



BEEF Industry Snapshot

Fifty years of progress in cattle production

Full life cycle of cattle production overlooked

By Al Rotz

The past 50 years have seen many changes leading to improved productivity and efficiency of beef cattle production in the U.S. These include many aspects of feed production as well as the management and genetics of cattle. Major changes have also occurred in the efficiency of producing resources used in cattle production such as fuel, electricity and fertilizer. Machinery size and efficiency have increased along with improvements in fuel efficiency, and the sizes of farms, ranches and feedlot operations have increased.

These improvements and related changes in cattle production have led to improvements in the environmental sustainability of beef production. While many have focused

on the environmental impacts of beef, few have looked at the progress being made over the full life cycle of cattle production. Our goal was to quantify the wide range of improvements made in U.S. beef cattle production from 1972 to 2022.

Our approach

Modeling tools supported by historical records were used to assess changes over time. Changes studied included cattle performance, feed consumption, fossil energy use, gas emissions, water use, land use and nutrient losses to the environment. A life cycle approach was used which not only included the direct impacts of the farms, ranches and feed lots but also those occurring in the production of resources used on these operations. Comparisons included both totals over all cattle produced and intensities expressed per unit of carcass weight produced.



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Historical annual data were gathered on crop and animal productivity from the National Agricultural Statistics Service and other sources. These included industry data on finishing cattle in-weights, out-weights, days on feed, average daily gain, feed intake, gain to feed ratio, dressing percentage and final carcass weight. These historical records were supplemented through producer interviews with historical perspectives.

Typical life cycles of cattle were defined for 1972 and 2022 from reported animal numbers, weights and times in the phases of cow calf, backgrounding and finishing operations. Finished cattle along with cull animals and their dressing percentages verified the total carcass weight produced each year. Cull animals and finished cattle from the dairy industry were included. Few dairy steers were finished in 1972.

This number has increased over the years, particularly with the increased interest in the use of beef breed crosses with dairy cows.

A beef cattle production model was used to simulate production systems across the U.S. for both periods. The model represented the differences in cattle performance and predicted the resulting environmental implications.

Feed production and animal performance

Yields of the major feed crops used for cattle production increased over the past 50 years. This was especially true for corn and other grain crops with moderate increases in forage crops. Corn grain yields increased by over 100%, while corn silage yields increased by 78%. The portion of corn land irrigated increased, likely due to increased production in the drier regions of the west. Wheat yields also increased by over 50%. Alfalfa hay

yields showed a trend toward a small increase, with a major decrease in production area and a substantial increase in the use of irrigation. This reflected a shift from dry land production in the east to irrigated production in the west. Grass hay production showed a 28% increase in harvested yield and a 28% increase in irrigation use.

With greater crop yields, the land area needed to produce feed decreased. Land area used for grazing pasture and rangeland decreased by 23% with little change in the portion irrigated.

The number of beef cows maintained as breeding stock decreased by 27% over the 50-year period. The annual number of dairy cows harvested was highly variable but trended down. The portion of the dairy herd harvested each year increased by 38%, reflecting an increase in dairy cow

replacement rate. The dress weight of all cows harvested increased by 37% over the 50 years.

Cattle finish weight grew steadily over the years with the weight in 2022 about 44% greater than that in the early 1970s. More cattle entered the finishing operation at a lower weight and younger age in 2022. As a result, the days-on-feed increased by 55% while time on pasture or rangeland decreased. Average daily gain during the finishing phase increased about 20%, while feed dry matter intake increased by about 30%. Overall, the gain-to-feed ratio did not change.

The number of cattle harvested each year showed a downward trend while the overall dressing percentage indicated a small increase. With fewer cattle being harvested and greater harvest weight, the annual carcass weight produced increased by 23%. A

major portion of this increase was culled animals from dairy farms, particularly calves raised and harvested for beef.

Environmental implications

Changes in feed production, animal performance and overall management have led to many improvements in environmental sustainability. With the decrease in animal numbers offset by the increase in animal size, little change was found in total feed consumption.

However, this included 10% less forage consumption along with 37% more grain and byproduct feeds fed. Increases in crop yields, particularly corn yields, led to less land use. Other predicted improvements included reductions in blue water use, fossil energy use and greenhouse gas emissions. There was little change in total nitrogen losses related to beef cattle production with an increase in

ammonia emissions offset by decreases in denitrification, leaching and runoff losses of nitrogen.

Some specific environmental implications of the changes in beef cattle production include:

- 14% fewer but larger cattle harvested in 2022 produced 23% more beef carcass weight
- Increases in crop yields, particularly corn yields, led to 11% reductions in cropland and total land use
- Water use from ground and surface sources decreased by 25% through more efficient irrigation along with greater crop yields and reduced land use
- Fossil energy use decreased by 23% through larger and more efficient machinery, increased crop yields and other efficiency improvements
- Greenhouse gas emissions decreased 11% including a 6%

decrease in methane emissions and 5% decrease in nitrous oxide emissions

- Nitrogen losses from cattle production showed little change due to a 38% increase in ammonia emissions offset by decreases in runoff, leaching and denitrification
- Phosphorus runoff decreased 56%

Considering the substantial increase in carcass weight produced over the period, greater changes were found when expressed per unit of beef produced. Therefore, the industry showed much greater improvements considering the impacts per unit of food provided. Some specific improvements expressed per unit of carcass weight produced were:

- Feed consumption decreased by 22%
- Cropland use decreased 32% and total land use decreased 29%
- Water use from ground and surface

sources decreased by 42%

- Fossil energy use decreased by 41% including 38% less fuel and 58% less electricity use
- Greenhouse gas emissions decreased by 31% including 27% decreases in methane and nitrous oxide emissions
- Total nitrogen loss in cattle production decreased 21% including a 6% increase in ammonia emissions and 56% decreases in runoff and leaching losses
- Phosphorus runoff decreased 65%

When it comes to sustainability, beef has received much criticism from the media. The industry can take pride in the improvements made and that this improvement continues.

Rotz is an agricultural engineer at The Pennsylvania State University.