Resource Leveraging in Agricultural Enterprises

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Abstract

Dairy Farming is an industry that's seen rapid change since the recent surge in implementing automatic milking systems (AMS). This has led to questions about efficiency, how has automatic milking systems affected the productivity and efficiency of dairy farms, and how animal health and welfare is impacted by these milking systems. This study analyzes recent dairy trends in Maryland as a whole and Frederick County, Maryland as well, showcasing important dairy metric areas across the industry over the years. Understanding these trends helps policymakers, farmers, and businesses make informed decisions about resource allocation, investment, and economic development initiatives. It gives a sense of how sustainable dairy farming is in the region, and what the current landscape is as a whole for the dairy industry. Understanding the benefits automatic milking systems have over the traditional milking parlors is also crucial. This is significant because it empowers farmers to adopt new technologies that enhance efficiency, reduce costs, improve animal welfare, and optimize overall farm management.

Introduction

The following project is thorough research and data analysis conducted on automatic milking systems (AMS) within Frederick County, Maryland, as well as dairy farming trends in the region as a whole. The impacts of AMS for the animals, farmers, and businesses is also a focal point. Our team spent three months exploring and researching the many different agricultural technologies that have been emerging within the different farming industries. We decided to focus our research on dairy farms as dairy products are some of the most essential food items produced in the United States. This brought our focus to AMS, and the ways it improves the lives of the farmers as well as the livestock in comparison to a traditional milking parlor, where everything is done by hand. AMS are fully robotic milking machines that cows are trained to go to whenever they need to be milked. When a cow is ready to be milked it walks into the station where the system then sanitizes and milks the cow using sensors to guide the suction cups to the udders. This agricultural technology has many upfront benefits like little to no maintenance, 24-hour milking, and no labor required to manually milk. In this research report, we explore the benefits and drawbacks of AMS, and their impacts on the future of dairy farming.

Dairy farms have been a staple in the United States as an opportunity for new jobs, boosting the economy, and providing a stable food source in many diets. Specifically in Maryland, dairy farms have existed as early as 1908 (Westwood 2020). Given the historical importance of the dairy industry in the United States, it's important to understand the state of that industry now, along with where certain dairy metrics (e.g. number of milk cows, average milk production per cow, etc.) are trending.

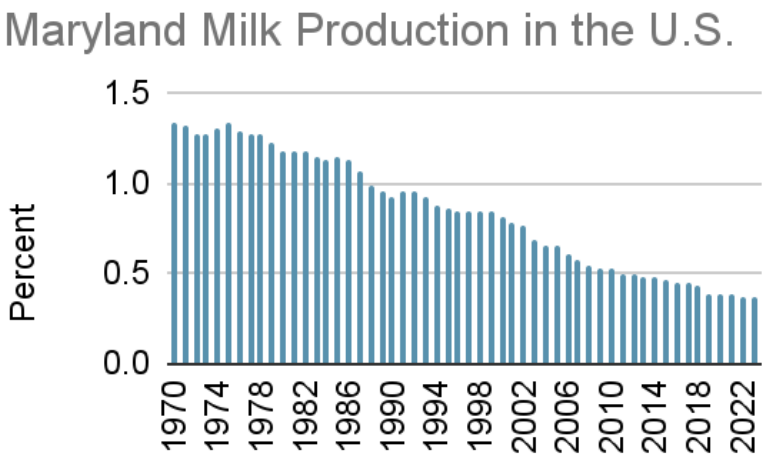
Additionally, with the rise of technological advancements, and the slow but steady integration of artificial intelligence (AI) and robotics into the agriculture industry, there are many ways that the daily lives of animals, and farmers can be improved. The adoption of these systems is being driven by generational changes and the multitude of advantages that they offer compared to traditional methods of milking and handling animals. Milking robots are now advanced tools that farms use to achieve improvements in milk quantity, production quality, and animal welfare. The important data they collect feeds into an evolved information system that allows farmers to make informed decisions and swiftly address critical issues before they escalate (Verde 2023).

In Maryland, automatic milking systems are a relatively new development locally and dairy farms are beginning to embrace a robotic future for the dairy industry. They are becoming more common as farmers seek solutions to problems caused by low milk prices and difficulties in finding labor. Farmers are starting to address the critical issue of labor shortages by bypassing humans altogether. Farms like Rocky Point Farm in Tuscarora, Maryland have seen a lot of success since integrating a robotic milking system. The fourth generation owners reported that the technology has helped reduce stress on themselves and cattle, detect infections, and ultimately affect happier, healthier cows (Mymdfarmers, 2022).

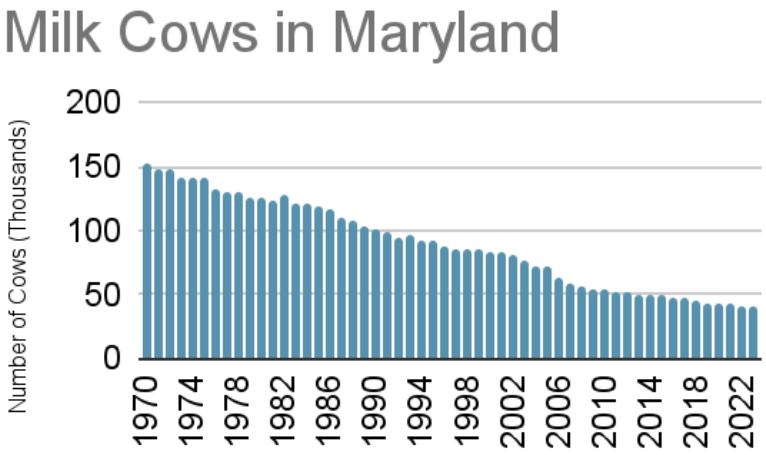
A plethora of our data was gathered from online sources, peer-reviewed journals, and an in-person visit to a dairy farm in Frederick, Maryland. We combed through online web pages and newsletters whose content is focused on dairy topics, herd management, and foraging. It was imperative that we narrowed down our sources to those related to dairy farm operations. Several articles published through Universities such as those found on the University of Maryland Extension's "Maryland Milk Moos" provided us with information regarding AMS functions,

instructions on operation, and relevant statistics such as labor costs, herd performance, and improvements in animal welfare.

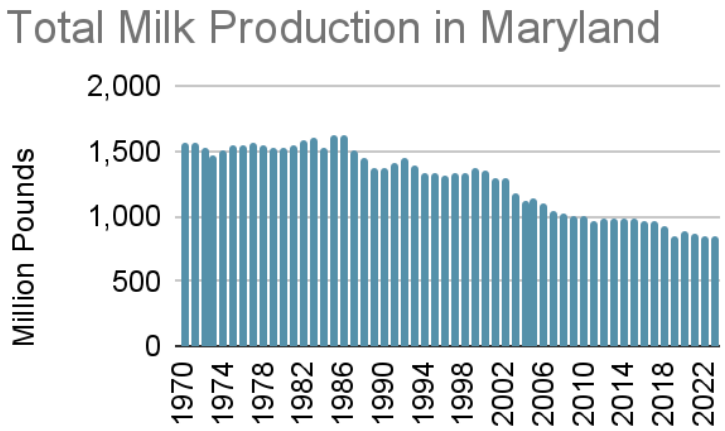
Analysis



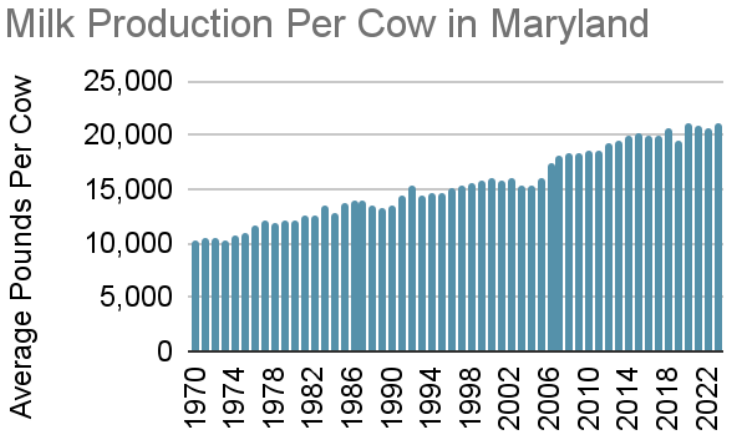
The figure shown above depicts the percentage of milk produced in the United States that Maryland accounts for. A steady decline is seen in the percentage of milk produced since the 1970s. This can be attributed to a number of factors including the fact that milk is not one of Maryland's highest produced crops, as well as the small number of dairy farms in Maryland.



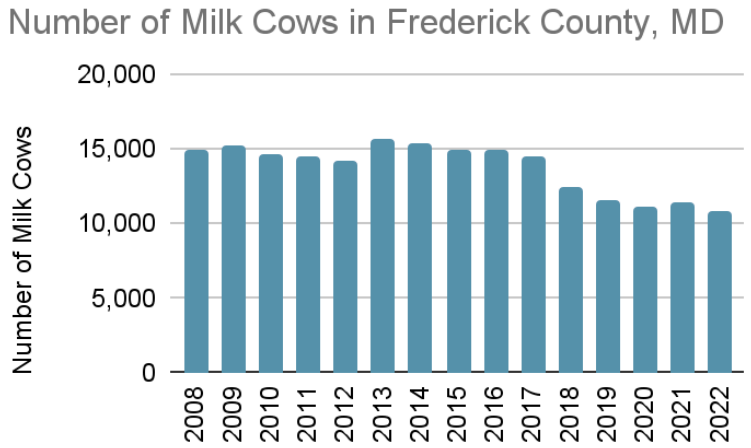
Shown above is a figure depicting the number of cows in thousands in the state of Maryland. Similar to the percentage of milk contributed to the United States total, a steady decline can be seen in the number of Maryland cows since the 1970s.



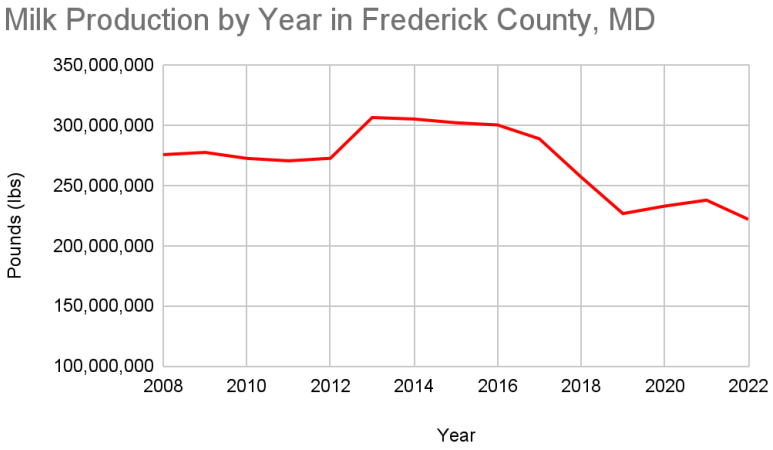
The above figure shows the total milk production in the state of Maryland. A steady decline from over 1.5 billion pounds of milk in 1970 to less than 1 billion pounds of milk in 2022.



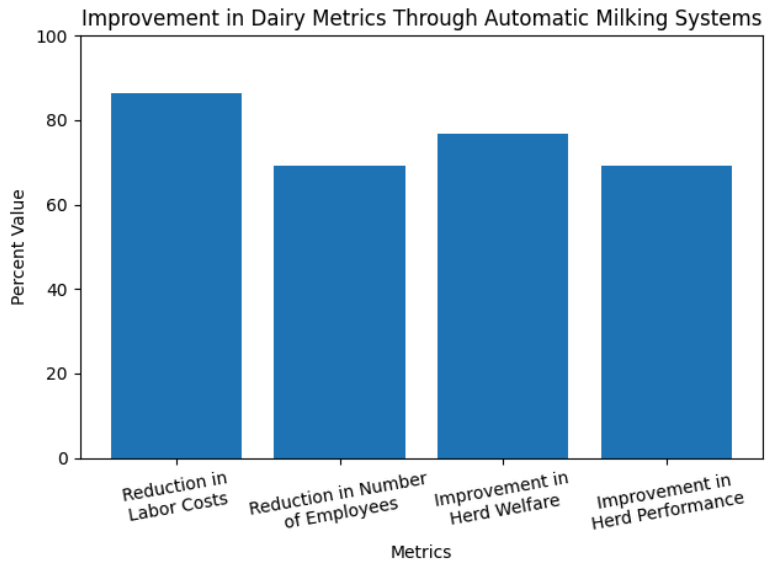
Shown above is the milk production per cow in Maryland. In contrast to the total quantity of milk produced in Maryland, a steady increase in the average annual milk production per cow has been observed since the 1970s.



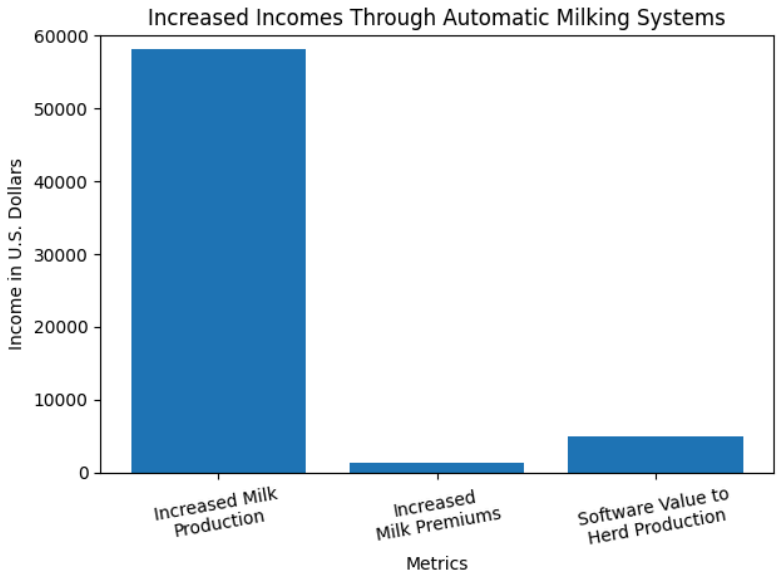
The figure above displays the total number of dairy cows in Frederick County, Maryland over time. Marked decreases in the number of cows can be seen around 2017.



Shown above is a visualization of milk production in Frederick County, Maryland over time. Milk production increased from around 275 million pounds in 2012 to over 300 million pounds in 2013. In recent years, milk production in Frederick County has dropped to around 225 million pounds.



The above figure displays percentage differences in different dairy metrics following the implementation of AMS technologies. Reduction in labor costs has been observed as the most significant difference in percentage with AMS dairy farming.



Shown above are values for increased incomes with AMS technologies, with increased milk production being the most significant.

Discussion

With the implementation of AMS technologies, significant effects on the level and manner of farm labor can be seen. In terms of how a dairy farm is operated, automation of processes through technologies like AMS allows for a style of farming that is more conducive to managing and monitoring sets of processes. In traditional dairy farming, multiple employees are tasked with handling individual processes, such as feeding, milking, cleaning, and breeding. With the implementation of automated technologies, however, entire functions of dairy farms can be overseen by a single employee. With AMS technologies, for example, only one person may be required to oversee the entire milking process at any given time. In turn, technologies such as AMS can allow dairy farmers to cut back on labor costs by decreasing the quantity of human labor that is required. It is estimated that the reduction in labor costs from heat detection, milking, and management can save dairy operations $38,982 annually (Schulte, K. & Tranel, L., 2013).

In addition to impacts on labor, the effects of implementing AMS can be seen in the cows themselves. The average quantity of milk that an individual cow produces can increase due to increased cow comfort as well as more precise, and thus, more optimal stimulation of a cow's udders during milking. It is believed that the increased comfort of the cows is related to the decrease in hands-on human labor in place of automated milking. The income increases for milk production and milk premiums following the implementation of AMS is estimated to be $59,529 annually (Schulte, K. & Tranel, L., 2013).

As of right now, with the current state of AMS, if the farm plans on only maintaining a small amount of cows, then it is not worth it as a farmer to invest in the utmost advanced technology. Due to it being so new, the prices are extremely high, limiting the amount of people

who can buy them and also receive a timely return on investment. If the farmer already owns a large dairy or is planning on expanding, then considering an AMS is recommended, as they are more prepared to spend the large sum of money and are able to profit much quicker than a small farm. This would be especially beneficial if the farmer is expanding, as they can configure their new farm designs around the technology. With continued investing, innovating, and adopting of AMS, more affordable options will be introduced for widespread use.

Dairy farms (with the exception of commercial farms) operate completely differently on a case to case basis. Because of this, data on the farms is on such an individual level that we cannot share, and depending on the farm, even view. The data itself is personally identifiable information and can be used to identify specific farms and to maintain the privacy of the farms, we are unable to use a lot of the data. On the other hand, while commercial dairy farms operate the same way from location to location, their data is kept especially private for business and economic reasons. Farms with automatic milking systems or other robotics also have their information contained in the brand's own database. In this case, the companies own the data, which is secured in their own private formatting that makes it difficult for outside researchers to analyze. If the data was used, it would also be a legal liability as neither the researchers nor farmers own the data.

Recommendations

For businesses and organizations that work in the agriculture field, especially the dairy industry, then we recommend these technologies to be invested in. With investments, this allows for more opportunities within the industry for more affordable AMS, as well as intuitive innovation for diversity within AMS. This can include smaller, more affordable AMS for small farms, helpful for the many family-run farms with older farmhands in Frederick County,

Maryland. The industry is still very new, so new ventures are not likely to be immediately shut down as there are opportunities for new products to be placed on the market.

If growers plan on expanding their farms or already manage a large farm, then upgrading to an AMS would be beneficial to their business. What type of AMS farmers should use depends entirely on their specific farm size, layout, and land. However, there are still many options that are available for those farms that cannot afford or should not purchase AMS based on size. There are technologies that are semi-automatic like portable milking machines that still require some hands-on use, but make the job much easier for the farmers and cows.

Future Research

Following this report, more research should be conducted in order to more deeply analyze the metrics and effects of AMS implementation. From an economic perspective, more quantitative data should be collected on the capabilities of AMS technologies and their impacts on dairy farming operations. To expand on this specific project, follow-up research might be conducted on a variety of dairy operations or could compare the effects of multiple instances of implementing AMS technologies. In branching out from the focus of dairy farming in Frederick County, Maryland, data might also be collected on a different scale such as city, state, national levels to gather information that is more appropriate or representative of AMS overall. Subsequent analyses may provide more valuable insights into the optimal scenario for AMS and the mechanisms of cost reduction or increase as a result of implementing the technologies.

Investigating how such automatic technologies make differences on a farm could also lead to more personalized recommendations for farmers considering investments in AMS. Predictive modeling, for instance, could take into account an array of variables that impact or are impacted by the implementation of AMS and estimate the financial costs and benefits associated

with AMS for a specific farm. Such an approach would enable farmers to make more secure and prudent decisions regarding technological investments. Modeling the economics of AMS might also allow for more predictable outcomes when choosing to invest in the technology. On the other hand, a more proactive approach involving predictive modeling might consist of designing a farm tailored for AMS technologies. This would allow dairy operations to be optimized for automatic milking, rather than adapting an existing dairy to new technologies.

Further research might also take approaches other than those prioritizing finances. Environmental implications of AMS technologies, for example, might be investigated through analyzing energy usage and pollution from dairy operations before, during, and after the implementation of the technology. Effects on local economies and workforces may also be a worthwhile subject of research considering the replacement of human labor with robotic labor and what this means for the surrounding communities.

Regardless of the lens that AMS or other robotic farming technologies are examined through, further research must be done in order to provide insight on the future of dairy farming and other agricultural industries.

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