Reducing enteric methane emissions from dairy cattle

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Methane emissions

- **methane represents 11% of total U.S. greenhouse gas emissions**
  - 2nd most important greenhouse gas after CO_2
- **enteric fermentation accounts for 27% of total U.S. methane emissions**
  - 2nd most important source after natural gas & petroleum systems
- **enteric CH_4 represents a loss of energy, 6-12% of gross energy intake**
  - energy that could otherwise be available for growth or production
- **reducing enteric CH_4 would benefit the environment and improve efficiency**

Integrating genomic, milk spectrometry, and microbial manipulations to mitigate enteric methane emissions from dairy cattle

overall goal: reduce enteric CH_4 emissions from dairy cattle by combining

- **selective breeding**
- **milk mid-infrared spectra**
- **rumen microbiome interventions**

Francisco Peñagaricano, quantitative genomics
Hilario C Mantovani, rumen microbiology
Heather M White, nutritional physiology
Kent A Weigel, breeding & genetics

Michael J VandeHaar, sustainable food systems
Robert J Tempelman, statistical genetics

James E Koltes, genomics & bioinformatics
Ranga Appuhamy, nutrition/sustainable agriculture

José EP Santos, nutrition, health & fertility
Kwang C Jeong, microbiology & food safety

Ransom L Baldwin, nutritional genomics
Paul M VanRaden, sustainable breeding goals
Asha Miles, genomics & microbiology
Elizabeth A French, precision feeding
Kenneth F Kalscheur, sustainable production

Kristen Parker Gaddis, genetics & genomics

Our plan

phenotyping
4,000 lactating cows
(6 research farms over 3 years)

measure CH_4 production, feed intake, milk energy, body weight, and milk spectra for 6-8 weeks in mid-lactation

selective breeding

develop genomic evaluations for methane emission traits

milk spectrometry

evaluate the use of milk spectra to predict CH_4 emissions

microbiome

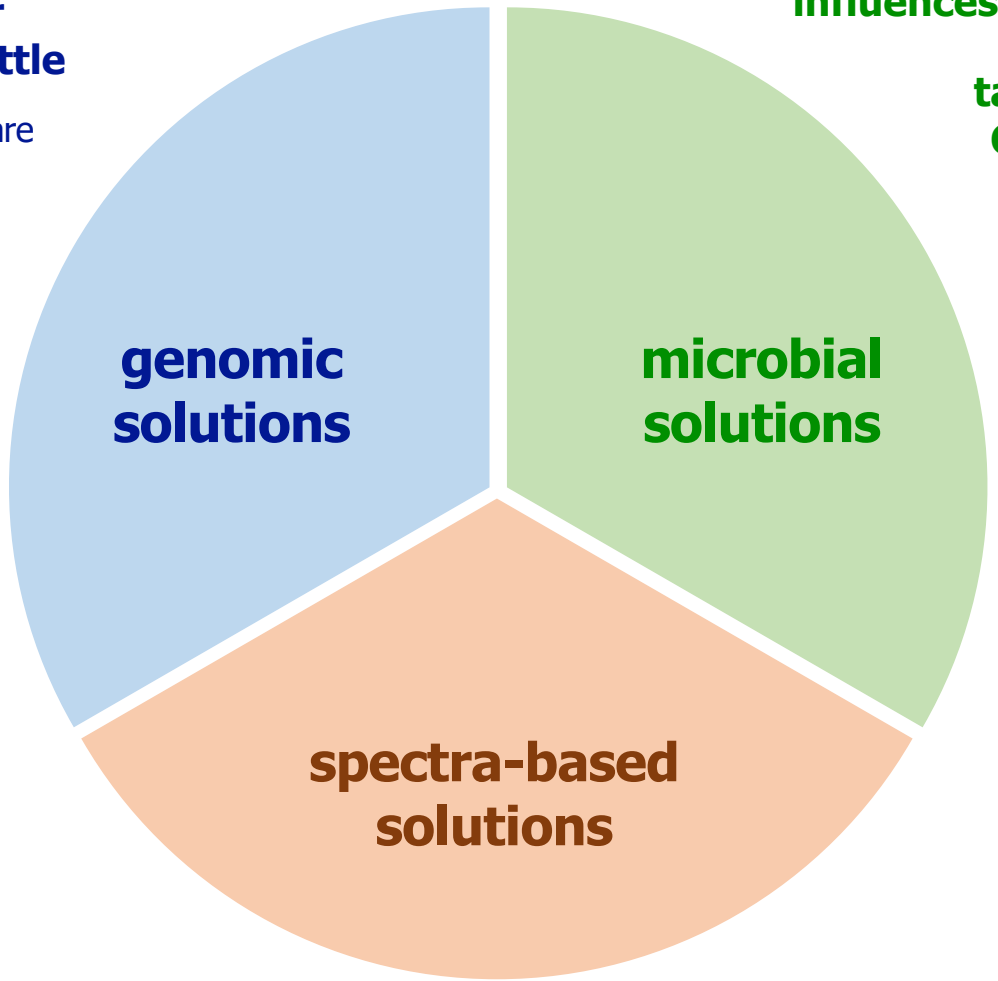
reveal the composition/activity of the rumen microbiome of cows with low & high CH_4 emissions
using metagenomics and metabolomics

exchange ruminal contents of low and high methane-emitting cows
decipher the relative contributions of hosts and microbes to CH_4 production

Outcomes/Solutions

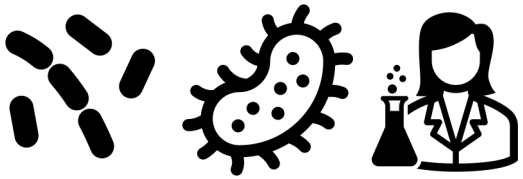
routine genomic evaluations for CH_4 emission traits in U.S. dairy cattle

changes achieved through genetic selection are incremental, cumulative and permanent
(very cost-effective strategy)



deeper understanding of how the host influences diversity/activity of methanogens

targeted strategies to reduce CH_4 formation in the rumen



reveal if milk spectra is a good predictor of CH_4 emissions

milk spectra could be used to increase the accuracy of genomic evaluations of CH_4 traits

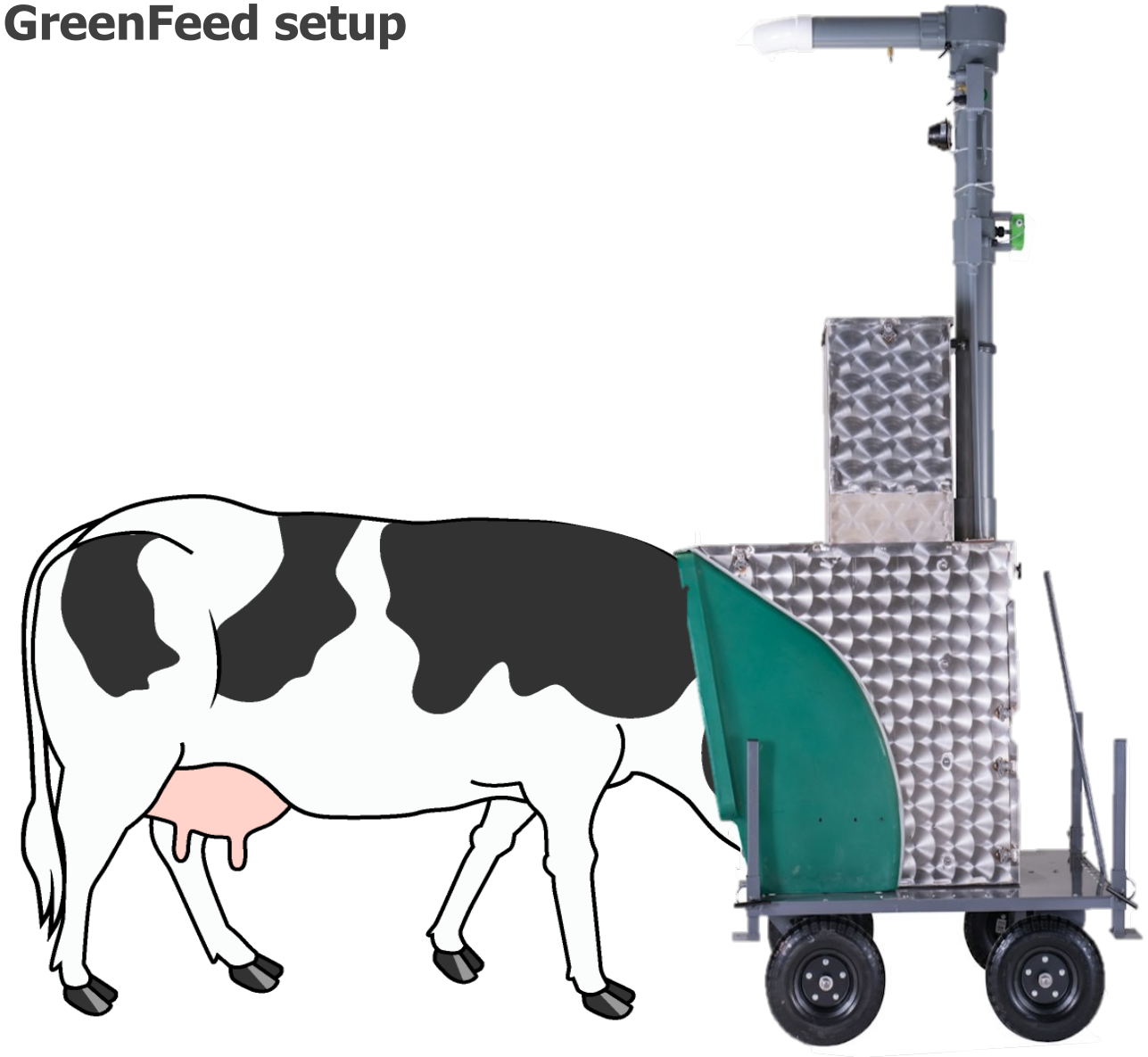
milk spectra could be used to optimize cow management in the dairy farm
(assign high methane-emitting cows to specific diets)

GREENER CATTLE INITIATIVE

CDCB
COUNCIL ON DAIRY CATTLE BREEDING

GreenFeed system

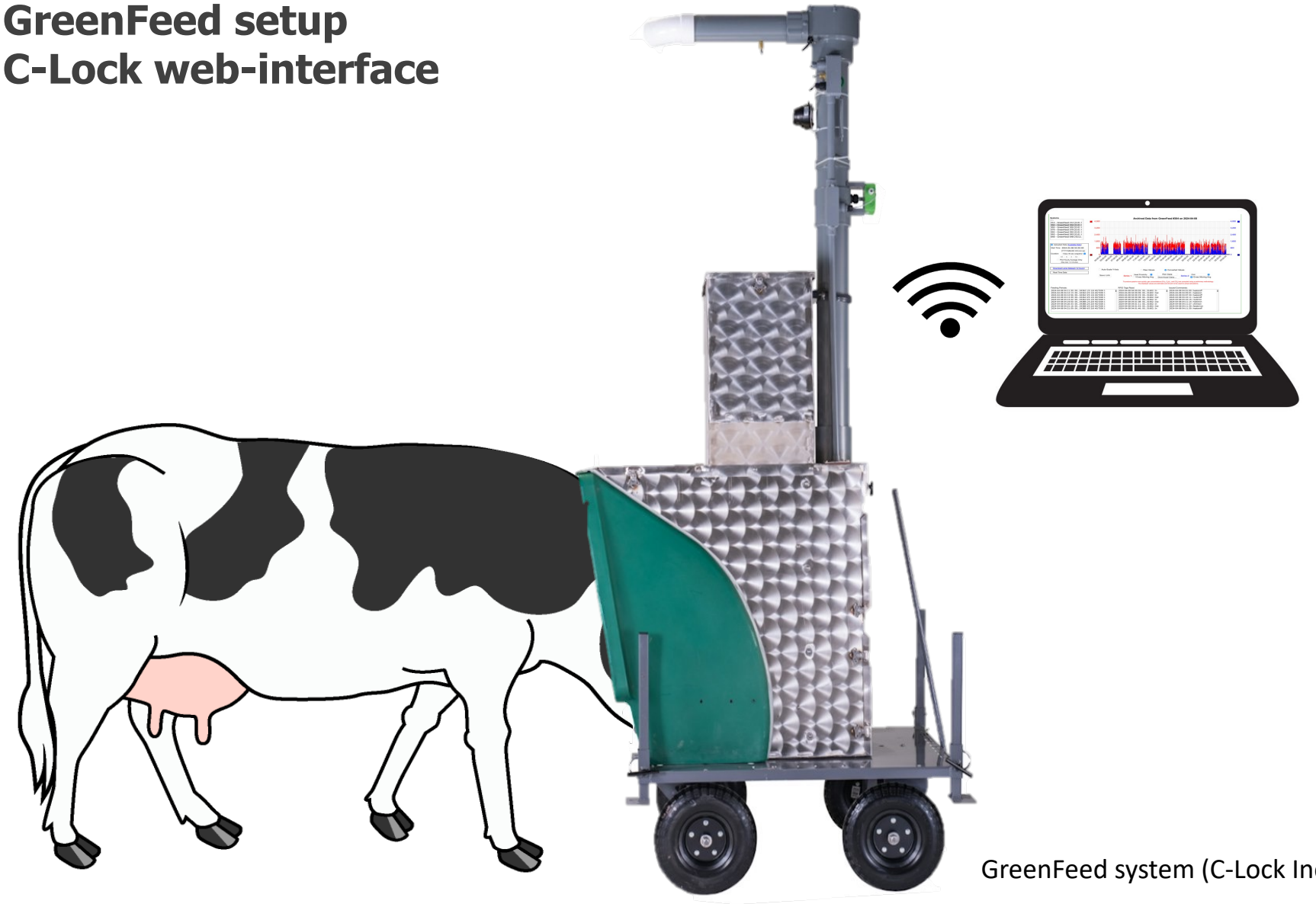
1. **GreenFeed setup**



GreenFeed system (C-Lock Inc.)

GreenFeed system

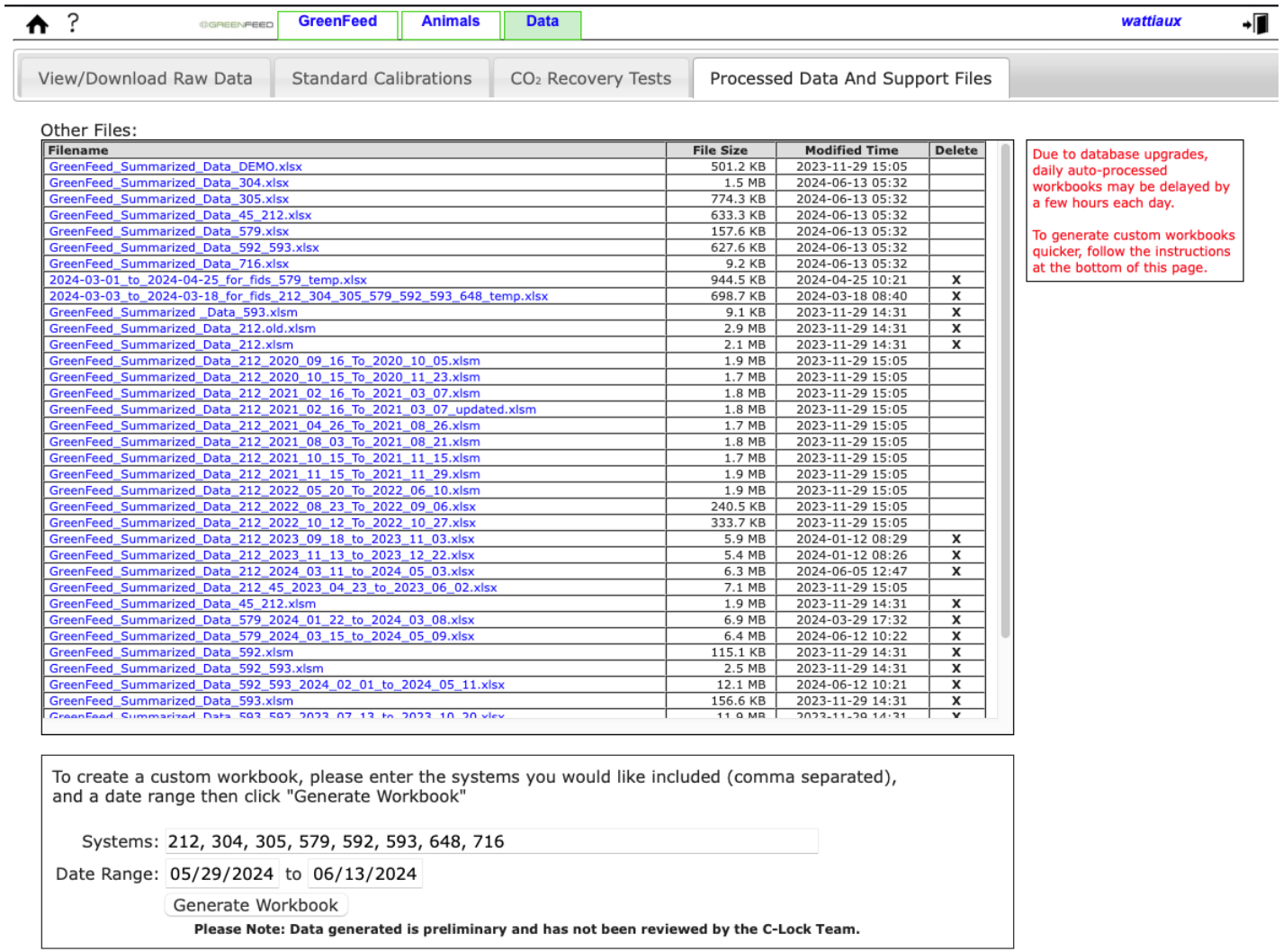
1. GreenFeed setup
2. C-Lock web-interface



GreenFeed system (C-Lock Inc.)

C-Lock web-interface

https://greenfeed.c-lockinc.com/GreenFeed/greenfeed.php



C-Lock web-interface

https://greenfeed.c-lockinc.com/GreenFeed/greenfeed.php

GreenFeed | Animals | Data | wattiaux

View/Download Raw Data | Standard Calibrations | CO_2 Recovery Tests | Processed Data And Support Files

Other Files:

Filename	File Size	Modified Time	Delete
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GreenFeed_Summarized_Data_305.xlsx	774.3 KB	2024-06-13 05:32	
GreenFeed_Summarized_Data_45_212.xlsx	633.3 KB	2024-06-13 05:32	
GreenFeed_Summarized_Data_579.xlsx	157.6 KB	2024-06-13 05:32	
GreenFeed_Summarized_Data_592_593.xlsx	627.6 KB	2024-06-13 05:32	
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Due to database upgrades, daily auto-processed workbooks may be delayed by a few hours each day.

To generate custom workbooks quicker, follow the instructions at the bottom of this page.

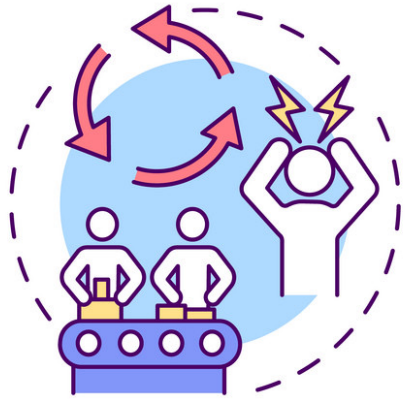
To create a custom workbook, please enter the systems you would like included (comma separated), and a date range then click "Generate Workbook"

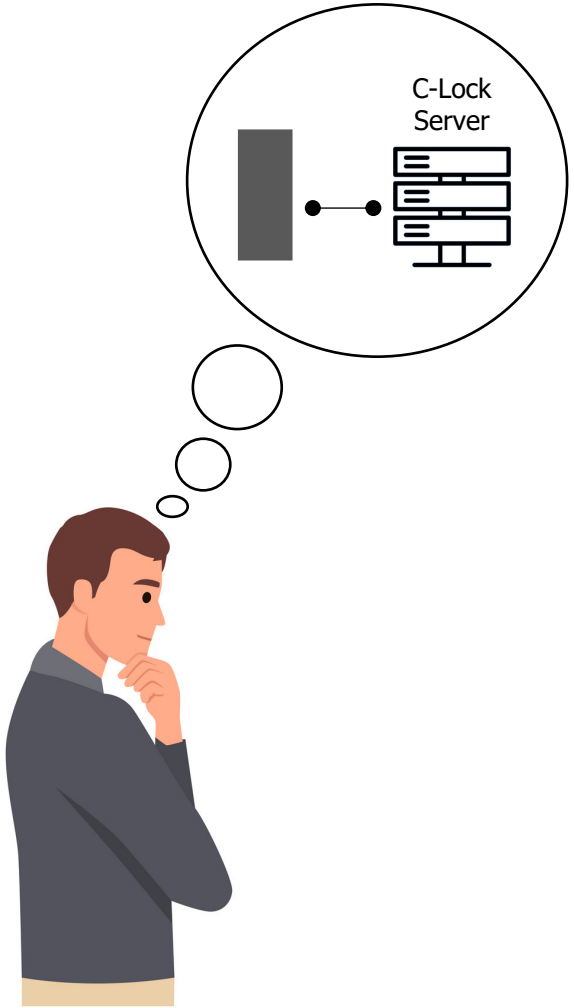
Systems: 212, 304, 305, 579, 592, 593, 648, 716

Date Range: 05/29/2024 to 06/13/2024

Generate Workbook

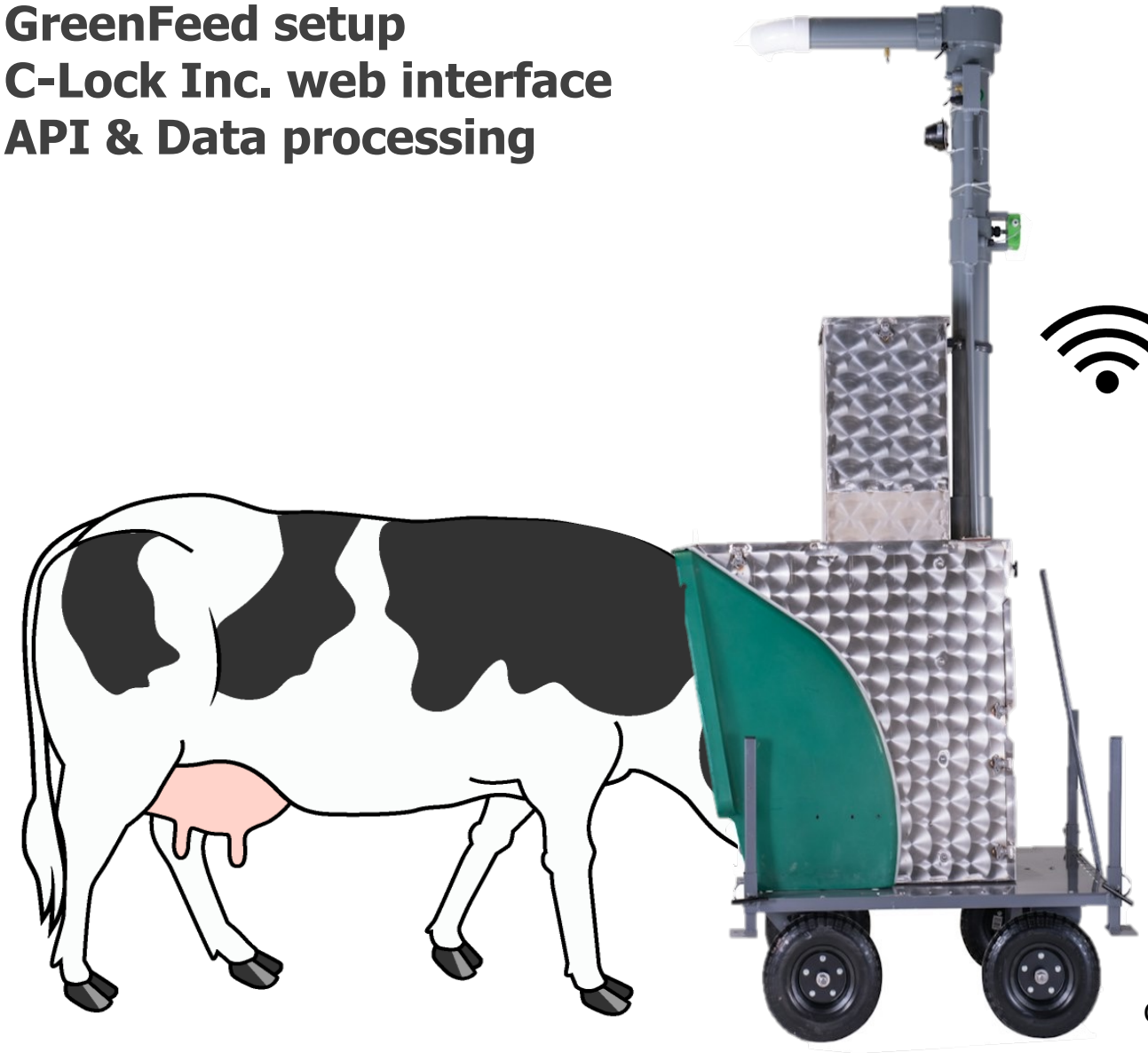
Please Note: Data generated is preliminary and has not been reviewed by the C-Lock Team.





GreenFeed system

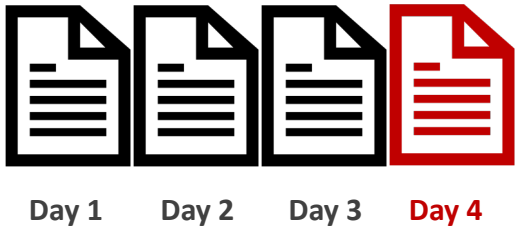
1. GreenFeed setup
2. C-Lock Inc. web interface
3. API & Data processing



GreenFeed system (C-Lock Inc.)

Challenge 1

Study: **ADSA 2024**
Unit: 579
Start Date: 11/30/2023
End Date: 01/11/2024

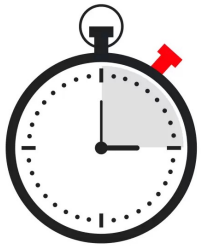


How many cows have records?

How many records per day? And per cow?

What is the average CH4 production per cow?

When are the cows visiting the GF? AM? PM?



10 min

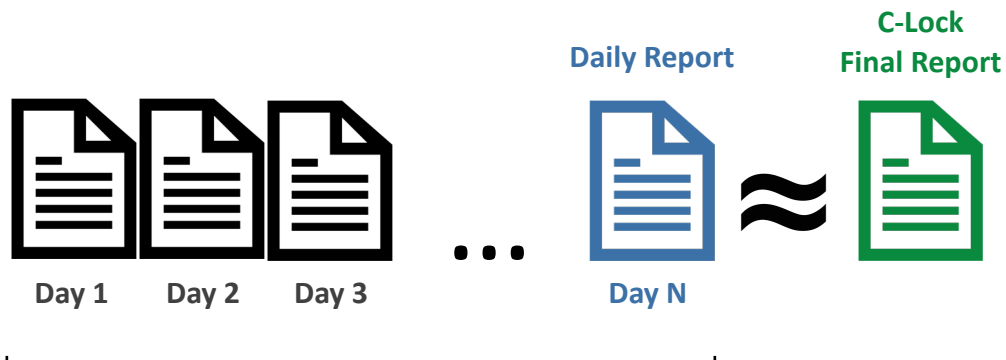
Answer the following questions using the software you prefer:

1. How many cows do you have?
2. How many records do you have per cow?
3. What is the average methane production per cow?

Challenge 1

1. Go to https://github.com/GMBog/GreenFeed/tree/main/ADSA/Challenge_1/
2. Download ADSA2024_GFdata_Day4.xlsx
3. Using the software of your preference, answer the following questions:
    - How many cows (or unique RFID) do you have?
    - How many records do you have per cow (or unique RFID)?
    - What is the average methane production (or CH4GramsPerDay) per cow?
4. Open Report_ADSA2024.pdf and compare your results

API & Data processing



download_data.py

download_data.R

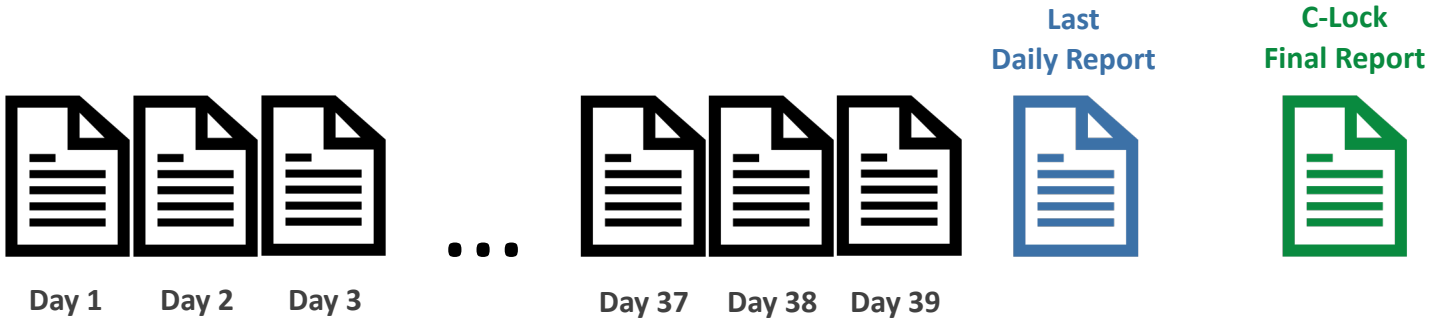
ReportsGF.Rmd

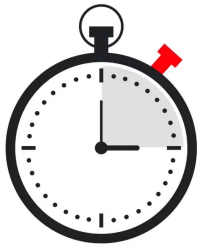
Report_XXXX.PDF

- Unit
- Days of experiment
- N cows with **records**
- Cows with no **records**
- Records per day
- Records per cow

Challenge 2

Study: **ADSA 2024**
Unit: 579
Start Date: 12/04/2023
End Date: 01/11/2023





5 min

Run download_data.R to get the Daily Report. Then, answer the questions:

1. How many cows do you have?
2. How many records do you have per cow?
3. What is the average methane production per cow?

Challenge 2

1. Go to https://github.com/GMBog/GreenFeed/tree/main/ADSA/Challenge 2/
2. Download ADSA2024_GFdata.xlsx, ADSA2024_EID.csv, download_dataADSA2024.R, ReportsGF.Rmd

Hint: Download Challenge 2/ folder using the following link (https://download-directory.github.io) and copy the path above.

3. Open download_dataADSA2024.R, inspect the code, and run it
4. Using R and Rmd, answer the following questions:
    - How many cows (or RFID) do you have?
    - How many records do you have per cow (or RFID)?
    - What is the average methane production (or CH4GramsPerDay) per cow?
5. Open Report_ADSA2024.pdf in Downloads folder

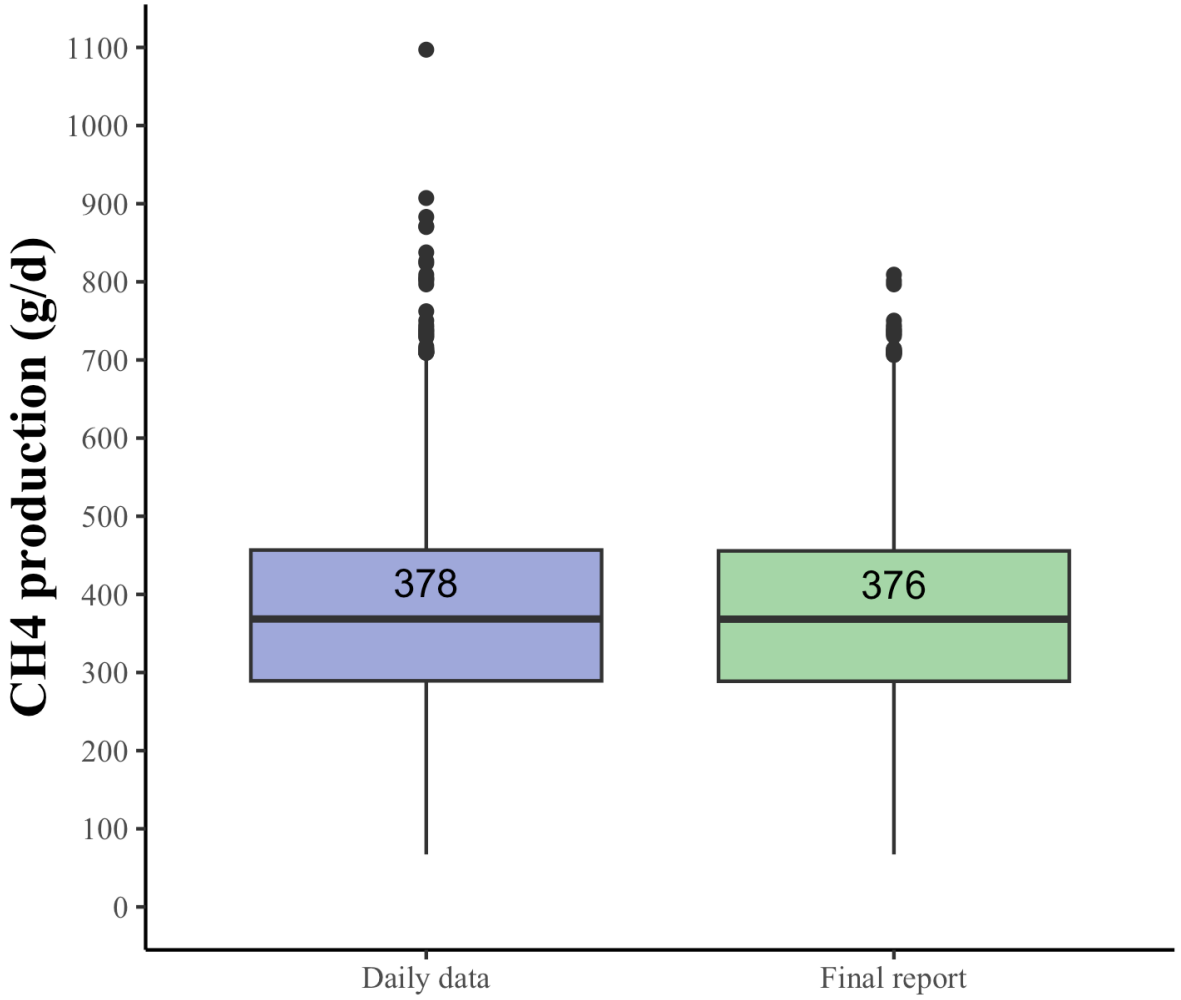
Comparing daily and final reports

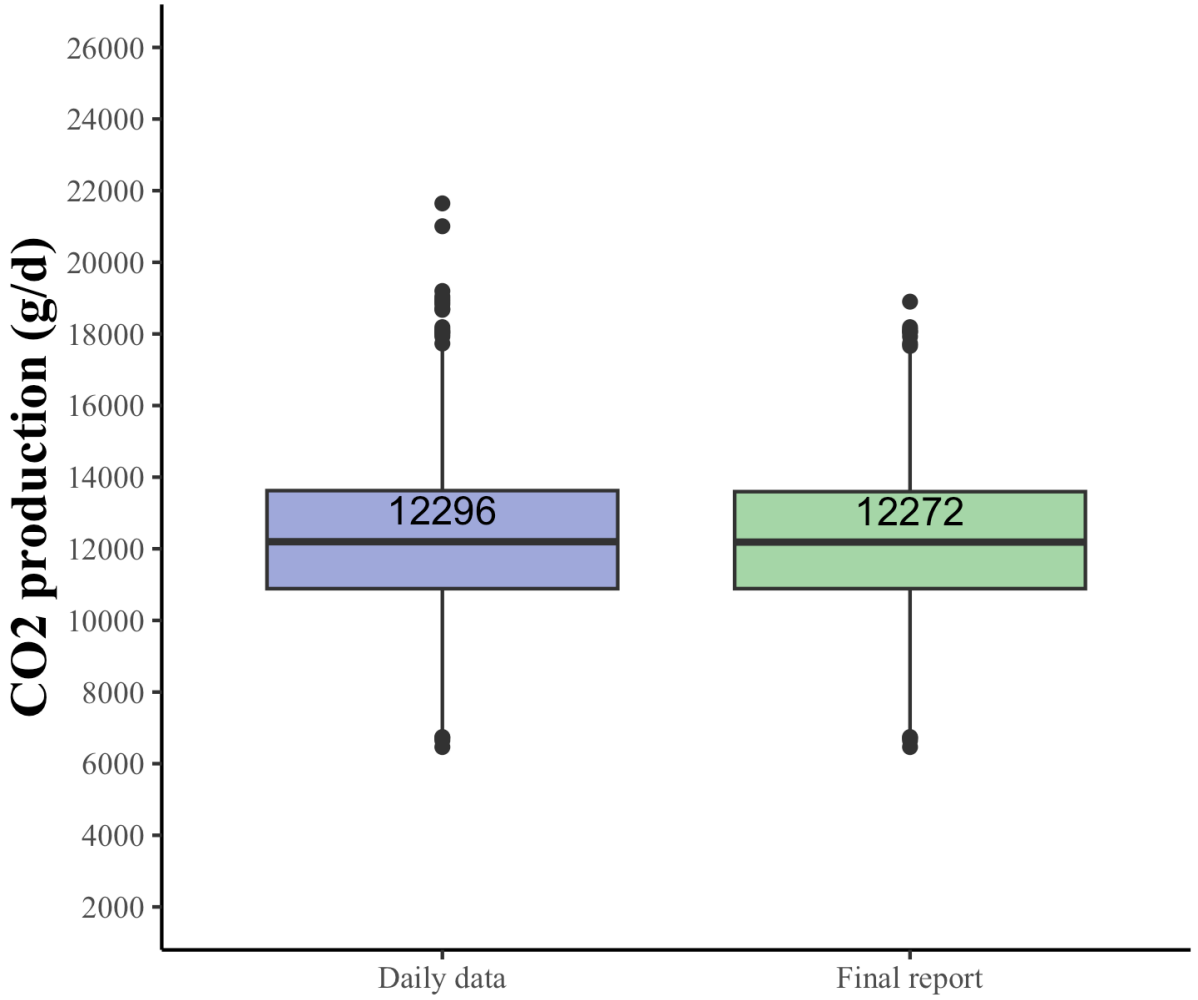
Study 1 – Unit 579

Daily Report

C-Lock Final Report

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison





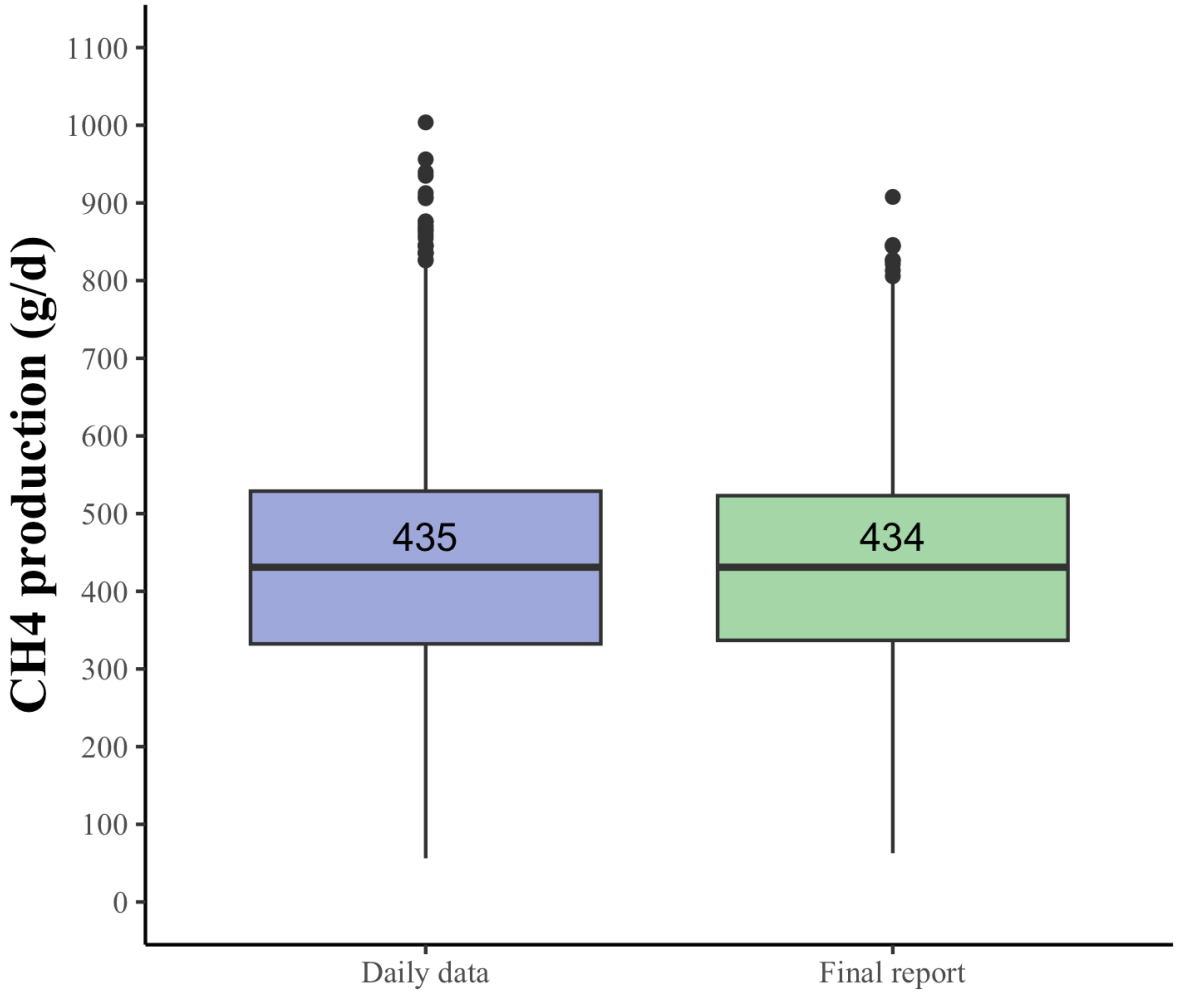
Comparing daily and final reports

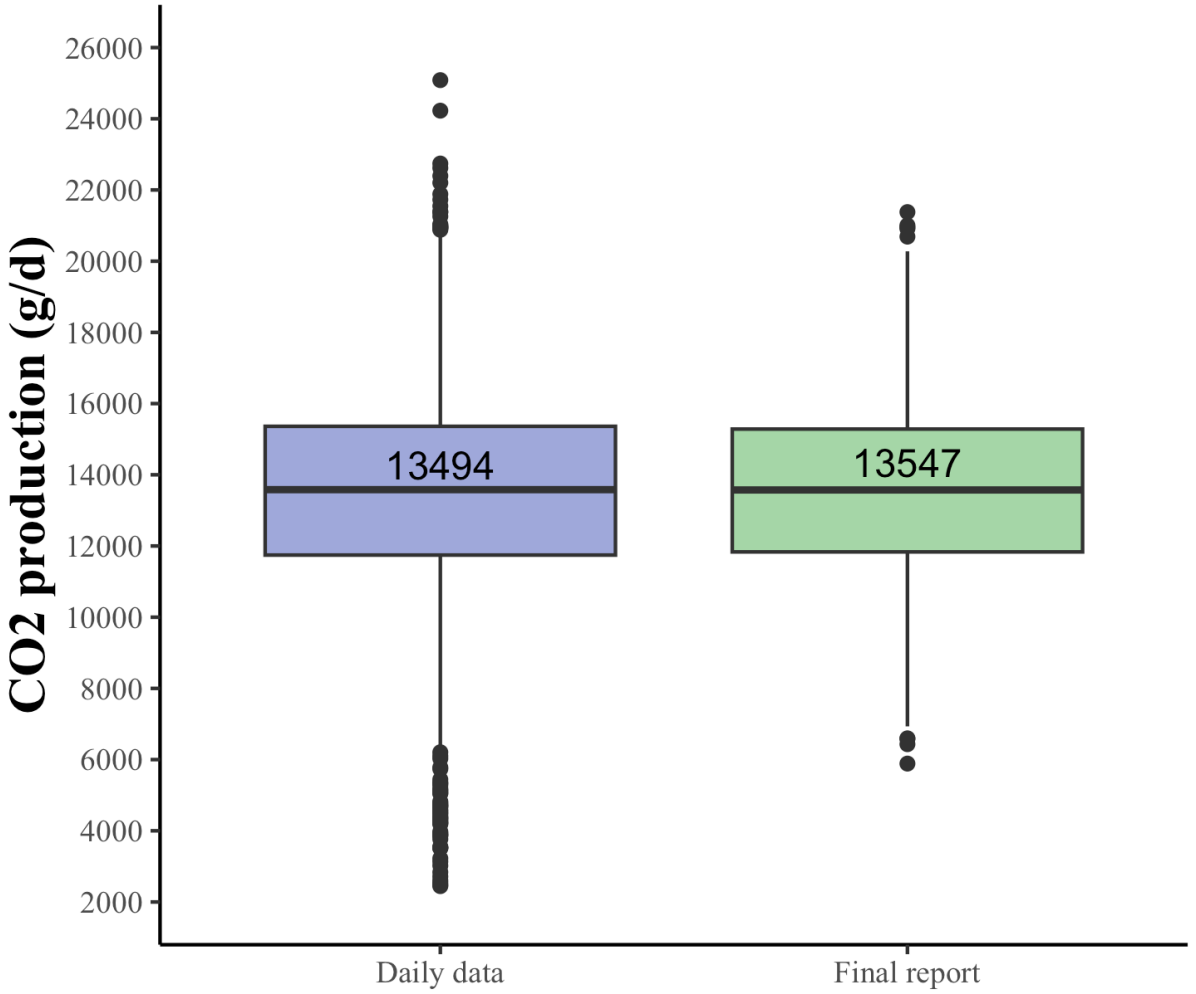
Study 2 – Unit 212

Daily Report

C-Lock Final Report

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison





Thank you for your attention!

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ANIMAL & DAIRY SCIENCES
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COUNCIL ON DAIRY CATTLE BREEDING