Automatic Milking Systems: Labor-Savings Route or Costly Gamble for Dairy Farmers?

Alejandro Gutiérrez-Li, Grace Melo, Shaheer Burney, Cesar Escalante, and Shree Ram Acharya

Automatic milking systems (AMS) can be promising labor-saving technologies that can help improve milk yield and potentially serve as an alternative to conventional milking systems (Bohj et al., 2022). While AMS reduce the demand for low-skilled workers for milking-related activities, some skilled labor is still needed for monitoring AMS, a task that might demand other skills and training that low-skilled laborers may lack. These skilled workers may require higher wages. For this reason, the effect of AMS adoption on net labor savings is not clear. Anecdotal evidence from interviews of Wisconsin farmers suggests that the limited availability and high cost of agricultural labor in recent years is one of the primary determinants of AMS adoption.

In some cases, costs differences between AMS and non-AMS seem to be limited, potentially due to a weak substitution between labor and capital (Steeneveld et al., 2012). For example, survey results in Canada show that after adopting AMS, the number of employees slightly decreased, while milking-related activities decreased by 62% (Tse et al., 2018). In the United States, economic gains (or losses) from AMS adoption seem to vary based on farm size and whether capacity is adequate for herd size (Rotz, Coiner, and Soder, 2002, 2003; Moyes et al., 2014). These findings suggest that it is crucial to evaluate how labor costs may shift across these operational factors.

To date, no previous work has assessed whether there are significant differences across operation size in the United States. For instance, it is unknown to what extent labor savings are more impactful for high-volume operations compared to low-volume operations. If savings are important, our understanding of whether they vary by model or by the rate of AMS adoption is limited.

We present the results of a dairy farmer survey that was sent to Midwestern adopters and nonadopters of AMS technologies. From the former group, we learned

different aspects associated with the costs and benefits that producers have experienced so far. In particular, we asked about labor savings associated with using automated devices and the considerations they had when they decided to adopt AMS. For the latter group, we gathered valuable information related to the main reasons farmers in this group have not mechanized their production processes and whether they might consider doing so in the future. Our study contributes to the literature on automation in the United States. By collecting data directly from producers, we were able to get first-hand information on different paths to the adoption of labor-saving technologies that can inform the expected experiences in the dairy sector and other industries.

Data

To address how AMS adoption influences the use of labor, we conducted a mail survey of dairy farms in the Upper Midwest in 2023. The goal of the survey was to evaluate the financial feasibility of adopting AMS and the impact of AMS adoption on farm operations (labor use, barn design, adoption of other technologies) and farmer well-being. The Survey Research Center (SRC) at the University of Wisconsin–River Falls conducted the survey on our behalf. The survey was distributed to 2,000 small, medium, and large dairy farms across Wisconsin and Minnesota. Data were collected over a 6-week period, and the SRC received 665 valid responses, for a response rate of over 33%. About 6% of the farmers in the sample use AMS, which aligns well with the SRC's estimate from other surveys that 7% of all Wisconsin dairy farms use AMS. The survey included questions on labor needs, herd size, paid labor wage, and key sociodemographic information.

Results

Survey findings highlight crucial differences in terms of labor demand by adoption. We also further break up these differences by farm size. Finally, we point out that

Table 1. Average Number of Full- and Part-Time Nonfamily Farm Workers by Milking Frequency and Business Size

Activity	AMS Adopters		Non-AMS Adopters		Change Full-Time	Change Part-Time
	Full-Time	Part-Time	Full-Time	Part-Time		
Overall employment	2.46	2.74	2.75	2.13	-0.29	0.61
By daily milking frequency						
Less than 2 times	0.00	0.00	1.42	1.38	-1.42	-1.38
2–3 times	1.83	2.49	2.18	1.82	-0.35	0.67
More than 3 times	2.75	2.25	15.00	3.00	-12.25	-0.75
By farm size (number of milking cows)						
100 and fewer	2.86	3.00	0.59	1.46	2.27	1.54
101–499	3.00	2.80	3.01	2.90	-0.01	-0.1
500–999	1.45	2.11	10.17	3.85	-8.72	-1.74
1,000 and more	3.86	4.17	12.39	3.09	-8.53	1.08

Note: In dairy farming, workers performing seasonal work that is not needed year-round can be considered part-time workers.

although AMS adoption is associated with a lower need for low-skilled labor, consistent with other studies, we found major differences in labor needs across AMS brands. The results will inform farmers and stakeholders about the potential heterogeneous impacts in labor costs of AMS adoption.

Full-Time versus Part-Time Labor Needs

Table 1 shows significant differences in labor hiring needs (full-time vs. part-time) by AMS adoption. AMS adopters rely more on part-time workers while nonadopters tend to maintain a larger full-time labor complement. This overall trend may reflect the contrasting working time requirements under the two milking systems (i.e., AMS and conventional milking systems for nonadopters). Many automated operations require fewer workers after the AMS has been set up and is in process. Rather than actively taking part in the milking process (e.g., attaching suction cups, cleaning teats) workers in this scenario must periodically monitor and ensure sustained, efficient running of milking machines. In contrast, traditional, non-AMS farms need workers to manually conduct the milking operations; hence, they would have to work longer hours.

These observations support the trends noted in labor demand according to daily milking frequency. For most farms milking fewer than twice a day, there would be a much lower need for nonfamily hired workers, as the tasks could easily be assumed by family farm workers. In contrast, non-AMS farms would need labor support from nonfamily workers even with twice daily milking frequency. When the farm's daily milking frequency is greater than two times, more full-time nonfamily hired workers are needed on non-AMS farms. The full-time nonfamily labor gap is much larger when farms milk three or more times per day as non-AMS farms employ 15 full-time nonfamily workers, while AMS farms can operate with around three.

Herd Size

Results on the labor needs according to the number of milking cows reveal other notable distinctions between the two milk production systems. Among AMS adopters, about 3 to 4 full-time nonfamily workers are hired across all milking cow categories (except for the 500–999 range), while for nonadopters, the demand for full-time nonfamily labor increases proportionally from smaller to larger milking cow categories. The almost constant full-time labor result for AMS might suggest that regardless of the size of the milking cow herd, the same number of workers is needed to perform some maintenance functions—a function needed for all herd sizes. In contrast, traditional non-AMS farms will need more workers as the milking cow herd size increases. With more milking cows, more workers are needed to manually extract milk.

Wage Rate

We asked farmers how much the average hourly wage rate for their workers has increased in the last few years (the previous and subsequent questions explicitly asked about changes in the last year, so we interpret farmers' responses as considering changes recently, that is, over the past 2–3 years or so). Overall, AMS workers' hourly wages have increased more than the non-AMS workers' wages. However, when wage increases are analyzed in greater detail, there is no clear trend of higher wage increases associated with just one milking system. For instance, when wage increases are analyzed according to daily milking frequency, AMS workers get a higher wage increase when cows are milked 2–3 times a day. However, when milking frequency is 3 or more times a day, non-AMS workers receive higher wage increases.

The same pattern is observed when wage increases are analyzed according to the number of milking cows. AMS workers enjoy larger hourly wage increases in the 100 and fewer and 500–999 milking cows categories. On the

Table 2. Average Increase in Nonfamily Workers' Hourly Wage Rates in Recent Years ($)

Activity	AMS Adopters	Non-AMS Adopters
All nonfamily workers	2.42	2.16
By daily milking frequency		
Less than 2 times	0.00	2.11
2 to 3 times	2.38	2.14
More than 3 times	2.76	2.84
By farm size (number of milking cows)		
100 and fewer	3.26	1.49
101–499	2.64	2.87
500–999	4.05	3.83
1,000 and more	2.22	2.60

other hand, workers in traditional, non-AMS farms receive higher hourly wage increases in the 101–499 and 1,000 and more milking cows categories.

As shown in Table 3, wage increases vary not only among adopters and nonadopters of AMS technologies. This could reflect the fact that different AMS can mechanize production processes to different degrees (likely as a function of the cost of the specific AMS), some demanding fewer workers than others to conduct the whole milking process. As the adoption of AMS is a relatively recent and slow trend, there is probably a learning curve for farmers and their workers to adapt to the use of the devices.

Overall, survey responses highlight three important results: (1) AMS workers experience higher hourly wage increases overall compared to non-AMS workers, though trends vary by milking frequency; (2) labor needs across herd sizes differ between AMS and non-AMS farms. For AMS farms, the number of full-time workers remains relatively stable across all herd sizes, as maintenance functions tend to be consistent regardless of herd size. In contrast, non-AMS farms require more full-time workers as herd size increases; and (3) AMS adopters are more likely to employ part-time workers, while non-AMS farms rely more on full-time labor.

Concluding Remarks and Implications

Tight labor markets and restrictive immigration policies have had a significant impact on the dairy sector, which has been left out of the H-2A program given its lack of production seasonality (Gutierrez-Li, Escalante, and Acharya, 2024). Limited and diminishing worker availability has incentivized dairy farmers to mechanize. While the adoption of automatic milking systems has grown in some parts of the country, these technologies are still not commonplace. Although some labor savings have been achieved, the net benefits of automation are heterogeneous and a function of many factors, including herd size, AMS type and brand, and operation size.

Table 3. Average Number of Nonfamily Workers and Hourly Wage Increases in AMS-Adopting Farms in Recent Years

AMS Model	Average Number of Nonfamily Workers		Average Increase in Hourly Wage Rate ($)
	Full-Time	Part-Time	
Lely	2.87	2.69	2.29
DeLaval	2.09	2.73	2.49
Boumatic	8.00	8.00	3.55
Galaxy	1.50	2.00	4.55
GEA	1.00	2.67	1.18
AMS equipment's age (installation year)			
Newest version (2015–2016)	3.08	3.08	2.41
New equipment but older version (2018–2019)	3.18	2.28	2.39
Second-hand (2015–2016)	3.67	3.00	2.70
Number of robots			
1-3	1.39	1.07	2.08
4-6	2.06	3.38	2.81
7 or more	12.75	5.5	2.80

The findings from this study offer key implications for industry, policy, and technology provision. For dairy farmers, especially those with medium to large operations, our results underscore the importance of carefully assessing AMS investments relative to their specific capacity to maximize potential labor savings. Policy makers may consider addressing labor policy constraints, such as the H-2A program's exclusion of dairy, or the development of incentives for technology adoption to alleviate labor shortages. AMS technology providers could use this information to refine and market their systems, tailoring solutions to diverse farm scales and offering training to address the skills gap in AMS monitoring.

For More Information

Bhoj, S., A. Tarafdar, M. Singh, and G.K. Gaur. 2022. "Smart and Automatic Milking Systems: Benefits and Prospects." In S. Sehgal, B. Singh, and V. Sharma, eds. *Smart and Sustainable Food Technologies*. Springer Nature Singapore, pp. 87–121.

Gutierrez-Li, A., C. Escalante, and S. Acharya. 2024. "The Costs and Benefits of Mechanization: A Look at the Dairy Sector." *Southern Ag Today* 4(16.3).

Moyes, K.M., L. Ma, T.K. McCoy, and R.R. Peters. 2014. "A Survey Regarding the Interest and Concern Associated with Transitioning from Conventional to Automated (Robotic) Milking Systems for Managers of Small-to Medium-Sized Dairy Farms." *Professional Animal Scientist* 30(4):418–422.

Rotz, C.A., C. Coiner, and K. Soder. 2002. *Economic Impact of Automatic Milking Systems on Dairy Farms*. ASABE. https://doi.org/10.13031/2013.10459

———. 2003. "Automatic Milking Systems, Farm Size, and Milk Production." *Journal of Dairy Science* 86(12):4167–4177.

Steeneveld, W., L.W. Tauer, H. Hogeveen, and A.G.J.M. Oude Lansink. 2012. Comparing Technical Efficiency of Farms with an Automatic Milking System and a Conventional Milking System." *Journal of Dairy Science* 95(12):7391–7398.

Tse, C., H.W. Barkema, T.J. DeVries, J. Rushen, and E.A. Pajor. 2018. "Impact of Automatic Milking Systems on Dairy Cattle Producers' Reports of Milking Labour Management, Milk Production and Milk Quality." *Animal* 12(12):2649–2656.

About the Authors: Alejandro Gutiérrez-Li (alejandro-gli@ncsu.edu) is Assistant Professor with the Department of Agricultural and Resource Economics at North Carolina State University. Grace Melo (grace.meloguerrero@ag.tamu.edu) is an Assistant Professor with the Department of Agricultural Economics at Texas A&M University. Shaheer Burney (shaheer.burney@uwrf.edu) is Associate Professor with the Department of Agricultural Economics at the University of Wisconsin–River Falls. Cesar Escalante (cescalan@uga.edu) is a Professor with the Department of Agricultural and Applied Economics at the University of Georgia. Shree Ram Acharya (achar136@umn.edu) is a Graduate Student at the University of Minnesota.