

Assessing livestock greenhouse gas emissions with COMET-Farm



C. Toureene¹, Easter M.¹, Swan A.¹, Paustian K.¹, Brown K.¹, Marx E.¹, Ziegler J.¹, Stermer M.¹, Velayudhan S.¹, Huber A.¹, Archibeque S.², Chambers A.³, and Eve M.⁴
¹Natural Resource Ecology Laboratory-Colorado State University, ²Colorado State University-Department of Animal Sciences, ³USDA Natural Resources Conservation Service, ⁴USDA Office of the Chief Scientist

Introduction to COMET-Farm

COMET-Farm is an integrated web-based decision support tool developed to aid farmers, agricultural producers, land managers and conservationists.

COMET-Farm provides total farm greenhouse gas (GHG) accounting and carbon sequestration occurring from these practices:

- Cropland, Pasture & Range
- Livestock
- Agroforestry
- Energy usage

By generating reports from users' current and potential future management scenarios, COMET-Farm allows users to evaluate how conservation practices may reduce GHG emissions and sequester carbon.

Animal Agriculture

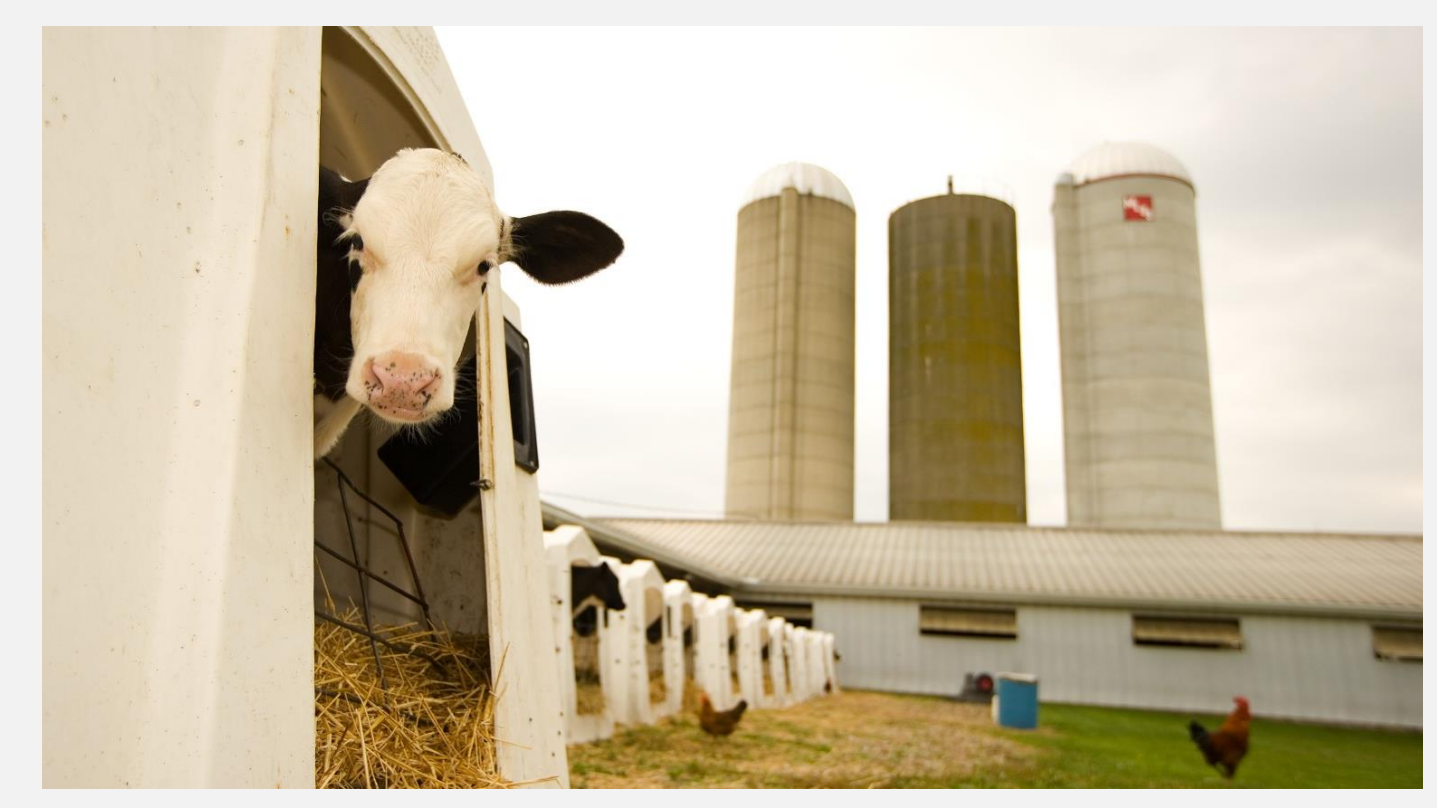
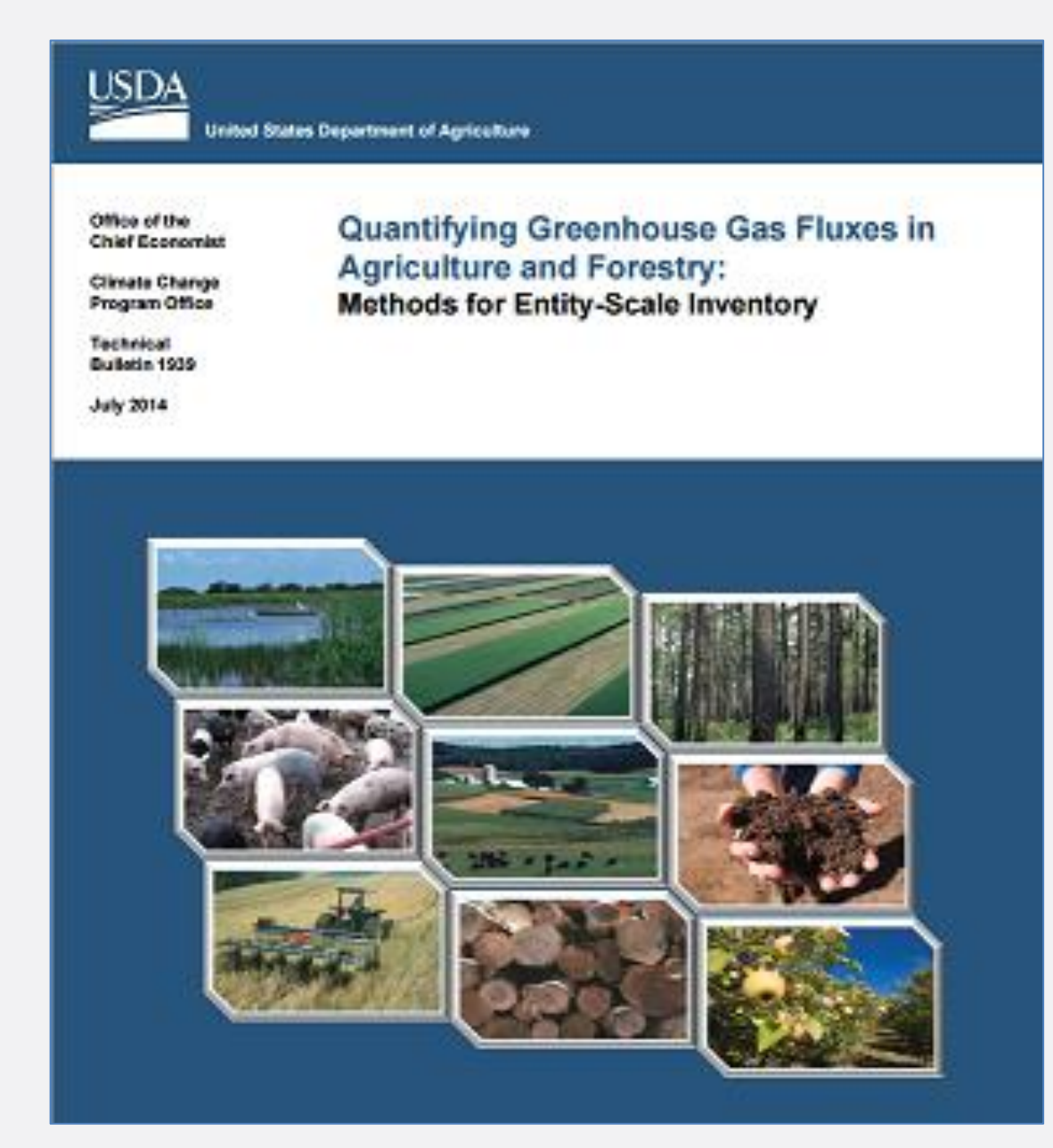


Photo courtesy of USDA Natural Resources Conservation Service

Livestock management practices contribute a significant amount of GHG emissions in the agricultural sector. COMET-Farm reports estimate:

- Methane from enteric fermentation
- Methane from housing and manure management
- Nitrous oxide from housing and manure management

Scientific Basis



COMET-Farm utilizes peer-reviewed greenhouse gas (GHG) inventory methods published by the USDA. The USDA report provides methods for estimating changes in GHG emissions and carbon storage at the farm scale. COMET-Farm integrates these methods into a powerful and useful tool.

Using COMET-Farm

Animal Agriculture Demo

This poster showcases the capabilities of the Animal Agriculture module of COMET-Farm utilizing real data from California Polytechnic State University's Cal Poly Dairy in San Luis Obispo.

- ### Baseline Scenario
- Population of 350 cows including heifers and calves
 - 180 lactating cows
 - Housed in free stall barns
 - Manure flushed into a single-cell lagoon

- ### Future Scenario: Digester Install
- A methane recovery system has been constructed at the dairy.
 - The new anaerobic digester system is a covered lagoon with a flexible membrane cover that floats on the surface and a gas collection system attached.
 - Biogas that is captured generates electricity for the dairy.

Getting Started

Creating a livestock project in COMET-Farm is easy. Simply create and name your customized project and begin to define activities. COMET-Farm relies on accurate climate data so location information is collected. Methods have been implemented to quantify emissions from a wide range of livestock categories. For the purpose of this poster we will be showcasing the dairy categories.

Selected Activities for the Current Project:

Animal Ag Demo Project

All Categories - Full Accounting

Cropland, Pasture, Range

Animal Agriculture

Agroforestry

[Define Activities >>>](#)

Select Animal Types

Cattle: Beef Cows, Beef Heifer Replacements, Beef Heifer Stockers, Beef Mature Cows, Beef Steer Stockers, Bulls, Charolais Replacements, Dairy Dry Cows, Feedlot Cattle

Poultry: Broilers, Ducks, Laying Hens, Pullets

Sheep: Feeder Sheep, Fleck Sheep

Swine: Gestating Sows, Grow-Finish Pigs, Lactating Sows, Weaning Pigs

Other: American Bison, Goats

Animal Details

Specific management data is collected from the user, starting with Animal Details. Animal details such as monthly populations, feed intake and milk production for each animal category are recorded.

Enter Animal Characteristics - Dairy-Lactating Cows

How many Dairy-Lactating Cows do you have, on average, per month?

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Housed Facility	180	180	180	180	180	180	180	180	180	180	180	180
Dry Lot	0	0	0	0	0	0	0	0	0	0	0	0
Pasture Range	0	0	0	0	0	0	0	0	0	0	0	0

Average Daily Feed Intake (lb): 55

Average live body weight (lb): 1500

Days in milk: 305

Milk production per day (lb): 75

Types of Feed

Next, detailed feed information is collected from the user to carefully estimate enteric fermentation. The user may adjust feed types on a month to month basis.

Feedstuff	Category	Year Selection
Grass Hay	Whole Plant Picked	Grass Hay
Chickpeas	Podded	Grass Hay
Chow	Stlage, High Stlage	Stlage, Mature Well Eared
Chow	Stlage, Mature Well Eared	Stlage, Mature Well Eared
Common Hay	Grass, White	Chow
Colfax	Grass, Stover Picked	Pulp Dried
Com	Grass, High Oil	Whole
Cottonseed	Grass, High Lysine	Whole
Corn	Grass, High CP	Whole
Cottonseed	Grass, High CP	Whole
Whole	Grass, High CP	Whole

Grass Hay: 45

Corn: 20

Stlage, Mature Well Eared: 14

Cottonseed: 11

Soybean: 10

Meal, Solv. Ext. 49% CP: 100

Housing Details

Detailed housing information is selected to accurately measure housing emissions.

Enter Animal Characteristics - Dairy-Lactating Cows

How is manure handled within your housing type?

Flushed Facility

Dry Lot

Pasture Range Pasture

Pit Storage

Bedded Pack

Flushed or Scraped

Area of the Barn floor covered with manure (sq ft): 36000

Manure System Types and Details

Finally, manure details are collected, including detailed information on the manure system type as well as specific manure details. Below are examples from the Baseline and future Digester Install scenario.

Enter Animal Characteristics - Dairy-Lactating Cows

For Dairy-Lactating Cows which manure management systems are currently in use?

Do you use a solid/liquid separator? Yes No

What is the separator type? Roller press

What is the primary solid treatment method? Composting

What is the primary liquid treatment method? Anaerobic lagoon, runoff holding ponds, storage tank

We noticed you selected Anaerobic lagoon, runoff holding ponds, storage tank for your previous animal category. Is this lagoon shared? Yes No

Enter Animal Characteristics - Dairy-Lactating Cows

For Dairy-Lactating Cows which manure management systems are currently in use?

Do you use a solid/liquid separator? Yes No

What is the separator type? Roller press

What is the primary solid treatment method? Composting

What is the primary liquid treatment method? Anaerobic Digester with Biogas Utilization or Methane

Enter Animal Characteristics - Dairy-Lactating Cows

What are your manure system details for Dairy-Lactating Cows?

Composting: What is the composting method? Passive Windrow

Anaerobic Digester: What is the digester type? USB type with floating gas holders no external water sea

Manure System Types and Details

Finally, specific manure details are collected. These fields are prepopulated with default values allowing the user to edit them if needed.

Enter Animal Characteristics - Dairy-Lactating Cows

What is the total dry manure produced per head per day (lb)?

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6

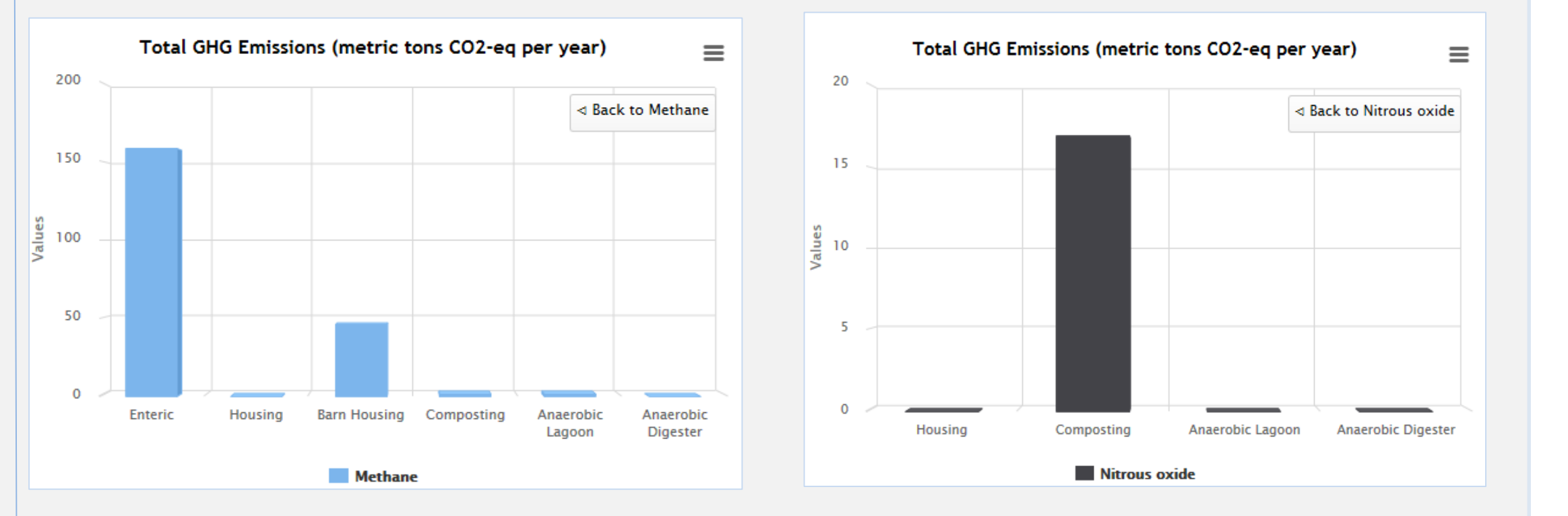
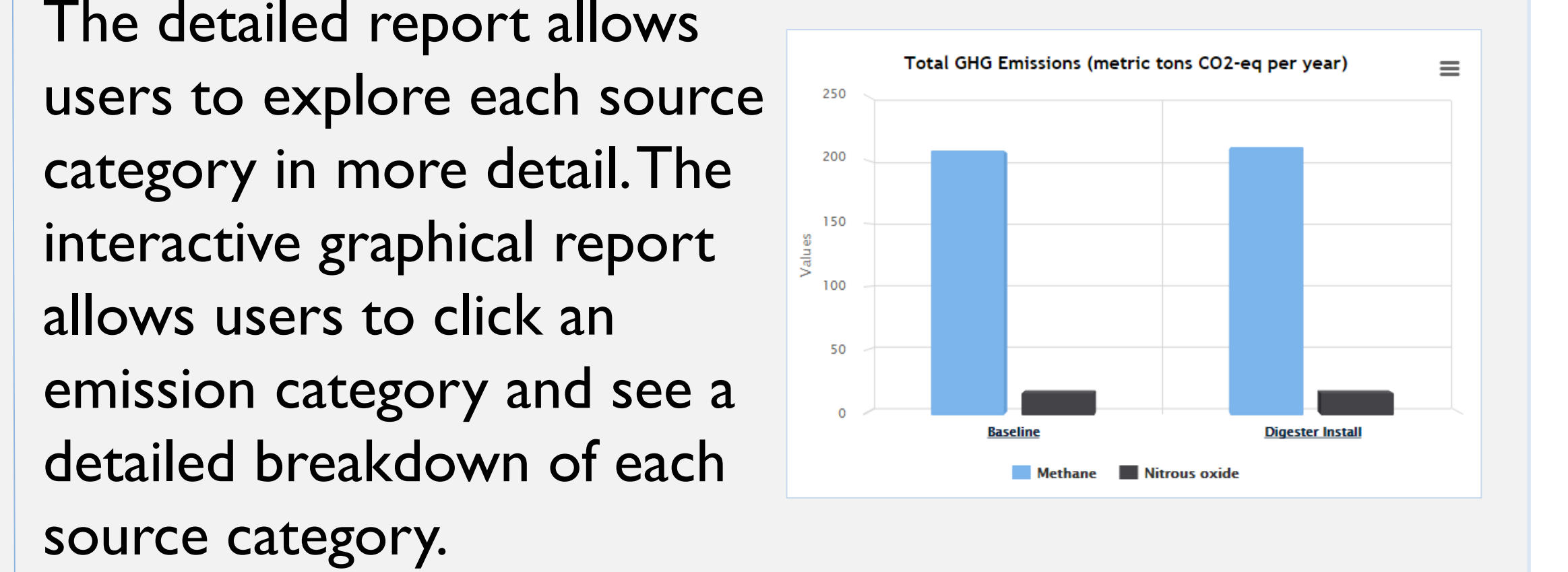
What is the average percent nitrogen content of the manure each month?

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	5	5	5	5	5	5	5	5	5	5	5	5

Report

Using the methods in the USDA document, *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry*, COMET-Farm calculates potential changes in GHG emissions and carbon storage. Results are provided in easy to read detailed tables and interactive graphical reports.

Source	Baseline Emissions	Digester Install Emissions	Change
Dairy-Heifer Replacements			
Methane (Basal CO ₂ eq/yr)	67.2	88.0	+0.8
Enteric	54.2	54.2	0.0
Housing	0.0	0.0	0.0
Barn Housing	32.2	32.2	0.0
Composting	0.4	0.4	0.0
Anaerobic Lagoon	0.4	0.0	-0.4
Anaerobic Digester	0.4	1.2	+0.8
Nitrous oxide (Basal CO ₂ eq/yr)	4.2	4.2	0.0
Housing	0.0	0.0	0.0
Composting	4.2	4.2	0.0
Anaerobic Lagoon	0.0	0.0	0.0
Anaerobic Digester	0.0	0.0	0.0
Total	91.4	92.2	+0.8
Dairy-Dry Cows			
Methane (Basal CO ₂ eq/yr)	137.2	128.6	-1.4
Nitrous oxide (Basal CO ₂ eq/yr)	15.6	15.6	0.0
Total	152.8	144.2	-1.4
Total (all animals)	497.8	452.6	-4.8



The example above shows the change in emissions when an anaerobic digester with methane recovery is installed in a future scenario. Sometimes we see an increase in overall methane emissions when a digester is installed due to digester leakage. The methane generated by anaerobic digesters is usually burned in a generator to produce on-farm electricity, is burned to heat water and buildings, or is piped to be used elsewhere to offset burning fossil methane (natural gas) in another location. These avoided fossil fuel emissions are a significant part of the overall life cycle benefit of installing anaerobic digesters, and that is the main GHG benefit to installing an anaerobic digester.

Conclusion

COMET-Farm estimates the 'carbon footprint' for all or part of the producers farm/ranch operation and allows users to evaluate options for reducing GHG emissions and maximizing carbon sequestration. Users are able to create up to 10 future scenarios with varying conservation practices to compare GHG mitigation strategies. COMET-Farm is a powerful tool designed to help agricultural producers make on-farm decisions to reduce energy costs, reduce GHG emissions and build soil health.

Acknowledgements

Funding provided by USDA-NRCS and USDA Climate Change Program Office. The COMET-Farm team acknowledges April Leytem (USDA ARS), Wei Liao (Michigan State University), Diana Pape (ICF International), Jeff Creque (Marin Carbon Project), and John Wick (Marin Carbon Project) for technical assistance.