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# Sources, Trends, and Drivers of U.S. Dairy Productivity and Efficiency

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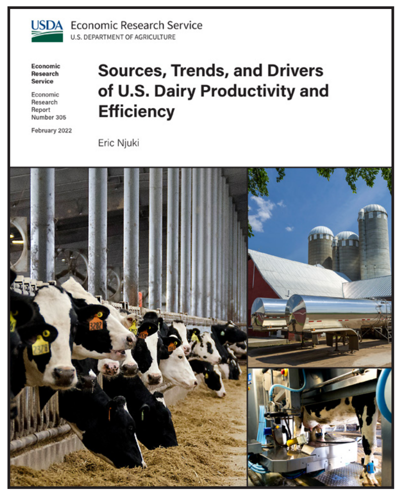
## What Is the Issue?




Global demand for milk and dairy products continues to rise, fueled by rapid population growth, rising household incomes, and favorable consumption patterns. Meanwhile, the United States plays a key role in world dairy markets having generated 11.6 percent of global milk output and 14 percent of global dairy exports in 2019 (United Nations Food and Agriculture Organization, 2020). Milk production for the domestic market continues to increase steadily. However, the net returns of production have consistently declined over the years because of production's rising costs, resulting in depressed profit margins for farmers. Furthermore, the national trend has been towards consolidation of dairy operations into larger and fewer farms. The majority of milk production in the United States is now concentrated in relatively few States located in the West, Southwest, Upper Midwest, and the Northeast regions (MacDonald et al., 2007; MacDonald et al., 2016; MacDonald et al., 2018; MacDonald et al., 2020). Despite continued growth in milk production, long-term climate trends and weather volatility may threaten this growth trajectory (Key and Sneering, 2014; Key et al., 2014).

This study builds upon previous USDA, Economic Research Service reports that focused on structural change and consolidation in the dairy sector by analyzing productivity growth, its sources, and current trends. In doing so, new insights are generated on critical questions, such as whether there are productivity gains in the dairy sector; how widespread these productivity gains/losses are across the sector; sources of productivity gains/losses; how environmental effects, that is temperature and precipitation, affect dairy productivity; the role of technological progress in productivity; and how organic dairy farming performs within the sector. In sum, this study seeks to understand the state of dairy production in the United States.

This study applied a model of productivity on dairy farms to generate measures of total factor productivity (TFP) to provide estimates of proximate drivers and components of TFP growth, including scale efficiency, technical efficiency, technological progress, and environmental components. In addition, the report compared and analyzed a single-factor productivity measure—milk output per cow (also referred to as milk yields).[1]

## What Did the Study Find?

- From 2000 to 2020, milk output per cow increased at an annual rate of 1.53 percent nationally, with significant variations across States.
- From 2000 to 2016, total factor productivity (TFP) growth increased at an annual rate of 2.51 percent, albeit with variations across States and across herd-size class.
  - Technological progress was the primary driver behind TFP growth—growth associated with the discovery of new systems, processes, and methods of turning inputs into outputs. Examples include improved genetics, selective breeding, enhanced feed formulations, and advanced digital record keeping.
  - The pace of TFP growth was slowed by substantial declines in the rate of growth of scale-and-mix efficiency—a measure of the benefits obtained by changing the scale of operations and technical efficiency—which is a measure of how successful operators are at attaining their full potential.
  - Environmental effects caused by weather variability and anomalies had a negative impact on the overall welfare of cows or cow comfort.
  - The average total factor productivity growth between 2000-2016 for organic dairy operations was 0.66 percent compared with conventional dairy operations, which grew at an annual rate of 2.51 percent.

## How Was the Study Conducted?

The study relied on data from several sources: farm-level data from the USDA Agricultural Resource Management Survey (ARMS); the Parameter-Elevation Regressions on Independent Slopes Model (PRISM) Climate Group weather data for the years 2000, 2005, 2010, and 2016; State-level data based on USDA, National Agricultural Statistics Service (NASS) milk production reports from 2000 to 2020; the Census of Agriculture from 2002 to 2017; and data from the Dairy Herd Improvement Association (DHIA) from 1996 to 2019. The ARMS records on production practices as well as costs and returns were used to track milk output while controlling for inputs such as milk cows, labor, feed, intermediate materials (i.e., expenses on veterinary, electricity and fuel, fertilizer and pesticides), and capital.

The ARMS data were augmented with weather information from the PRISM Climate group to capture the production environment's characteristics. Subsequently, a total factor productivity (TFP) index covering the years 2000–2016 was measured and decomposed into various components, including scale-and-mix efficiency, technical efficiency, technological progress, and environmental effects to identify sources and drivers of productivity growth. Data from USDA, NASS milk production reports and the Census of Agriculture were used to construct measures of milk output per cow, providing additional information on structural and productivity patterns at the State levels from 2000 to 2020. Finally, data from the Dairy Herd Improvement Information Association (DHIA) provided additional information on milk output per cow by various herd-size classes and cow breeds from 1996 to 2019. The combination of these data sources provided a holistic picture on several aspects of productivity growth, including total factor productivity, and milk output per cow.

[1]Other measures of single-factor productivity include milk per hectare, milk per unit of labor, and milk per feed unit.