



The AgSTAR Program: Practices to Reduce Methane Emissions from Livestock Manure Management

Speaker Introductions

- Vanessa McKinney, US EPA

- Vanessa McKinney is the Program Manager for EPA's AgSTAR Program, where she works with U.S. livestock, biogas and government stakeholders to advance the deployment of digesters and biogas systems. She has over a decade of experience in energy efficiency, renewable energy and air emissions regulation and policy. Vanessa completed B.A. degrees in Economics and Environmental Science from Hood College, and a M.A in Global Environmental Policy from American University's School of International Service.



- Greg Zwicke, USDA-NRCS

- Greg Zwicke is an Air Quality Engineer on the NRCS National Air Quality and Atmospheric Change Team, where he co-leads the agency's efforts in providing air quality and climate change assistance. Greg received BS and MS degrees in Agricultural Engineering from Texas A&M University with a focus on environmental engineering and air quality and is currently pursuing a PhD in Atmospheric Sciences at Colorado State University.



How AgSTAR Works



PARTNERSHIP PROGRAM

Collaborative program sponsored by EPA
and USDA.

- 1 Promote Anaerobic Digestion**
Advancing economically and environmentally sound livestock manure management.

- 2 Strong Ties**
Working with industry, government, NGOs and university stakeholders.

- 3 Helping Hand**
Assisting those who enable, purchase, or implement farm anaerobic digestion projects.

Resources for the Agriculture Sector

www.epa.gov/agstar



Success Stories

- Project profiles
- Interviews with operators

Market Trends

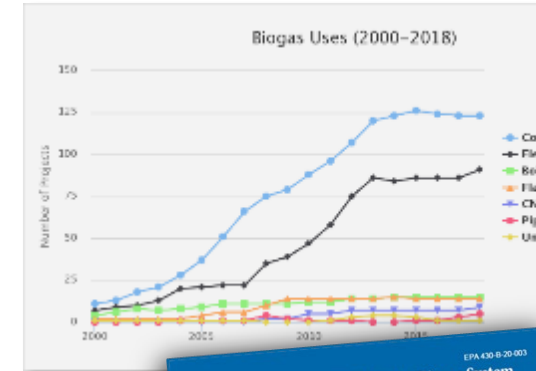
- Anaerobic digestion project database
- Market Opportunities Report

Technical Information

- Biogas Toolkit
- Updated 3rd Edition Project Development Handbook
- Operators Guidebook
- Anaerobic Digestion Risk Analysis Checklist

Collaboration

- Webinars
- Industry events & trainings



Purpose of Webinar

- Provide an overview of the [Practices to Reduce Methane Emissions from Livestock Manure Management](#) resource.
- Discuss the manure management practices that reduce livestock manure methane emissions.
- Discuss how NRCS and extension can use the resource to encourage adoption of manure management practices that reduce methane.

Practices to Reduce Methane Emissions from Manure Management

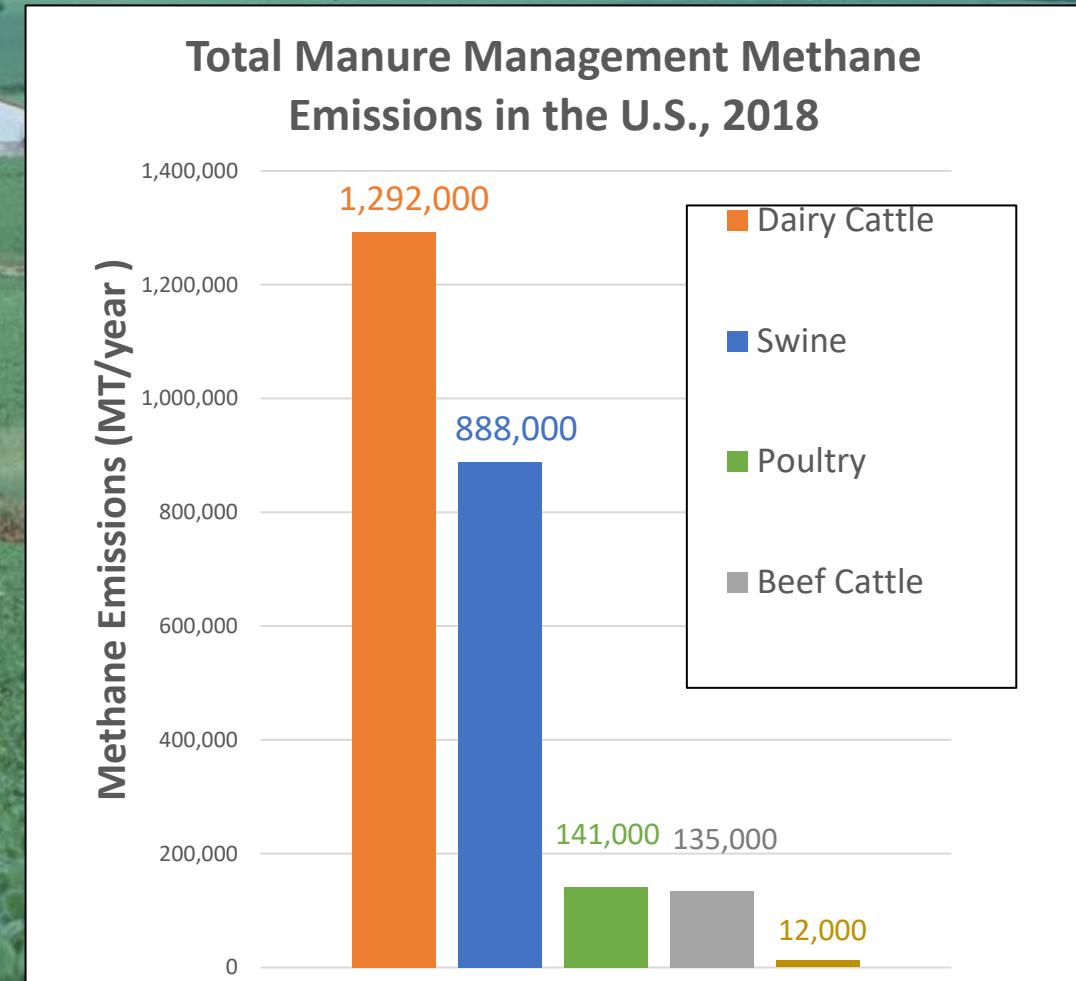
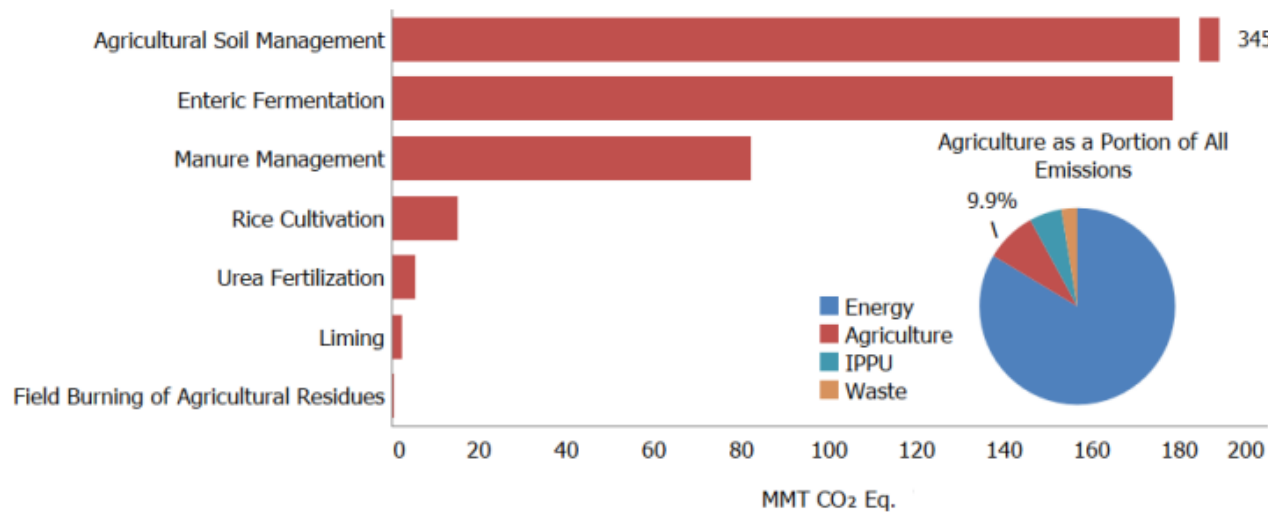
- Intended for farmers as a source of information to evaluate market-ready manure management practices that can reduce methane emissions.
- Developed jointly by EPA's AgSTAR Program and USDA's Natural Resources Conservation Service.
- [Published on EPA's AgSTAR website](#) and shared with AgSTAR/USDA joint webinars for federal and state agriculture extension officials, strategic partners, and the public.



Why reducing methane emissions from livestock is important



Figure 5-1: 2020 Agriculture Sector Greenhouse Gas Emission Sources



Relative Methane Reductions of Manure Management Practices

Manure Management Practice	Relative Methane Reductions*
Anaerobic Digestion	
Daily Spread	
Pasture-Based Management	
Composting	
Solid Storage	
Manure Drying Practices	
Semi-Permeable Covers, Natural or Induced Crusts	
Decreased Manure Storage Time	
Compost Bedded Pack Barns	
Solid Separation of Manure Solids Prior to Entry into a Wet/Anaerobic Environment	

How methane reductions were estimated

- Methane emissions and reductions calculated based on the methodologies provided in:
 - Inventory of U.S. Greenhouse Gas Emissions and Sinks
 - 2006 IPCC Guidelines for National Greenhouse Gas Inventories
 - 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- Methane reductions are estimated based on converting from an uncovered anaerobic lagoon in a dry temperate climate.
- Anaerobic digestion methane reductions assume energy production and include indirect reductions resulting from the avoided use of fossil fuels.

Key Considerations for Evaluating Manure Management Practices

Key Considerations for Evaluating Manure Management Practices

- **Cost.** Consider costs related to basic and specialized equipment, labor, installation, operation, and maintenance.
- **Return on investment.** Evaluate manure management practices for opportunities to offset costs or generate revenue.
- **Goals and priorities.** Account for the operation's water quality goals, labor requirements, nutrient utilization, or other priorities.
- **Regulatory implications.** Evaluate regulatory implications of changing manure management practices, such as need for permits.
- **Safety protocols.** Review and adjust existing safety protocols to account for new manure management practices.
- **Unique operation characteristics.** Consider the operation size, type and amount of manure, and the existing manure management system to determine the feasibility of switching practices.

Based on content from [*The FARM Environmental Stewardship Continuous Improvement Reference Manual*](#), Chapter 5, National Dairy Farm Program, 2017.

For each manure management practice, the webpage provides:

- Description of practice
- Best use cases
- System requirements
- Challenges/limitations to implementation
- Potential methane emissions reductions
- Cost considerations
- Links to more information



Anaerobic Digestion

Anaerobic digestion is a process through which microorganisms break down organic matter in the absence of oxygen. Anaerobic digestion with biogas flaring or utilization reduces overall methane emissions and provides many benefits.

- Most common on swine and dairy operations that manage manure as a liquid or slurry and collect at a single location.
- Suitable for all climates, depending on the anaerobic digestion type selected.
- Suitable for large and small facilities (although there are economies of scale favoring large operations).

Methane emissions are directly and indirectly reduced but nitrous oxide emissions may increase slightly.



Anaerobic Digestion



System Requirements

- Manure should be managed as a liquid or slurry.
- Pretreatment may be required to reduce the size of the feedstock and remove contaminants.
- Needs infrastructure to process, transport, and destroy or use biogas and digestate products.

Challenges and Limitations

- Requires staffing for regular maintenance and management.
- May be subject to permitting requirements.
- High initial expenses.

Cost Considerations

High capital and operating costs can be offset by the production of electricity, heat, and/or transportation fuel, the injection of biogas into existing natural gas pipelines, and the development of byproducts such as fertilizer or bedding.

Daily Spread

In a daily spread management practice, manure is removed from a barn and is applied to cropland or pasture daily.

- Suitable for smaller farms.
- Suitable for warmer climates as this practice is done daily, regardless of soil condition, weather, or time of year.
- Manure should not be spread near waterbodies or on snow to prevent runoff.

Methane emissions and net GHG emissions are expected to decrease.



Daily Spread



System Requirements

- Equipment to collect and land apply manure daily.
- Avoid spreading manure near wells, springs, sinkholes, terrace tile inlets, wetlands, or on slopes adjacent to streams, rivers, or lakes.
- Adequate land area to apply manure is needed.

Challenges and Limitations

- Best suited for smaller farms that have time and resources to spread manure daily.
- There can be concerns for the area's water quality when spreading manure during precipitation events or in colder climates due to runoff from frozen ground.
- Daily spread can result in over application of nutrients if there is not adequate land to apply manure.

Cost Considerations

There are daily labor and equipment costs associated with this management practice.

Pasture-Based Management

Consists of rotating animals between fenced grazing areas. Manure is left as-is to return nutrients and carbon to the land.

- Best suited for ruminants, such as grazing cattle, which can rely on grasses as their main feed source.
- Suitable where forage is available year-round and animal confinement is not necessary for protection from the weather.

Methane emissions are expected to decrease but nitrous oxide emissions may increase.



Pasture-Based Management



System Requirements

- Sufficient fenced acreage per animal to support the animals' nutritional needs, allow for rotated pastures, and manage the nutrient load of the manure.
- Supplemental manure management for milking areas in dairy operations and for areas of animal confinement.

Challenges and Limitations

- Labor and investment required to:
 - Develop a grazing management plan.
 - Perform pasture maintenance such as the spreading of nutrients and weed management.
 - Provide water and any supplemental nutrients.
 - Manage temporary fencing needed for pasture management.
- Grazing and rotating animals near streams or waterbodies will require added fencing to protect water quality.

Cost Considerations

Fencing and the purchase of land may be necessary. Labor and capital investment in pasture maintenance should be considered as well. A supplemental feed budget is necessary when the nutrient needs of animals cannot be met solely by grazing.

Composting

Composting is the aerobic decomposition of manure or other organic material by microorganisms in a managed system.

- More suitable for manure from dairy, horses, goats, poultry litter, and beef cows with a moisture content of 40-65%.
- Typically, better suited for warm climates, but composting within buildings or with covers can make the practice suitable for colder weather climates.
- Suitable for operations that use liquid storage systems with solid separation, where liquids are stored, and solids are composted.

Methane emissions are expected to decrease, but nitrous oxide emissions may increase.



Composting



System Requirements

- Space requirements are dependent on each unique system's characteristics.
- Equipment to monitor temperature, as well as equipment for aeration or turning is needed.
- Proper ratios of carbon to nitrogen must be maintained.
- Proper moisture content must be maintained.

Challenges and Limitations

- Wet or more concentrated manure needs to be dried or mixed with material to compost properly.
- Compost and weather conditions need to be monitored to maintain the rate of decomposition and determine how often to turn windrows.
- Compost must be managed properly to prevent odors, ammonia emissions, and water quality issues associated with stormwater runoff from the composting area.

Cost Considerations

The initial infrastructure, materials, and equipment are the main components of the cost, but regular maintenance is required. The costs may be mitigated by the sale of compost.

Solid Storage

Solid storage is the storage of manure, typically for a period of several months, either in an open area with unconfined piles or stacks or in a dedicated storage facility where the manure is confined within the walls of the facility.

- Suitable for any animal type.
- Typical in colder climates; covered facilities can aid with snow and rainfall events.
- Where rainfall/runoff is an issue, consider using a roofed manure storage facility or vegetated filter strips to treat runoff water.

Methane emissions are expected to decrease but nitrous oxide emissions may increase.



Solid Storage



System Requirements

- Sufficient storage space is needed. Size is dependent on each unique system's characteristics.
- An impermeable surface may be needed in humid climates.
- Surrounding land needs to be well-drained with vegetated filter strips around the drainage area.
- USDA NRCS standards specify that dedicated storage facilities should have walls surrounding at least three sides.

Challenges and Limitations

- Pests and odor are concerns with this practice.
- Manure needs to be regularly gathered and managed to ensure easy and efficient transport.
- There are often local and state laws regarding construction and management of manure storage facilities.
- Manure should be covered to better manage moisture and avoid anaerobic conditions in the stored manure.

Cost Considerations

The costs associated with storing manure in piles or stacks is low, however the costs of constructing dedicated storage facilities are higher.

Manure Drying Practices

- Manure drying involves any of a variety of methods to reduce the liquid content of manure to achieve a solids content of 13 percent or more. Manure drying is commonly used so that the manure can be stored or transported more easily.
- Best suited for ruminants, such as grazing cattle, which can rely on grasses as their main feed source.
- Commonly used at poultry operations but can be used with other animals.
- Suitable at farms that use manure scraping or a flush and solid separation system that produce drier manure.

Methane emissions are expected to decrease but nitrous oxide emissions may increase.



Manure Drying Practices



System Requirements

- Equipment and infrastructure are dependent on the manure drying technique:
 - Open solar drying requires the installation of a drying pad; size is dependent on the farm system.
 - Closed solar drying requires the development of a specialized building.
 - Systems utilizing alternative heat sources require specialized ventilation systems and drying equipment.

Challenges and Limitations

- The different manure drying techniques present different challenges.
- The drying process must be regularly monitored so dry manure can be removed and fresh manure can be added to the system.
- There may be local, state, or regional permitting requirements.

Cost Considerations

Infrastructure costs for space requirements or specialized buildings vary based on the different manure drying techniques. Additional equipment is necessary to optimize drying time and to spread and collect manure. There are also associated labor costs.

Semi-Permeable Covers, Natural or Induced Crusts

Semi-permeable covers or natural or induced crusts enclose open manure storage. These covers can reduce methane, ammonia, and odor. Geo-textile, straw, wood chips, and induced or natural crusts can be used in this practice. Induced or natural crusts are a result of biological and physical activity that occurs in the manure.

- Best suited for dairy cattle operations.
- Suitable for all climates.
- Straw covers are typically used for small, accessible manure storage areas.

Methane emissions are expected to decrease but nitrous oxide emissions may increase.



Semi-Permeable Covers, Natural or Induced Crusts



System Requirements

- Installation of a cover or generation of a crust barrier over outdoor liquid manure storage or treatment areas (such as an anaerobic lagoon).
- Natural or induced crusts are more likely to form with the following conditions: heavy organic bedding use, high-forage diets, limited wash water, shallow storage structures, and low wind disturbance.
- The application of straw covers requires the use of a straw chopper or blower.

Challenges and Limitations

- Covers require maintenance to:
 - Prevent leaks in the cover.
 - Repair tears and remove debris.
 - Straw must be broken up prior to covering the lagoon, and straw covers only last up to 6 months.

Cost Considerations

Maintenance, equipment, and materials costs are dependent on the type of cover used.

Decreased Manure Storage Time

- Decreasing manure storage time involves limiting the amount of time manure is stored by processing or transporting it out of a storage facility, such as a slatted floor pit storage, at a reduced storage interval. Reducing the time in storage reduces the time that the stored material is in anaerobic conditions
- Suitable for all animal types.
- Suitable for warmer climates that have favorable land application conditions.
- Farms with enough land area and flexibility to land apply the manure even during less than favorable weather conditions.
- **Methane emissions are expected to decrease but nitrous oxide emissions may increase.**



Decreased Manure Storage Time



System Requirements

- Sufficient appropriate land to apply manure (e.g., cropland, grasslands, woodlands).
- May require alteration of the farm's nutrient management plan.
- Land application equipment.

Challenges and Limitations

- It may be difficult to schedule frequent land applications for some crop rotations and special equipment may be required. Timing of land application will need to be managed to avoid application to frozen or wet ground, which could cause runoff and water quality issues.
- Increased land application requires more dedicated labor.

Cost Considerations

Equipment changes for more frequent manure land application may be needed. There may also be increased labor costs for this technique.

Compost Bedded Pack Barns

Compost bedded pack barns are a housing system that include a deep bedding - such wood shavings, sawdust, or other adsorbent bedding materials. Animals can freely roam on the pack and through walkways to access the feeding area. The bedding can be removed, and land applied or composted further.

- Primarily used with dairy cows; more rarely used with swine and beef cattle. This system is generally an alternative to tie or free stalls for dairy cows.
- Suitable for northern climates, although more heat and bedding are required in colder temperatures.
- **Methane emissions are expected to decrease but nitrous oxide emissions may increase.**



Compost Bedded Pack Barns



System Requirements

- A ventilated housing system with appropriately sized resting space is required.
- The bedded pack requires aeration (usually twice daily) to manage moisture.

Challenges and Limitations

- Sufficient space should be available for each cow to ensure there is enough dry material to properly handle manure, urine, and pack moisture levels.
- If poorly managed, the bedded pack can become a favorable environment for pathogens, which can negatively affect the health of the animals.

Cost Considerations

A new barn or modification is often required to ensure there is adequate ventilation and space for each animal. The cost of a compost bedded pack barn can be less expensive than a traditional liquid storage.

Solid Separation of Manure Solids Prior to Entry into a Wet/ Anaerobic Environment

Solid-liquid separation can be used to achieve objectives such as excluding solids from storage structures or lagoons, improving pumping characteristics, reducing organic loading on a treatment lagoon, and treating runoff from outdoor feedlots.

- Commonly used for dairy cattle and swine but can be used for beef cattle and poultry if the manure is handled as a liquid or slurry or is combined with other liquids.
- Where a decreased lagoon organic loading is desired because separating solids reduces lagoon organic loading.
- Separating solids can also allow for hauling of manure to fields further away, which can improve nutrient management.

Methane emissions are expected to decrease but nitrous oxide emissions may increase.



Solid Separation of Manure Solids Prior to Entry into a Wet/Anaerobic Environment



System Requirements

- Manure must be handled as either a liquid or a slurry.
- If sand bedding is utilized, the sand must be removed prior to solid-liquid separation.
- The separation method is dependent on the characteristics of the manure and the climate.
- In colder climates, separation may need to be done in a building.

Challenges and Limitations

- Capital and operational costs associated with solid-liquid separation may not be feasible for small operations.
- Sand bedding can cause issues with the separation equipment.

Cost Considerations

Each type of separation method has equipment, labor, and space requirements. Energy requirements can be high and can increase costs. Cost savings can occur by replacing straw or other materials used for cattle bedding with the removed solids.

Funding Opportunities

- NRCS

- Environmental Quality Incentives Program (EQIP)

- <https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives>

- Conservation Stewardship Program (CSP)

- <https://www.nrcs.usda.gov/programs-initiatives/csp-conservation-stewardship-program>

NRCS Conservation Practice Standards

- Anaerobic Digester
 - Code 366 (Anaerobic Digester)
- Daily Spread
 - No official CPS, but land application is in Code 590 (Nutrient Management)
- Pasture-Based Management
 - Code 528 (Prescribed Grazing)
 - Code 512 (Pasture and Hay Planting)



NRCS Conservation Practice Standards

- Composting
 - Code 317 (Composting Facility)
- Solid Storage
 - Code 313 (Waste Storage Facility)
 - Code 367 (Roofs and Covers)
- Manure Drying Practices
 - No official CPS, but potential for Code 629 (Waste Treatment)



NRCS Conservation Practice Standards

- Semi-Permeable Covers, Natural or Induced Crusts
 - Code 629 (Waste Treatment) - Straw pond covers
 - Code 367 (Roofs and Covers)
- Decreased Manure Storage Time
 - Code 313 (Waste Storage Facility)
 - Code 318 (Short Term Storage of Animal Waste and Byproducts)



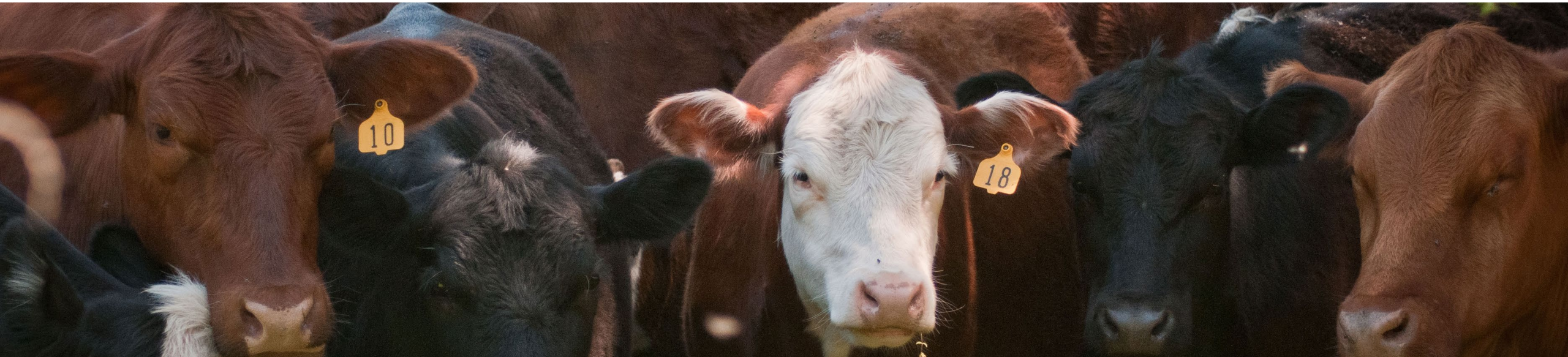
NRCS Conservation Practice Standards

- Compost Bedded Pack Barns
 - Code 313 (Waste Storage Facility)
- Solid Separation of Manure Solids Prior to Entry into a Wet/Anaerobic Environment
 - Code 632 (Waste Separation Facility)



There are multiple manure management practices that may result in reduced methane emissions, including:

- Anaerobic Digestion
- Daily Spread
- Pasture-Based Management
- Composting
- Solid Storage
- Manure Drying Practices
- Semi-Permeable Covers, Natural or Induced Crusts
- Decreased Manure Storage Time
- Compost Bedded Pack Barns
- Solid Separation



Any questions?



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