generation robotic milking systems, defined as those installed before January 1, 1998 are compared to second generation systems installed in the period January 1998 to March 1999, and third generation systems installed since March 1999 (Van der Vorst 2000). It was noted that the increase in total plate count in second generation robots from 8,000 ± 3000 prior to installation to 12,000 ± 5000 after installation, was less severe than the 17,000 ± 7000 reported for first generation robots.

Since Ontario's first robotic milking system was installed in March 1999, by the above definition, all of the Ontario systems are "third generation" technology. In the Dutch situation, third generation equipment is being installed by experienced installers working with knowledgeable producers and advisors. But with little prior experience, the Ontario situation involves third generation equipment installed by first generation technicians on first generation farms.

In table 1, monthly SCC and Bactoscan results for AMS herds are compared to results of all Ontario herds shipping over 40,000 liters per month. This level of production was chosen to ensure AMS herds were compared to herds similar in size. Data prior to March 2000, is based on less than 7 AMS herds and is not reported due to small sample size. The information in table 1. should be considered preliminary since even 7 to 13 herds is a very small sample size. SCC trends in Ontario AMS herds are similar to the Dutch results.

Table 1. Monthly Milk Quality of Ontario AMS herds compared to all Ontario herds shipping over 40,000 liters per month.

| Month | Number of Herds | | Average SCC ('000) | | Average Bactoscan ('000) | |
|---|---|---|---|---|---|---|
| | AMS | All Herds* | AMS | All Herds* | AMS | All Herds* |
| 03-'00 | 7 | 1608 | 273 | 232 | 89 | 44 |
| 04-'00 | 8 | 1495 | 274 | 225 | 32 | 28 |
| 05-'00 | 8 | 1603 | 243 | 234 | 86 | 34 |
| 06-'00 | 9 | 1426 | 293 | 258 | 65 | 65 |
| 07-'00 | 11 | 1450 | 332 | 274 | 110 | 30 |
| 08-'00 | 11 | 1452 | 321 | 276 | 330 | 41 |
| 09-'00 | 12 | 1376 | 285 | 261 | 111 | 36 |
| 10-'00 | 13 | 1450 | 246 | 225 | 53 | 26 |
| 11-'00 | 13 | 1355 | 249 | 220 | 87 | 34 |
| Ave** | | | 280 | 245 | 107 | 38 |

*all Ontario herds shipping over 40,000 liters in the stated month
** Raw average of the 9 months listed

The trend in Ontario bactoscan results indicates AMS herds have bacteria counts 3x higher than the provincial average for herds of similar size. This is worse than first generation robotic systems in the Dutch study. While based on limited observation, many of which are made on very recent installations, this data suggests that "experience and installation" may have a larger impact on bacteria counts than the technical advancements in the equipment itself. Based on this limited data and the producer interviews no single specific cause for the high bacteria counts is apparent. Very high counts in the warmest months of July, August and September suggest milk cooling may be a factor. General observations on cleanliness of stalls and manure on udders, as observed during herd visits, suggest that inadequate teat cleaning may also be involved.

With respect to freezing point data roughly 78000 monthly freezing point tests were conducted for all Ontario dairy producers last year. Of these 105 were above the Ontario penalty level of –0.535, for a penalty incidence of 1.3 penalties per thousand tests. AMS farms have had 123 freezing point evaluations since they began milking with the systems, and have had 2 penalty level results, or 16 per thousand.

## Summary

Automatic Milking Systems have considerable potential to benefit family dairy operations in the 100 to 150 cow range by making them more competitive with larger herds. Most questions related to robotic milking are best answered by assessing the European experience. Issues more specific to North American conditions may include adaptation of robotic milking to large herds, dealing with freezing barn environments, feeding strategies for total mixed rations, stray voltage, and water quality. Milk quality concerns, specifically the consistent increase in bacteria counts reported in studies wherever AMS systems are introduced, require a concerted global research effort to define the contributing factors and offer solutions.

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