Economics of Robotic Milking

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Take Home Messages

- Robotic milking will become more common place in the dairy industry in the next 10 years.
- There are many different options when choosing robotic equipment; some options are proven and some are being proven.
- Robotic milking systems only harvest milk. Robots do not produce milk. Cows produce milk. This makes cow comfort, nutrition, facility design, cow behavior, etc major determining factors in the overall economic success of the system.
- Milk can be efficiently and economically harvested with robotic milking systems.
- When switching to robotic milking, depending on the system chosen, it may be necessary to totally rethink the management scheme of the dairy.
- Labor savings may be overstated in some systems.
- Feed costs may increase, but feed cost per cwt of milk might decrease if there is also an increase in milk production when adopting robotic milking.
- Bottom line, milk harvested daily per robot is a critical factor in the overall economic success of a robotic dairy.
- Published research data on systems, barn designs, cooling systems, etc, introduced in the last five years is limited and in many cases uncollected. Use caution when evaluating new systems and designs based on old data.
- We are just getting started. The journey is exciting and we will see many modifications and improvements in the next decade of robotic milking.

Introduction

Robotic milking equipment is becoming an important part of the dairy industry in the US, North America and the world. It is anticipated there will be significant growth in the application of robotics in the next 10 years. The US has seen significant expansion of this segment in the last

decade. Today, many of the milking robots reside on farms with less than 250 cows. However, the interest in application of robotics to large scale dairy operations is growing rapidly, and we now have several examples of robot farms in herds of more than 1,000 cows. Internationally, the largest dairy using robotic milking is currently milking over 4,000 cows daily. It is likely that units of this size or larger will be established in the US in the next 2-3 years. The purpose of this paper is to discuss some of the key economic issues and challenges in adopting this technology on dairy farms.

System Types

Robotic milking systems have traditionally been built on the concept of a box stall which usually contains a single milking unit. A few designs use multiple milking stalls served by a single robotic arm. Today, these box systems typically contain one robot and a stall for a single animal. These types of systems also incorporate a feeding station. The purpose of the feeding station is to attract the cow to the milking point and to supplement the nutrition program. In some cases, multiple feeds can be offered. Level of feed offered and types of feed offered can be controlled on an individual cow basis to more closely match nutrient requirements. Adoption of this type of milking requires dairy farms to rethink the application of common dairy practices like feeding, breeding and treatment. All of our current animal management schemes need to change to accommodate the change in the milking system. This is difficult and requires the farm to now more effectively use cow behavior as we move from fetching the cows to the milking parlor to moving the milking parlor to the cows and depend on the voluntary movement of cows to the milking center. This is a complicated and challenging move for larger dairy producers. While it can be successfully accomplished, it will require a large change in paradigms of dairy farm operation.

We are now seeing the adoption of rotary milking parlors that are either fully or partially robotic. While these systems have been utilized in Europe for nearly two decades, we are first seeing these installed in the US. These systems only milk cattle. There is not a feeding system associated with the milking process. Cattle are generally housed and managed the same way as a dairy utilizing a conventional milking parlor. The whole system of animal management and farm procedures does not need to be adjusted. We are currently in the very early stages of working with these systems and the next few years will provide us with some of the needed data to more fully evaluate the economics of these systems.

Key Economic Issues With Milking Boxes

In the past these individual box milking stalls could only effectively milk 50-55 cows per day in confinement facilities. One of the economic limitations has been the amount of milk harvested daily in relationship to the debt acquired when purchasing a single unit with a cost of $180,000 to $200,000. Table one demonstrates the amount of milk required to service of a loan of $180,000 at various lengths. An interest rate of 5% and a milk price (less hauling and marketing) of $0.15 was utilized in the calculations. Many current robotic dairies harvest less than 5,000 pounds of milk per box. Based on the table, a dairy harvesting only 4,000 pounds per robot with a 7- year loan would need to utilize about 14% of the milk income to service the robotic milking equipment debt. With the current narrow dairy margin, farms harvesting less than 5,000 pounds of milk per robot box may experience a tighter financial position than those harvesting 6,000 pounds or more.

Figure 1 demonstrates the effect of the number of cows milked and production per cow on the daily potential milk harvest. Many of the older box systems only effectively handle about 50 cows per

day. When numbers rise above this level, daily harvest per cow deceases and there is generally increased labor needed for fetching and training. In order to achieve 5,000 pounds of daily harvest, the herd would need to achieve 100 pounds daily/cow. While a few farms have been able to achieve this level of production, it is difficult to maintain and requires a high level of management. Likely more intensive management than a conventionally milked herd achieving similar levels of production.

However, some of the newer systems being offered can now handle up to 70 cows per milking point. This is due to changes in the method of teat detection and reduced box time due to quicker attachment and milking. As demonstrated in Figure 1, herds that can use a box to milk 70 cows each day can achieve a daily of harvest of 5,000 pounds with much lower milk production per cow. Obviously, herds that can achieve 90 or 100 pounds of milk per cow with these numbers will achieve a much greater income stream than lower producing herds. However, the window of success may be expanding due to increasing the number of cows over which the investment is distributed. In the next couple of years, it will be interesting to watch the success of producers currently installing this type of equipment.

Other economic considerations that are important to the profitability of box units include actual labor cost or savings, feed cost, loss of labor efficiency for certain tasks like breeding or treatment, equipment maintenance cost, increased value of labor, and understanding the impact of animal behavior on the success of the system. As stated earlier, level of milk production and cows milked daily are important factors in determining the level of milk harvested by the system. Harvested milk is critical on the economic success of the dairy. With the robotic boxes, it is important to recognize that animal behavior greatly influences visits to the robot. This not only impacts the amount of milk removed at each visit, but also the availability of feed to supplement the feed bunk. Keeping in mind that each pound of increased intake would result in an extra 3 pounds of milk production. A few more pounds of feed intake could greatly impact the daily level of milk production. With robotic milking boxes, it is critical to understand the interaction of nutrition and cow behavior that occurs at the milking station.

Key Issues Robotic Automation On Rotary Parlors

Efficiency in rotary milking parlors has been an interesting journey. When we first started utilizing these systems, entry time was 8-10 seconds. It is the entry time that determines the number of cows milked each hour with these systems. We now have systems that are running with less than 5 second entry times. A parlor with an 8 second entry time can milk about 450 cows per hour while one running with a 5 second entry time could milk 720 cows per hour. The number of stalls on the wheel is adjusted to provide the correct amount of time for prep, attachment and milking. Obviously, a parlor milking 720 cows per hour will harvest more milk than one only milking 450 cows. We have really pushed the limits of milking efficiency with rotaries in recent years. As a result, many of our larger dairy operations are watching the adoption of robotics on rotary parlors very closely. The rotary milking concepts match their current management paradigms and would be easier to incorporate into existing facilities. In some cases, the robotic equipment is cheaper per stall than the box milking units. However, we need to carefully evaluate the total situation. First, most economics on rotary milking would be based on milking 22 hours per day with the remaining 2 hours for maintenance and cleaning. Some dairies milk even more hours per day due to efficiencies discovered in maintenance and cleaning. When considering a robotic rotary, it might not be realistic

to assume that only two hours per day will be required for cleaning and maintenance. Keep in mind that if one needs to stop the deck for repair, all the units will be idle until the repairs are finished. While we are still learning, it is important to note that we need to carefully determine the practical number of milking hours each day.

The second issue to address is entry time or the number of cows that can be milked/hour. This is likely less than with conventional rotaries. This is due to the time required to detect teats, clean teats and attach the inflations. In general, if the system can milk 400 cows/hour, then the entry time would be about 9 seconds. This is a major difference from what we observe with conventional rotaries and needs to be evaluated in the economic analysis.

In conventional rotaries, we generally have one person to prep, one to dry, one to attach, one to reattach and a fifth person to apply post dip and check for complete milkout. Rotaries with low minimal entry time may distribute these tasks differently, but it is not unusual to see a team of 5 on conventional rotaries. So, the question is how much labor can be removed with robotics on a rotary deck? With the current robotic rotary systems, there are generally people present in the parlor. The number needed depends on the udder confirmation and animal behavior. Farms may move non-conforming cattle to a couple of pens reducing the labor presence in at least part of the pens. However, there is generally still the need for at least one person in the parlor during operation. Thus, all milking labor has not been removed. Just like the box units, it all comes down to the amount of milk harvested per robot daily.

It is also possible to only assign certain tasks to the robot. Several versions of technology could be adopted to apply pre-dip and post-dip and eliminate the labor needed for those specific tasks. The cost of this equipment varies and is largely associated with the actual detection of teats prior to dip application. Those robots with camera technology are much more expensive than those that just blindly spray. Some of these units also brush or prep the teats. Thus, we might be able to remove a couple of people from the milking parlor. We would still manually wipe and attach. This could allow a similar number of cows to be milked per hour because humans are faster at drying and attaching units. There as some examples of producers successfully operating rotary decks with only two people by adopting a post-dip robot and removing the person to reattach units. While there may be concerns about missed cows, cows that consistently drop units will likely be culled due to low production or mastitis. Over time, we select for cows that conform to the system.

Impact On Labor Cost

One of the greatest debates over robotic economics is the impact on labor cost. Many of the earlier economic studies performed with smaller robotic units, often showed minimal changes in labor cost. Labor for milking is generally about 50% of the total labor cost on a dairy with a conventional milking system. One should not assume that moving to robotic milking will slash the labor cost by 50%. It is generally much less than this and sometimes it has been minimal. If the labor is transferred from milking to other activities that profit the dairy, then we may see a net gain in income without a decrease in labor cost. It is also important to recognize that robotic milking will require an increased skill level and increased training. This will result in a more valuable labor

resource that commands a higher wage. In all cases, labor is a critical factor in determining the overall economics of adopting robotic technology in the milking parlor.

Other Economic Considerations

Capital requirements are one of the major considerations in the economic equation. Fully robotic milking systems may cost $2,500 per cow as compared to about $250 for a conventional milking system for a similar sized dairy. As a result, we generally need to see an increase in milk production and a decrease in labor cost to cover the additional capital required for the milking equipment. Actual comparisons of supplies, maintenance and running costs of conventional and robotic systems are generally a minor factor in the overall economic picture.

Feed cost is often discussed when considering the robotic milking boxes. One should expect an increase in daily feed cost per cow when moving to robotic milking boxes. However, if the move results in an increase in milk production per cow, then the feed cost per cwt of milk produced is often reduced, thus, improving profitability. One should carefully evaluate the difference in delivering some of the nutrition in the milking stall vs the feed bunk. What is the true increased cost of nutrients fed in the robot? Keep in mind that the shrink in an enclosed feeding system will be much lower than the commodity shed and should be accounted for in making the case for feeding in the milking station. It has also been observed that limiting feed availability in the robot may increase labor needed for fetching and training. The amount fed could influence animal behavior and thus increase milk production and reduce labor requirement.

Summary

There are many things to consider about the overall economics of robotic milking equipment. Increased equipment cost can be offset by increases in milk production as well as decreased labor cost. As labor cost increases, dairy producers will likely move toward the adoption of more robotic equipment in existing and new dairy facilities. There is also a concern of labor availability in some areas, and robotics may become necessary regardless of economic considerations. Overall economic sustainability of robotic milking is no different than conventional milking. It all comes down to generating enough milk income to cover the increased cost of equipment that is not offset by labor savings.

Table 1. Relationship between daily milk harvested and debt service requirements

Pounds of Milk Harvested, Daily	Percentage of Daily Milk Harvested Required to Service Loan			
	Length of Loan*			
	5 yr	7 yr	10 yr	15 yr
3,000	25.2%	18.8%	14.1%	10.5%
4,000	18.9%	14.1%	10.6%	7.9%
5,000	15.1%	11.3%	8.5%	6.3%
6,000	12.6%	9.4%	7.1%	5.3%
7,000	10.8%	8.1%	6.1%	4.5%

*Loan of $180,000 at 5% interest rate

Figure 1. Effect of cow numbers and milk production per cow on daily milk harvest