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Carbon Credits from Livestock Production

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Interest in climate change has prompted a market for carbon credits. Learn how livestock operations produce greenhouse gases and ways to reduce emissions and benefit from carbon credits.

Climate change has become a hot topic and has prompted a market for carbon credits. How does this impact livestock producers? This publication briefly explains greenhouse gases and the relevance to livestock production, defines "carbon credit," and highlights ways livestock producers can benefit from the growing market for carbon credits.

Greenhouse Gases

Greenhouse gases have become newsworthy and carbon credits exist because of concerns about global warming. Several scientific studies have provided evidence that increasing concentrations of greenhouse gases have increased the earth's average air temperature, resulting in the phenomenon termed *global warming*. Resulting projections suggest that the rising temperatures may produce changes in weather trends, sea levels, and land-use patterns. Collectively, these changes are examples of *climate change*.

The phrase *greenhouse gas* comes from the way certain gases in the atmosphere — primarily carbon dioxide, methane, and nitrous oxide — mimic a greenhouse by trapping heat. Just like a greenhouse, these gases allow sunlight and solar energy to enter the atmosphere freely, and as the earth's surface gives off heat, greenhouse gases trap the heat within the atmosphere.

Carbon dioxide (CO_2) is used as the reference greenhouse gas. All other greenhouse gases are compared using *carbon dioxide equivalents* (CO_2e). For example, methane has a heat trapping potential 21 times greater than that of carbon dioxide, so 1 metric ton of methane is equal to 21 metric tons of carbon dioxide (21 CO_2e) when released into the atmosphere. The greenhouse gas effect of nitrous oxide is 298 times greater than that of carbon dioxide. So, even though methane and nitrous oxide gases are not as common in the atmosphere as carbon dioxide, they still have a large effect.

The phrases *carbon footprint* and *carbon credit* come from the use of carbon dioxide as the reference greenhouse gas and from the growing emphasis on reducing dependence on fossil fuels, which are carbon-based materials. The phrase *carbon sequestration* applies to those processes that remove CO_2 from the atmosphere and provide a net reduction in greenhouse gases on a long-term basis.

Role of Agriculture

According to the National Energy Information Center, greenhouse gases have increased by about 25 percent since large-scale industrialization began around 150 years ago. Greenhouse gases are formed by both natural and man-made processes. Burning fossil fuels (e.g., automobiles, home heating, utility plants) is the major man-made source of greenhouse gases (CO_2).

Agriculture as a whole is thought to contribute less than 10 percent to the projected total of greenhouse gases. The largest share of agricultural greenhouse gases are contributed by processes usually categorized as soil management. When soil organic matter (called *sequestered carbon*) is converted to carbon dioxide following tillage, erosion, and other soil disruptions, the CO_2 is released into the air.

Livestock production mainly produces and releases greenhouse gases the following ways:

- Cattle and sheep produce methane during digestion of feed.
- Stored manure generates methane.
- Nitrous oxide may be released from manure that is applied to pastures and cropland.
- Respiration produces carbon dioxide.
- Carbon dioxide is released during operation of engines and other power supplies.

Potential Impacts on Agriculture

There is some concern that public policies regulating greenhouse gas emissions may impose new restrictions on animal agriculture or some sort of "cow tax" on livestock operations. Currently, agriculture is not the main target of activists and policy makers, but producer organizations would be wise to stay abreast of legislative efforts on this matter.

While it has become fairly clear that agriculture, including livestock production, contributes greenhouse gases to the atmosphere, it is very likely a minor contributor.

Still, for producers interested in taking a proactive stance, there are manageable opportunities within agriculture to reduce greenhouse gas emissions.

The greatest opportunity lies in land conservation practices, such as reduced-tillage farming. Within animal agriculture, capturing methane during manure storage is certainly feasible. Until recently, the main incentives for capturing methane were to use it as fuel (biofuel) or to help control odor (although methane is odorless it can be managed along with odorous

Table I. Relative effect of manure management practices on methane and nitrous oxide emissions. USDA, 2006.

Livestock Category	*Description of Management Practice*	*Relative Methane Emissions*	*Relative Nitrous Oxide Emissions*
Pasture/range/paddock	Waste from pasture- and range-grazing animals is deposited directly onto the soil.	Low	High
Daily spread	Waste is collected and spread on fields. There is little or no storage of the waste before it is applied to soils.	Low	High
Solid storage	Waste (with or without litter) is collected by some means and placed under long-term bulk storage.	Low	High
Dry lot	Waste is deposited directly onto unpaved feedlots where the manure is allowed to dry and is periodically removed (after removal it is sometimes spread onto fields).	Low	High
Liquid/slurry	Waste is collected and transported in a liquid state to tanks for storage. The liquid/slurry mixture may be stored for a long time and water may be added to facilitate handling.	Moderate to high	Low
Anaerobic lagoon	Waste is collected using a flush system and transported to lagoons for storage. Waste resides in lagoons for 30 - 200 days.	Variable	Low
Pit storage	Waste is stored in pits below livestock confinements.	Moderate to high	Low
Poultry house with bedding	Waste is excreted on poultry house floor covered with bedding; poultry can walk on the floor.	Low	High
Poultry house without bedding	Waste is excreted on poultry house floor, which is not covered with bedding; poultry cannot walk on the floor.	Low	Low

Table II. Baseline annual GHG emissions (metric tons CO_2e per head per year). CCX, 2008.

Manure management system	*Dairy cow*	*Dairy heifer*	*Feedlot steers*	*Feedlot heifers*	*Swine <60 lbs*	*Swine 60 - 119 lb*	*Swine 120 - 179 lb*	*Market swine >180 lb*	*Breeding swine*
Liquid slurry/pit storage	1.72	0.76	0.75	0.72	0.09	0.15	0.24	0.32	0.34
Anaerobic lagoon	4.60	2.02	2.01	1.94	0.25	0.39	0.65	0.87	0.91

gases). More often than not, costs associated with capturing and managing the methane exceeded potential revenues. This is where carbon credits come into the picture.

Carbon Credits

Although there's considerable debate about the extent of global warming, evidence supporting its existence and associated pressures to respond are mounting. International policies have been initiated in several countries to reduce the amount of greenhouse gases being released. Currently in the U.S., no such policy is in place at the federal level, although California is adopting greenhouse gas legislation. Anticipating that such a policy may be more widely enacted in the future and building upon past successes using market-driven environmental programs to encourage change, a market was developed for buying and selling carbon credits.

The idea behind carbon credits is that many businesses may prefer to financially compensate other enterprises for reducing greenhouse gas emissions rather than make the changes necessary to reduce their own emissions. With a market in place, a buyer can purchase carbon credits from a business (seller) that has verifiably reduced its emissions to offset (on paper) some or all of the greenhouse gases released by the buyer's operation. For example, an electric power plant could reduce greenhouse gas emissions by implementing clean-burning technology, or it could offset a portion of the plant's emissions by purchasing carbon credits, potentially from a livestock producer who uses a methane digester.

The net reduction of greenhouse gases represented by carbon credits, also referred to as offsets, is transferable on the open market. In North America, this market is the Chicago Climate Exchange (CCX), a "voluntary, legally binding integrated trading system to reduce emissions of all six major greenhouse gases." This market is largely speculative in the U.S. because there are currently no federal requirements in place that cap or place a limit on greenhouse gas emissions. Research is also ongoing to improve the calculations used to determine the credit given for different practices.

Opportunities for Livestock Producers

On livestock operations, the two main sources of greenhouse gases are the animals themselves and the manure the animals generate.

Opportunities to control gas emissions directly from animals are very limited. When livestock and poultry breathe, they produce carbon dioxide as a normal product of respiration, as do humans. Carbon dioxide is an unavoidable product of this essential life process. Methane is also a normal byproduct of digestion and is more prevalently released by ruminants through *enteric fermentation*. Enteric fermentation is the largest source of methane from livestock production; however, relatively few changes can be made to reduce these emissions. Methane inhibiting antibiotics, higher quality feed, and lower animal intake generally lead to reduced emissions.

Manure is the other major source of emissions. The most prevalent greenhouse gas emissions from manure — carbon dioxide, methane, and nitrous oxide — are caused by the biological breakdown of organic matter in the manure. Handling manure as a solid material or in an aerobic system (where it is exposed to the air) results in relatively low methane emissions but potentially high nitrous oxide emissions *(Table I)*. Meanwhile, handling manure as a liquid or in an anaerobic system (where it has little air exposure) results in relatively high methane emissions and low nitrous oxide emissions. The average greenhouse gas emissions from various liquid manure

Table III. Effect of rangeland management practices on carbon sequestration. USDA, 2006.

Practice	*Description*	*Average sequestration factor (metric tons CO_2/ac/yr)*
Improved rangeland management	Grazing management, Riparian management, Prescribed burning	0.12
Improved pastureland management — fertilizer application	Applying nutrients consistent with plant uptake requirements	0.36
Improved pastureland management — improved forage species	Planting species adapted to soils, climate and grazing needs	0.30
Improved grazing management on pasture	Rotational grazing, improved forage systems	1.2

management systems used in Nebraska are shown in *Table II*. Information for other states can be found on the CCX Web site (*chicagoclimatex.com*).

Manure Storage and Treatment Systems

One way for livestock operations to receive carbon credits is to use a cover to collect the gases that are generated during storage of manure and treat or burn the gas.

The gas coming off of a covered manure storage or lagoon in colder climates is seasonal, so often it is directed to a flare and burned. Treating or burning the collected gas produces CO_2, so some greenhouse gas is still released to the atmosphere. The carbon credit accounts for the reduction in greenhouse effect achieved by emitting carbon dioxide instead of methane. Systems that emit nitrous oxide (e.g., some biofilters) may actually increase greenhouse gas emissions (*Figure 1A-1B*).

Figure 1. A) Covered anaerobic lagoon. B) Biogas flare

A big advantage of anaerobic digesters is that the controlled digestion process produces gases of high enough quality (especially methane content) to result in biogas suited for productive uses. If electricity or usable heat is generated from combustion of the collected gases, two additional opportunities for reducing greenhouse gas emissions can result.

First, by burning methane that is generated on the farm, less fossil-fuel-based energy must be purchased and combusted, which can result in nearly a one for one reduction (offset) of greenhouse gas emissions. Second, using excess biogas or farm-generated electricity for off-farm enterprises that consume fossil fuels also reduces greenhouse gas emissions. Exporting green energy to off-farm users may significantly improve the economic viability of a digester. The amount of additional carbon credits derived depends on the type and quantity of energy produced.

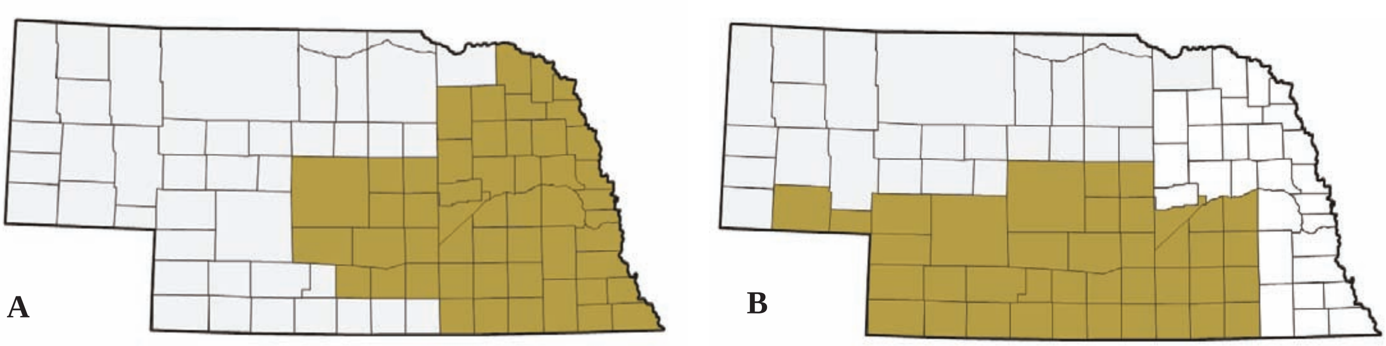
For manure storage covers and digesters to be eligible for carbon credits, projects must have been started on or after Jan. 1, 1999, and be used with conventional management practices for manure in liquid form: outdoor liquid/slurry storage, storage below animal confinements (for periods exceeding one month), and anaerobic lagoons. Programs are available to help with funding and implementation of these projects, such as grants through the USDA EQIP or the Lagoon Cover Program through the Environmental Credit Corporation. See the Web sites listed below for more complete information:

- EPA's AgStar funding list: *www.epa.gov/agstar/resources/funding.html*
- Environmental Credit Corp.: *www.envcc.com*

Rangeland

Another method for sequestering carbon is through improved rangeland management and restoration activities (e.g., cell grazing, rotational grazing, intensive grazing practices). By increasing plant productivity, soil organic matter will increase for several years following the adoption of conservation practices. Some average values that can be expected are listed in *Table III*. These values will vary depending on soil and climatic conditions. Currently, producers will receive credit for rangeland management

Sustainable Rangeland Management Soil Offset Map | **Conservation Tillage Soil Offset Map**



Carbon Sequestration Rate (metric tons/acre/year)
Non-degraded managed rangeland/restoration of degraded rangeland

Central Great Plains LRR H 0.20/0.52 — Western Great Plains LRR G 0.27/0.42

Carbon Sequestration Rate (metric tons/acre/year)

Zone A, 0.6 — Zone G/H, 0.6 if irrigated

Figure 2. Carbon credit rates for a) rangeland management and b) conservation tillage . CCX, 2008

improvements according to *Figure 2A* for management plans developed after 1999. New grassland plantings, such as on converted cropland or waterways, will also sequester carbon, and a producer can receive credit for 1 metric ton/ac/yr throughout the Midwest.

Feed Production

There are additional opportunities for livestock operations that grow their own feed to receive carbon credits through conservation tillage. Conservation tillage practices that minimize soil disturbance may increase soil organic matter levels. Research is ongoing to refine the calculation of this credit. *Figure 2B* shows the going credit rates available through CCX. Aggregator fees are not included.

How to Get Carbon Credits for Your Operation.

The carbon credit market has relatively few buyers and many sellers, as with many agricultural markets. Since each acre of land can sequester only a relatively small amount of carbon in any given year, it is impractical to attempt marketing individual acres or even hundreds of acres for credit trading. Similarly, it may not be feasible to directly trade carbon credits associated with covering a lagoon or building a digester. For that reason, aggregators play a critical role in organizing and delivering larger quantities of sequestered carbon for marketing as carbon credits.

Aggregators are organizations (nonprofit or for-profit) that work with producers to determine:

- the qualifying amount of carbon credits,
- the practices necessary to achieve that potential,
- how to verify that carbon sequestration or offsetting is occurring, and
- how to aggregate carbon credits and market them to buyers.

Among many others, the Iowa Farm Bureau, North Dakota/National Farmers Union, SunOne Solutions, and Environmental Credit Corporation are aggregators for the CCX. Each charge a fee for aggregating the carbon credits.

As part of the agreement to sell carbon credits, greenhouse gas reduction must be verified periodically by an approved verifier who reviews records, gas flow measurements, operational procedures, etc. Producers are required to maintain documentation and their operations may be inspected to ensure compliance. For methane capture projects, verifier costs usually run from $3,000 to $5,000 for the initial verification, and annual carbon audits cost $700 - $1,000. For agricultural soil credits, verification costs usually run at about 8 percent of total carbon credits.

The price received for carbon credits will vary depending on the market and the trading fees agreed upon with your aggregator. Check current market prices at *www.chicagoclimate.com*.

Example Carbon Credit Estimates

Assume a carbon credit price of $4/metric ton/year and that the aggregator receives 10 percent.

1) A Nebraska Model wean-to-finish swine farm has a one-time barn capacity of 2,400-head and a 1.2 million cubic-foot anaerobic lagoon that will be covered and the gas flared. From *Table II*, we have the baseline values (CO_2e per head per year) for market swine in metric tons (Mg) per year. To get a yearly value, average the time the hogs are at the different weights for the year.

Baseline calculation:

<60 lbs	0.25 yr	x	0.25 Mg CO_2 e /head /year	x 2,400 head	= 150 Mg
60- 119 lb	0.25	x	0.39	" "	= 234
120- 179 lb	0.25	x	0.65	" "	= 390
>180 lb	0.25	x	0.87	" "	= 522
Total					~ 1,300 Mg/yr

Carbon credits:

About 85 percent of those emissions are from methane. By capturing that methane and flaring it (converting it to CO_2), a producer could expect to receive credit for:

(1,300 Mg/yr) x (0.85) – [(1,300 Mg/yr) x (0.85) / (21 CO_2 e for methane)] = 1,050 Mg/yr

(1,050 Mg/yr CO_2 e) x ($4/ Mg CO_2 e/yr) x (0.9) **~ $3,800/yr**

The value above carbon credit income would have to be compared to the annualized capital and operating cost of the initial investment.

Synthetic plastic membrane cover costs for anaerobic treatment lagoons are highly variable and range from $4 to $8/ft for full coverage covers. For this example, assume a total of 171,616 square feet would be needed to fully cover the lagoon, for a cost of: $4/ft x 171,616 sq ft = $686,464.

Simple payback without accounting for interest is 180 years. However, the payback time would be less if a cost share program was utilized or the carbon credit rates increase substantially.

2) A Sandhills cow-calf operation with 10,000 acres, 2,000 of which are degraded, could receive:

Nondegraded:	(8,000 ac) x (0.27 Mg/ac/yr) x ($4/Mg/yr) x 0.90 = $7,776/yr
Degraded:	(2,000 ac) x (0.40 Mg/ac/yr) x ($4/Mg/yr) x 0.90 = $2,880/yr
Total:	**~$10,700/yr**

This publication has been peer reviewed.

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