Union of Concerned Scientists

EXECUTIVE SUMMARY

RAISING THE STEAKS

Global Warming and Pasture-Raised Beef Production in the United States

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Emissions of two important heat-trapping gases from agriculture account for about 6 percent of total global warming emissions in the United States, according to the U.S. Environmental Protection Agency. Beef production contributes about a third of those emissions, or roughly 2.2 percent of the total. Livestock contribute a greater share of global warming emissions in parts of the world with lower industrial emissions—about 18 percent, according to one estimate, including contributions from deforestation driven by livestock production.

Agriculture emits all three major greenhouse gases—methane, nitrous oxide, and carbon dioxide—but the latter is a small part of the total in the United States and is not considered in this report.

Beef cattle and stored cattle manure are responsible for 18 percent of U.S. methane emissions—which have 23 times the warming effect of carbon dioxide emissions. Methane from beef cattle accounts for about 1.4 percent of combined U.S. heat-trapping emissions.

The Union of Concerned Scientists estimates that beef cattle produce roughly another 0.8 percent of U.S. global warming emissions in the form of nitrous oxide—which has about 296 times the warming effect of carbon dioxide. Nitrous oxide is produced in growing grains used to feed beef cattle in CAFOs (confined animal feeding operations), from pasture, and from stored manure.

All beef cattle spend the first months of their lives—and sometimes more than a year—on pasture or rangeland, where they graze on forage crops such as grass and alfalfa. While some continue to live and feed on pasture until slaughter, most U.S. beef cattle are fattened, or "finished," for several months in CAFOs, where they eat grain rather than forage.

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This report evaluates the prospects for changing management practices to reduce the climate impact of the time beef cattle spend on pasture or rangeland. Improved practices are most readily applied to the finishing stage of fully pasture-raised systems—a growing alternative to CAFOs, given research showing that pasture finishing has nutritional and environmental benefits. But such practices could also apply to the range portion of a CAFO system.

This report shows that use of practices that reduce methane and nitrous oxide emissions from beef production would have a measurable although relatively small impact on the U.S. contribution to climate change.

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However, pasture plants can remove carbon dioxide from the atmosphere and store—or sequester—it in soil, further reducing the climate impact of beef production. And in the long term, the use of climate-friendly best practices in the United States may lead to substantial cuts in global warming emissions if adopted in countries where beef production accounts for a greater share of those emissions.

> **Practices that reduce heat-trapping emissions and boost carbon sequestration also typically curb other important environmental harms from pasture beef production.**

Practices that reduce heat-trapping emissions and boost carbon sequestration also typically curb other important environmental harms from pasture beef production. For example, excess nitrogen—the source of nitrous oxide emissions—from pastures, CAFOs, and crops used to feed beef cattle in CAFOs pollutes air and water, acidifies soils, reduces biodiversity, and shrinks Earth's protective stratospheric ozone layer. The environmental benefits of practices that reduce the climate impact of pasture beef are another important reason to adopt them.

Key Findings

Major findings of this report include:

The use of pasture management practices that improve the nutritional quality of forage crops could reduce methane emissions from pasture beef by about 15 to 30 percent. However, some grazing lands would not benefit from these practices, so overall reductions in U.S. global warming emissions would be considerably less than 0.5 percent—or one-third of the 1.4 percent of emissions that now come from beef production by applying these practices where appropriate.

The use of better management practices on pastures that have not been well managed, or the conversion of crop acres to pasture, could allow pastures to sequester about 0.8 to 1.0 metric ton of carbon per hectare. Better management practices on pasture could offset 0.1 to 2 percent of annual U.S. heat-trapping emissions, depending on which practices land managers adopt. Converting croplands to pasturelands could increase that amount, but new practices may involve tradeoffs in heat-trapping gases that need to be considered.

In many areas, soil could continue to add carbon for several decades—until the rate at which soil loses carbon equals the rate at which it accumulates. Land managers must sustain the practices they use to enhance carbon sequestration, or soil could release the stored carbon back into the atmosphere.

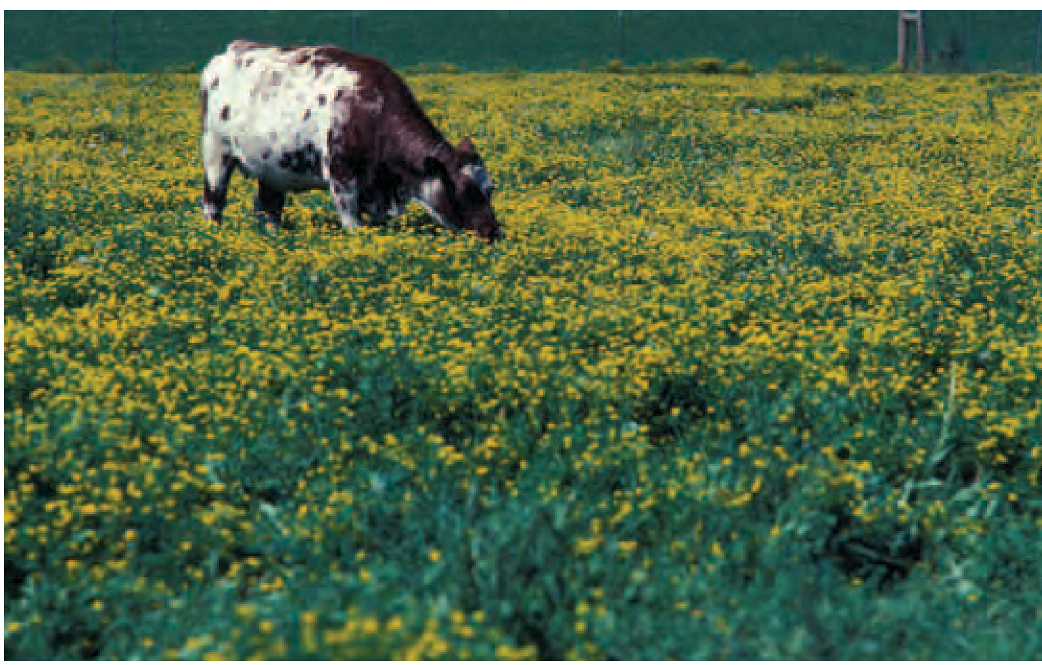
Best management practices used to grow crops, such as no-till methods for corn used in beef CAFOs, sequester about only half as much carbon as well-managed pasture. And only about 20 to 25 percent of U.S. corn acres now rely on no-till farming—a practice often linked to greater carbon sequestration.

Best management practices available now that can reduce the climate change impact of pasture beef include:

- Increasing the percentage of legumes in forage mixtures, which improves their nutritional quality and thus reduces methane emissions from cattle digestion.
- Avoiding excessive use of nitrogen fertilizer to curb nitrous oxide emissions.
- Using moderate stocking densities (the number of cattle per acre) to avoid excessive manure buildup and thus methane and nitrous oxide emissions, and to allow pastures to recover from grazing.
- Avoiding the use of low-quality, mature pasture crops to graze cattle.
- Preventing overgrazing to increase carbon sequestration in pasture soils.

Other innovative practices that may have climate benefits include:

- Breeding better pasture species to improve the nutritional quality of pasture forage. Higher-quality forage could reduce methane and nitrous oxide emissions by accelerating cattle growth and allowing cattle to use the nitrogen and carbohydrates in forage more efficiently.



USDA-ARS

Birdsfoot trefoil, pictured here flowering in a pasture, produces chemicals called condensed tannins that improve feed efficiency when grazed by cattle, reducing methane emissions. A legume, birdsfoot trefoil also adds nitrogen to the soil, making it available to other plants in a pasture and thus improving their productivity.

- Planting birdsfoot trefoil in pastures. This legume produces beneficial condensed tannins—compounds that may reduce methane and possibly nitrous oxide emissions.
- Moving water and shelter sources to ensure that manure from grazing cattle is spread more evenly on pastures, reducing methane and nitrous oxide emissions.
- Using nitrification inhibitors—chemicals that prevent the microbial processes that change ammonia to nitrous oxide—to reduce nitrous oxide emissions from urine patches.

Further research is needed to better quantify the cuts in global warming emissions from all these practices. Several other practices that optimize grazing and pasture growth—including managed rotational grazing, which entails moving grazing cattle among fenced pasture areas frequently—seem promising but also require more research. And the possible synergies of integrating several promising practices would particularly benefit from further analysis.

Most U.S. beef cattle today spend several months in CAFOs (confined animal feeding operations), which can fatten cattle more quickly than pasture but are characterized by crowded conditions and the production of unmanageable amounts of waste.

Smart Pasture Operations versus CAFOs

Studies have come to different conclusions about the climate impacts of pasture beef finishing and CAFO systems. Analysts often do not have enough information to accurately compare these types of beef production. Variations in pasture management practices and local conditions can alter the outcomes of such comparisons—as can the assumptions analysts make. For example, the climate impact of pasture finishing versus CAFOs varies depending on how quickly pasture soils accumulate carbon.

The rate at which cattle gain weight has a large impact on the global warming emissions of beef on a per-pound basis, with implications for comparisons of production systems. The high-starch feeds used in CAFOs enable cattle in those systems to gain weight more rapidly and efficiently than cattle that feed on pasture forage, and with fewer calories lost to methane emissions. Across nine studies, for example, the average weight gain of cattle eating forage was 76 percent that of cattle eating a grain-based diet. Slower weight gain also means that cattle produce methane and nitrous oxide emissions for a longer period of time.

However, the dietary efficiency of forage can vary greatly. One study showed cattle grazing on poor-quality forage gained weight just 27 percent as quickly as cattle eating grain-based feed used in CAFOs, while other studies showed similar weight gain rates for high-quality forage and grain-based feed.

In one recent study, cattle in Iowa eating forage gained 0.6 kilogram (kg) per day, while the average from nine studies of cattle forage was 1.03 kg per day—72 percent greater efficiency. Given the higher forage efficiency values in some studies, it appears that adopting available practices that improve forage quality could minimize the climate emissions advantage of grain.

Well-managed perennial pastures generally sequester more carbon than row crops such as corn, offsetting the feed efficiency of CAFOs. Growing the grain fed to cattle in CAFOs also produces global warming emissions, which should be taken into account when comparing pasture finishing and CAFOs.

Land productivity also affects the climate impact of beef production, and thus any comparison between the two systems. Fertile soil allows higher productivity of pasture forage and grain—and thus beef—per unit of land than poor soil. Higher pasture productivity also increases the potential amount of biomass—forage and manure—that soil can store as carbon.

Most U.S. feed grain crops are grown on higher-quality land than that used for most pasture beef production. Analyses that overlook differences in land quality may underestimate the potential for reducing the climate impact of pastures compared to CAFOs.

Recommendations

The federal farm bill and other policy mechanisms offer substantial opportunities to reduce the climate change impact of pasture beef production. The following recommendations would improve our understanding of the potential for best practices to curb the heat-trapping emissions and boost the carbon sequestration of pasture beef, and spur the use of those practices:

1. The U.S. Department of Agriculture (USDA) should expand its research on global warming emissions from

pasture beef production, and further develop management practices to curb those emissions. Critical needs include:

- Breeding and development of other practices to promote more nutritious pasture crops.
- Investigating the most effective combinations of climate-friendly practices.
- Improving the ability of high-quality legumes to become established and to persist in mixed pastures.
- Improving the efficiency with which pasture crops use nitrogen.
- Boosting forage yields and extending the period of high-quality pasture growth.
- Collecting information on practices now used to manage the quality of pastures and the amount of carbon in various soils.
- Optimizing intensive rotational grazing systems and investigating their impact on methane and nitrous oxide emissions and long-term carbon sequestration.
- Pursuing whole-farm studies of suites of climate-friendly practices to identify synergies, optimize carbon budgets, and evaluate any tradeoffs.
- Developing demonstration projects and educational materials to alert cow-calf operators and pasture beef producers to the advantages of better pasture management.

2. The USDA's Natural Resources Conservation Service should expand its efforts to encourage best management practices that reduce methane and nitrous oxide emissions and boost carbon sequestration. This work should include:

- Using the Conservation Stewardship Program to provide incentive payments for:
  - Practices that may reduce methane and nitrous oxide emissions, including increasing the share of legumes and improved forage crops in forage mixtures, using moderate cattle stocking densities, using appropriate amounts of synthetic fertilizer, avoiding grazing cattle on low-quality mature pasture—such as by substituting high-quality stored forages—and encouraging more even distribution of manure on pastures.
  - Practices that increase carbon sequestration, such as supplying the precise amount of nutrients that crops need from legume species, manure, or synthetic fertilizer, and preventing overgrazing.
- Providing technical assistance to beef producers to help and encourage them to implement such practices.
- Providing transitional support through the Environmental Quality Incentives Program to beef producers that switch from confinement to pasture-based finishing systems that use best management practices.

3. State- and federally funded university extension services should advise and train beef producers on climate-friendly practices, including use of the highest-quality forage, and strategies to prevent overgrazing.

N. Wade Snyder, USDA-ARS

Here, a scientist with the U.S. Department of Agriculture's Appalachian Farming Systems Research Center records the species composition of a pasture. Such records are used by scientists and land managers to develop pasture management strategies that help farmers achieve production goals while meeting the nutritional needs of grazing livestock.

The full text of this report is available on the UCS website at *www.ucsusa.org/raisingthesteaks.*

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

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