

Carbon Footprint Tips for Arkansas Producers

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Greenhouse gases (GHG) are a group of gases that trap the sun's energy inside the Earth's atmosphere, causing a heating effect known as global warming. These gases include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), in addition to a variety of hydrocarbons (Figure 1). These gases occur in nature due to the biological processes (plant respiration and microbial respiration during decomposing of plant and animal matter) and geological processes (volcanic eruptions).

Throughout history, these gases were kept in balance because they were re-absorbed by plants and forests during photosynthesis and dissolved into the oceans. Because of increased human activity that relies heavily on burning fossil fuels and removing forests, the concentration of GHG in the atmosphere has been steadily rising. Burning 1 gallon of gasoline, for example, produces 19.6 pounds (8.89 kilograms) of CO₂ that are released to the atmosphere. [Note that 1 pound = 0.454 kilogram.] Greenhouse gases stay in the atmosphere for years, depending on the gas type, which increases their concentration in the atmosphere over time, resulting in climate change that threatens our communities across the planet.

Carbon footprint is a tool developed to evaluate the quantity of GHG released to the atmosphere as a result of specific human activities, such as manufacturing a product or growing a crop. This tool helps manufacturers, producers and consumers

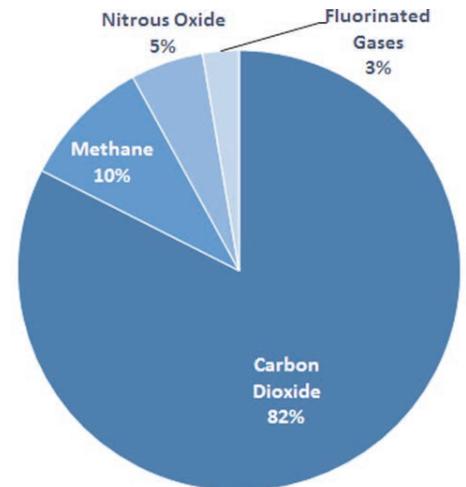


Figure 1. Greenhouse gases in the atmosphere.

quantify the impacts of their activities on the atmosphere. Carbon footprint also helps these groups make choices that reduce these impacts. For instance, awareness about the negative consequences of wasting used material has encouraged municipalities and citizens to adopt recycling. The recycling of metals, paper and glass reduces resultant GHG production and emissions because recycled materials can displace the need for and use of raw materials.

In this fact sheet, we discuss the usefulness of carbon footprint and highlight some tips that Arkansas producers can use to reduce their carbon footprint.

Simplified Carbon Cycle

Carbon is the building block of all living organisms. Carbon cycles in the environment go through all three phases: solid, liquid and gas. In the

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atmosphere, carbon is most often bound with oxygen in a gas form as CO₂. Carbon dioxide is the most abundant GHG in the atmosphere. Plants use CO₂ and sunlight to grow and build new cells through photosynthesis. Carbon makes up 50 percent of plant dry matter by weight. As plants die, they are consumed for food by other living organisms (soil bacteria, animals and humans), releasing that carbon back to the atmosphere as CO₂. Plants and animals that are buried deep in the ground are transformed, over thousands of years, into fossil fuels. When we extract and burn fossil fuels, most of the carbon that has been accumulated over thousands of years is quickly released to the atmosphere as CO₂.

Greenhouse Gases and Climate Change

Without CO₂ and other GHGs, plants would starve and Earth would be inhospitably cold. On the other hand, excessive burning of fossil fuels for energy and deforestation lead to increased CO₂ in the atmosphere. Unfortunately, we have burned enough fossil fuel that there is about 19.4 percent more CO₂ in the atmosphere today than there was in the early 1980s even. Similarly, CH₄ and N₂O concentrations in the atmosphere increased by 17.4 percent and 10 percent, respectively, during the same period. As a result, more out-going radiation is trapped inside the Earth's atmosphere by absorption from GHGs and the Earth is becoming warmer. Reducing GHG emissions is key to slowing or reversing climate change impacts. Greenhouse gas impacts on climate change depend on three main factors:

- Their concentration in the atmosphere.
- The longevity of these gases in the atmosphere.
- The strength of these gases to absorb out-going radiation and affect global temperatures.

Although the most abundant GHG, CO₂ has the smallest global warming potential on a mass basis. Therefore, CO₂ is used to standardize the relative strength of all GHG gases as CO₂ equivalents (CO₂e). For example, 1 pound of CH₄ is equivalent to 25 pounds of CO₂, while 1 pound of N₂O is equivalent to 298 pounds of CO₂. Therefore, if the production of a widget releases a total of 100 pounds of CO₂, 10 pounds of CH₄ and 1 pound of N₂O, the carbon footprint of this widget can be calculated as follows:

$$\begin{aligned} \text{Total carbon footprint} = & \\ & (100 \text{ lb CO}_2 \times 1 \text{ lb CO}_2\text{e/lb CO}_2) + \\ & (10 \text{ lb CH}_4 \times 25 \text{ lb CO}_2\text{e/lb CH}_4) + \\ & (1 \text{ lb N}_2\text{O} \times 298 \text{ lb CO}_2\text{e/lb N}_2\text{O}) = \\ & 648 \text{ lb CO}_2\text{e} \text{ (293.9 kg CO}_2\text{e)} \end{aligned}$$

Potential Impacts of Climate Change on Agriculture

There are numerous potential impacts of global warming and climate change on agriculture:

- Extreme temperatures and/or precipitation could damage crops or reduce yields.
- Drought could become a challenge in areas where summer temperatures are projected to increase and precipitation is projected to decrease. As water supplies are reduced, it may be more difficult to meet water demands for irrigation.
- Weeds, pests and fungi thrive under warmer temperatures, wetter climates and increased CO₂ levels. The geographic range of weeds and pests would likely expand, adding new challenges to crops previously unexposed to these species.
- The yields for some crops, like wheat and soybeans, could increase up to 30 percent under a doubling of the atmospheric CO₂ concentration while yields for other crops, like corn, may only increase by up to 10 percent. Researchers highlight that other factors, such as water scarcity and extreme temperatures, might counteract potential yield increases.

Who Contributes to the Carbon Footprint?

Carbon footprint is generated from many sources. Every time we use energy that comes from fossil fuels, we release CO₂ and increase our carbon footprint. According to the Environmental Protection Agency, the electricity we use in our homes generates the largest share of our carbon footprint (31 percent) (Figure 2). Most power plants rely on coal or natural gas to produce electricity, while some rely on solar, wind and hydropower. Power plants that burn fossil fuel to generate electricity produce the most CO₂.

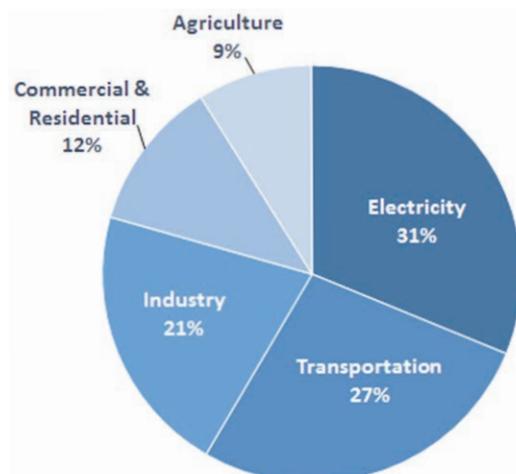


Figure 2. Contributions of different economic sectors to carbon emissions

Table 1. Carbon footprint (lb CO₂e) of 1 pound of different food choices

Cabbage	Potatoes	Flour	Milk	Beans	Rice	Chicken	Pork	Cheese	Beef
0.13	0.26	0.66	0.79	0.88	2.64	3.74	5.54	9.81	16.24

Generating 1 kilowatt-hour (kWh) of electricity generates 1.52 pounds CO₂e.

Transportation and industry produce 27 percent and 21 percent, respectively, of our carbon footprint. When we use our cars, they add to the carbon footprint because cars use gasoline to run, and they produce CO₂ as a byproduct. Buses, trains and planes also produce CO₂. For instance, driving a 21 mile-per-gallon car for 1 mile could generate about 0.92 pound of CO₂e. Trash also contributes to the carbon footprint. The government estimates that every 1 pound of trash produces 1 pound of GHGs as decomposing trash produces CO₂ and CH₄ over time.

Industrial activities contribute about 12 percent to the carbon footprint. Producing 1 pound of cement contributes, on average, about 1.76 pounds of CO₂e. Agricultural activities also contribute about 9 percent to the carbon footprint. According to Table 1, producing 1 pound of beef, cheese and pork contributes 16.24, 9.81 and 5.54 pounds CO₂e, respectively. Agricultural practices, such as over-application of fertilizers and open burning of crop residues, contribute to the carbon footprint of crop production.

Various countries in the world contribute different amounts of GHG to the atmosphere. Table 2 shows the top six countries that contribute GHGs from fossil fuel combustion and some industrial processes.

Table 2. Top producers of GHG and their populations

Country	Share (%)	2015 Population (millions)
China	28%	1,367
USA	16%	321
EU-28	10%	514
India	6%	1,252
Russia	6%	142
Japan	4%	127

General Tips to Reduce Your Carbon Footprint

The tips that can be used to reduce your carbon footprint are also useful as economic tips for saving money and maintaining a healthy lifestyle.

- Choose foods with a lower carbon footprint.
- Avoid wasting food.
- Carpool when you can.

- Drive fuel-efficient vehicles.
- Drive only when necessary.
- Walk and bike whenever you can.
- Make sure your home is well insulated.
- Conserve electricity as you can.
- Power off and disconnect your appliances when not in use.
- Use energy-efficient appliances.
- Lower the thermostat temperature in your house during the winter and raise it in the summer.
- Reduce the amount of trash you create by recycling and reusing.
- Print double-sided when possible.

Tips to Reduce Your Farm's Carbon Footprint

- Reduce tillage or follow a no-tillage system to reduce fuel consumption and soil carbon emissions.
- Use recommended fertilizer rates and incorporate fertilizer soon after application to reduce gaseous losses.
- Avoid over-fertilizing low-yielding fields and consider planting different crops in these fields.
- Consider using the optimum amount of animal waste as fertilizer.
- Follow recommendations for herbicide and pesticide use.
- Consider adding biochar as a soil amendment.

What Is the Role of Biochar in Mitigating Carbon Footprint?

- Biochar, a charcoal-like substance, is the byproduct of heating any organic material, i.e., rice husks or rice straw, at relatively low temperatures and with limited oxygen. This process is known as carbonization and is used for producing biochar.
- The biochar yield is about 50 percent of the original biomass weight. Biochar is approximately 50 percent carbon. In other words, 0.25 pound of carbon (or 0.92 pound of CO₂e) could be prevented from release to the atmosphere by carbonizing 1 pound of crop residues.
- Biochar soil application could potentially provide an ecological service by sequestering carbon in the soil, thus creating a carbon sink.
- Producers can layer biochar into their fields where it becomes part of the soil matrix and helps retain water and essential agricultural nutrients like nitrogen, phosphorous and potassium.

Selected Resources

Food carbon emissions calculator, <http://www.foodemissions.com/foodemissions/Calculator.aspx>.

The Berkeley Institute of the Environment (BIE) CoolClimate Carbon Footprint Calculator, <http://coolclimate.berkeley.edu>.

The Nature Conservancy Carbon Footprint Calculator, <http://www.nature.org/greenliving/carboncalculator/index.htm>.

Venkat, K. (2011). The Climate Change and Economic Impacts of Food Waste in the United States. *Int. J. Food System Dynamics* 2 (4), 2011, 431-446.

EPA 430-R-14-003, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*. April 15, 2014. U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460. <https://www3.epa.gov/climatechange/Downloads//ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf>.

Schimmelpfennig, D., J. Lewandrowski, J. Reilly, M. Tsigas, I. Parry, R. Mendelsohn, and T. Mount (1996). *Agricultural Adaptation to Climate Change*. Economic Research Service, USDA, Agricultural Economic Report. URL www.ers.usda.gov/media/490977/aer740a_1.pdf, (740).

Butler, J. H., and S. A. Montzka. (2015) *The NOAA Annual Greenhouse Gas Index (AGGI)*. Published online Spring 2015, retrieved October 5, 2015, from www.esrl.noaa.gov/gmd/aggi/aggi.html.

The World Factbook, Central Intelligence Agency website, <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2119rank.html>.

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