EVOLUTION OF AUTOMATED MILKING IN THE USA

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At the time this paper was written there were three commercial farms and one university farm using eight Automatic Milking (AM) units in Wisconsin and two commercial farms in Pennsylvania using five AM units. All of the commercial farms are 'single family' operations using two or three single box units and milking from about 100 to 200 cows. There is also interest in implementing AMS technology on large farms (> 1000 cows) but none of these projects has been implemented yet.

It remains to be seen whether the adoption rate of AM in the USA will be as rapid as the experience in northern Europe. The incentives for and constraints on AMS technology are somewhat different in the USA than in Europe or Canada.

- There is no milk quota system as exists in Europe and Canada, and government support of the milk price is being phased out. As a result the price of milk is much more volatile in the USA than the EU and Canada.
- The cost of milking labor in the USA is considerable lower than that in Europe. The average wage paid to farm labor on field and livestock operations in 2001 was $7.86/hr and has shown a steady increase over the past 10 years of about $.25/hr per year (USDA, 2001). Among the highest wage rates for livestock workers occur in the lake states of Wisconsin, Minnesota and Michigan and the pacific coast states of California, Oregon and Washington.
- The barriers to herd expansion are higher in Europe (due to available agricultural land, milk quota and environmental regulation) and in Canada (due primarily to milk quota) than in the USA.

This paper will explore the implications of these conditions on the future implementation of AM in the USA.

The Future of AM on Small Farms in the USA

The types of AMS currently available on the market were developed primarily to meet the needs and market and social conditions of single-family owner/operator dairy farms in Europe. There are a considerable number of similarly sized single-family owner/operator dairy farms in the traditional dairy states in the USA: Wisconsin, Pennsylvania, Minnesota, Michigan, New York, and Vermont. Although the number of these moderate scale dairies has been declining, they are still home to half of all dairy farms and roughly 40% of all dairy cows in the country (USDA, 1999). These farms are generally located near population centers where the urban pressures of higher land prices, higher price for labor and increasing environmental regulations are significant factors in the future economic viability of these farms. Health issues, unusual work hours, and

working conditions have made obtaining reliable milking labor a major concern of these dairy producers. AMS technology can provide an option for these farms to reduce the labor requirements of milking and allow some of these farms to continue dairy production and make them more attractive to new producers.

Economic and social conditions that act to maintain dairy production near population centers favor the application of AM technology. An example of an economic factor that helps maintain farms in urban areas is a public policy decision to reduce the taxes on agricultural land as long as it stays in agricultural production, rather than taxing this land on its market value as residential property. A social factor that helps maintain agricultural production near urban areas are programs such as Community Supported Agriculture (CSA) in which urban residents make purchasing agreements directly with local agricultural producers.

Economic and social factors that act to limit farm size and increase environmental controls also favor the adoption of AM on small farms. Increasing environmental (and aesthetic) concerns act to place limits on the number of animals concentrated at a single location. Farms that are limited in size due to factors such as milk quota or available land area are typically more mechanized than farms without this constraint.

Many of factors that favor the adoption of AM on small farms near populated areas are also incentives for farmers to relocate to less populated areas. The cost of environmental and aesthetic compliance will make the cost of producing milk in populated areas generally higher than parts of the country where these costs are not as high. Milking labor is also generally higher in cost and less available near populated areas because of the many other employment opportunities.

The option of relocation is more easily available to these small farms located near urban centers than for similar farms in Europe. It has been common in the USA, as the value of farmland increases due to urban expansion, to sell farms near cities and buy land in a less populated area (e.g., migration from the Chino valley of California to northern California, Idaho, New Mexico, etc.) This is also an international phenomenon, which has occurred across the ocean with farmers selling relatively high-priced land in the Northern Europe and relocating to Canada and the USA. The relative cost of relocation and the economic and social incentives (and disincentives) to maintain farms near population centers will have a major impact on the adoption rate of AM on small farms in the USA.

A common motivation for implementing AM in the USA is that the independent owner/operator does not want to become an employer and spend time managing employees. Perhaps the most valuable asset of the owner/operator dairy farm is their specialized management skill and the time to implement these skills. Milking comprises about half of the labor expended on small dairy farms amounting to 40 to 50 million person-hours per year in Wisconsin. AM replaces the physical labor of milking which frees owner/operators to make better use of their time for management functions. It is likely that farms with a high level of management skill will choose to increase the number of cows milked to make maximum use of their highest value input. With the present level of AM technology, it appears that a single-family, owner/operator is capable of managing on the order of 200 – 300 cows. The adoption of AM on this type of farm will likely

result in a substantial increase in herd size and increase in milk sales. This will result in a better economic situation if the increased costs are less than the associated increase in income. The owner/operator will need to acquire higher-level management skills of cows, business and technology to optimize the investment in automation.

At present, AMS technology is more costly than other methods of harvesting milk. It is clear, however, from the adoption rate in Europe and high degree of interest in the USA that this is not the sole factor in the decision to purchase an AMS. It appears that many producers are willing to pay a premium for the improved quality of life offered by AMS. A thorough economic analysis of whole-farm operations is required in order to accurately assess each individual situation. However, some rough approximations of general trends can be made. Dairy production is steadily moving to large farms because of the associated economies of scale as well a host of other economic and social conditions. The economics of milk production using AM technology must be able to compare favorably to large farm in the to be viable in the long term.

The cost of the equipment and labor for harvesting milk on large farms in the USA is about $300 per cow per year (taking into account only the annual cost of investment in the milking machine and the annual labor cost). A comparable cost of the equipment and labor to harvest milk using AM in the USA is currently $600 to $700 per cow per year (taking into account only the annual cost of investment in the AM unit and the annual labor cost). Note that these are only approximate 'partial budgets' and do not take into account the cost of animal housing, housing of the milking facilities, or differences in the many other production inputs. Based on this simplistic calculation, if the productivity/cost ratio for AM technology improves by a factor of about two it becomes very comparable to the most economically efficient competitive methods of milk harvesting. If these sorts of significant gains in the productivity/cost ratio are realized for the current model of voluntary milking using AM harvesting technology, then it will compete very favorably with other forms of milk harvesting technology on both small and large farms.

These advances in productivity/cost ratio are within the realm of possibility. The most expensive parts of single box AM systems are typically idle for more than half the time. Multiple box systems have suffered efficiency losses because of the difficulties in managing voluntary cow movement in large group sizes. Reconfiguration of AM barns to take advantage of advances in management of cow behavior offers the possibility to substantially increase the productivity/cost ratio. Further advances will undoubtedly occur in automatic sensing and data management strategies to further increase efficiencies and automate the tasks now being performed by humans using AM systems.

The Future of AM on Large Farms in the USA

There has been considerable interest in using AM technology on large farms in the USA. The most common concept is to multiply the type of modules already in use on small farms in Europe. There are, however, a number of clever minds evaluating alternate ways that AM might be implemented on large farms.

Robotic technology is very well suited to performing repetitive tasks in a well-defined environment, for example, welding on automobile assembly lines. The milking process is much

more complex than these types of industrial applications of robotic technology because cows are more complex creatures than lumps of steel. A number of intelligent decisions must be made to determine if the cow is ready to be milked, if the milk is suitable for sale and to determine how to implement the milking process. These tasks are relatively easy for a human to perform. The greatest challenge in implementing AM technology and the greatest concern from the regulatory agencies are the incorporation of 'artificial intelligence' into the decisions made by a computer controlled automatic milking unit.

An intermediate option for AM technology, which may be particularly attractive on large farms, could be as an assistant to a human operator. The AM unit could perform the repetitive and physically demanding parts of the milking process (automatic preparation, attachment and detachment) while a human makes the higher-level intelligent decisions, making best use of the strengths of each. AM technology is already priced at a level to be competitive as a labor saving device to assist a human in the task of milking in a large milking parlor, perhaps allowing a large milking parlor to be operated by one person rather than 4 to 6 people. The realization of this concept will require significant development work.

Conclusion

A number of dairy producers in the USA have already made the decision to implement AM technology and the robots are already here. It is quite probable that this technology will be increasingly adopted on dairy farms in the USA. The rate of adoption and the types of farms that choose to use AM technology is uncertain. Difference in the economic and social pressures on dairy farms between the USA and Europe and Canada will likely result in different adoption rates and implementation strategies for AM milking. The main barrier to adoption at present is the relative cost of using AM compared to conventional milk harvesting technology. A major difference in the decision to invest in dairy operations is the volatile milk price in the USA compared to Europe or Canada. If the price of milk is unknown, or known to be volatile, the risk of investment is much higher. This implies that the investment in AM technology must come much nearer to that of conventional milk harvesting systems to achieve the rate of adoption in the USA that has been seen in Europe and Canada.

References

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