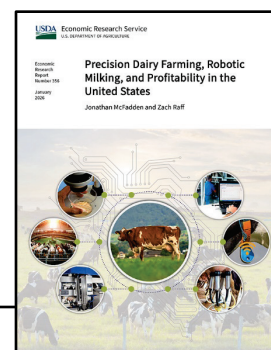


A report summary from the Economic Research Service

Precision Dairy Farming, Robotic Milking, and Profitability in the United States

Jonathan McFadden and Zach Raff



Key Points

- USDA's Agricultural Resource Management Surveys show that U.S. adoption of precision dairy technologies related to milking, breeding, and data systems increased steadily between 2000 and 2021.
- Precision dairy technologies and robotic milking adoption rates vary substantially by technology, geography, and herd size.
 - We examine in-depth the following 10 precision dairy technologies and practices: holding pen with an udder washer, milking units with automatic takeoffs, computerized milking systems, artificial insemination (AI), embryo transfer (ET), sexed semen, individual cow production records, nutritionist designed diets, computerized feed delivery systems, and “box” robots, which are automated milking systems that have a box-like appearance.
 - In 2021, at least 90 percent of U.S. milk production came from farms using individual cow production records, nutritionist-designed feed, or reproduction-related technologies (e.g., sexed semen).
 - The Fruitful Rim region contains the highest adoption rates of precision dairy technologies, although dairies across all regions of the United States use these technologies. Adopters of complex combinations of precision dairy technologies are, on average, larger than non-adopters. But the largest percentage of adopters of “box” robots are in the 50–149 head range. Partially automated technologies (like computerized feed delivery) were used in producing roughly half of U.S. milk in 2021. By contrast, only 6 percent of U.S. milk came from cows milked via “box” robots.
- The use of precision dairy technologies and robotic milking also varies significantly by farm operator and operation characteristics.
 - Relative to nonadopters, adopters are younger and more educated—with dairies that are larger, more connected via high-speed internet, and having newer barn infrastructure.
 - Adopters have lower expenditures on paid labor (e.g., hired workers on larger dairies), unpaid labor (e.g., family members on smaller dairies), and veterinary care and medicine. Similarly, adopters are more likely to milk their cows 3 or more times per day, have higher milk output per cow, and lower operator hours.
 - These differences between adopters and nonadopters are more pronounced on farms using “box” robots for milking.

Key Points (cont.)

- Precision dairy technologies and robotic milking increase dairy net returns, which are a measure of profitability that subtract the dairy enterprise's operating costs and overhead expenses from milk and cattle sales and other dairy-related income.
 - Operations using two or more classes of precision technologies (non-robotic milking, reproduction-related, or data systems) have 13 percent higher dairy net returns than nonadopting operations, on average.
 - First-of-its-kind estimates suggest that use of “box” robots for milking increases dairy net returns by 13 percent, relative to nonadopters.

Why Does This Matter?

Dairy farm numbers in the United States are decreasing but dairy farm size has been steadily increasing. As dairy farm size increases, dairy farmers streamline their management operations and increase their capital use to meet increasing consumer demand for dairy commodities. The far-reaching technological progress underlying these structural changes has implications for dairy productivity, which is linked to precision dairy farming—technologies that collect and analyze on-farm data to help operators tailor their practices to individual cows and automate routine

tasks. Past academic and government research has discussed the costs and benefits of precision dairy technologies, but little work has been done to quantify their impact on U.S. farmers' net returns. This report provides an overview of conventional and precision dairy technologies, their adoption rates, and the characteristics of adopting operators and farms—and then estimates how these technologies affect dairy profitability. The analysis provides the first set of profitability estimates surrounding robotics use in U.S. dairy production using a nationally representative, multi-year sample of commodity producers across the country.

A Few More Details

The study uses data from the Agricultural Resource Management Survey (ARMS), administered by the USDA, Economic Research Service (ERS) and the USDA, National Agricultural Statistics Service (NASS). We analyze detailed data from 5 waves of ARMS—2000, 2005, 2010, 2016, and 2021—for dairy producers to determine precision technology adoption trends and their relationships to operation and operator attributes. The analysis combines these data with ERS's Commodity Cost and Returns dairy data, which provide information on dairy revenues, costs, and net returns for milk. We use the combined data to estimate an economic model of dairy net returns that controls for bias resulting from correlations between farmers' precision dairy farming decisions and unobservable factors that also influence profitability. The study also draws from the dairy science and agricultural engineering literatures to overview and describe the precision technologies of interest.