GreenFeed Emissions Monitor

INSTALLATION AND OPERATION

TRAINING IN
QUALITY ASSURANCE FOR GREENFEED USERS IN THE REGION
4-6 February 2025 | SEARCA & UPLB DTRI

Climate Smart Agriculture Initiative New Zealand
UC DAVIS COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES
GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES
SEAMEO SEARCA

Contents

Overview

This workshop aims to equip participants with foundational knowledge and hands-on insights into GreenFeed technology for measuring methane (CH_4) emissions in livestock systems. Participants will explore where GreenFeed fits among methane measurement technologies, understand its components, and gain practical guidance on its operation. The workshop is designed for researchers and farm managers seeking effective tools for methane mitigation strategies.

This training workshop is a joint activity of the Philippine and Vietnam Greenhouse Gas Measurement Hubs, through the support of the New Zealand Government's Climate Smart Agriculture Initiative and the University of California, Davis. It is being undertaken to improve ASEAN regional capability in greenhouse gas measurement and support the objectives of the Global Research Alliance on Agricultural Greenhouse Gases.

The workshop will be opened by the following representatives of the organisations engaged in providing the training:

> **Prof. Roger Hegarty**: The New Zealand Government's Climate Smart Agriculture Initiative;
>
> **Dr. Shimels Wassie**: University of California, Davis;
>
> **Prof. Amado A. Angeles**: University of the Philippines Los Baños; and
>
> **Dr. Glenn B. Gregorio**: Center Director, Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

This workshop introduces participants to GreenFeed technology, its role in CH_4 measurement, and practical insights into its components and operation. GreenFeed is a robust tool for monitoring methane emissions from ruminants, designed for cost-effective and non-intrusive data collection. The workshop will provide participants with the knowledge to operate and integrate GreenFeed into research or farm systems for precise GHG monitoring and mitigation strategy evaluation.

Instructors and Content Developers

Professor Roger Hegarty

A leading researcher in animal science and methane emissions, Professor Hegarty's expertise spans ruminant nutrition, feed conversion efficiency, and methane production mitigation. His interdisciplinary work integrates themes like grazing, residual feed intake, methanogenesis, and fatty acid metabolism. With over 300 citations on his methane-related studies, his recent work includes a universal equation to predict methane production in forage-fed cattle and innovative methodologies to estimate daily methane emissions using short-term breath measures.

Mr. Graeme Bremner

Mr. Graeme Bremner is a highly experienced Technical Officer with over four decades of dedicated involvement in animal research. He has been the principal technician responsible for the operation and quality assurance (QA) of the University of New England's (UNE) respiration chambers and GreenFeed units. His meticulous approach to QA processes has facilitated groundbreaking research and the development of innovative methodologies in livestock management and environmental sustainability. Graeme's deep technical knowledge, practical

skills, and unwavering commitment to excellence make him an invaluable contributor to the field of animal science and research.

Dr. Amelia Almeida

Amelia is a Senior Lecturer in Animal Science at Massey University, New Zealand's premier dairy research and teaching facility. She has international experience in Brazil, the USA, Australia, and New Zealand working in small and large ruminant feeding standards development and emission measurement. She has provided extensive input into these notes and advice on GreenFeed use in dairy systems.

Module 1: GreenFeed Technology and Methane Measurement

This initial module aims to equip participants with foundational knowledge and hands-on insights into GreenFeed technology for measuring methane (CH_4) emissions in livestock systems. Participants will explore where GreenFeed fits among methane measurement technologies, understand its components, and gain practical guidance on its operation. The workshop is designed for researchers, and farm managers seeking effective tools for methane mitigation strategies.

1.1: Introduction to Methane Measurement Technologies

Fundamental Principles of Gas Measurement

Mass Measurement and Conservation of Mass: All gas measurement systems fundamentally rely on the principle of conservation of mass, which states that the total mass entering a system equals the total mass exiting it, provided no losses or accumulation occur. This principle forms the cornerstone of accurate greenhouse gas quantification[1].

To measure gases accurately, several critical parameters must be considered and monitored[1]. **Flow rate** is fundamental, as it determines the amount of gas passing through a system per unit of time and is typically measured in volume or mass. **Pressure** and **temperature** are essential for correcting gas density and volume, as both influence the behaviour of gases. **Gas composition** is another crucial factor, as it determines the specific properties of the gas, such as molecular weight and energy content, which are necessary for conversions between units like parts per million (ppm) and grams.

Additionally, factors like **humidity** or water vapour content must be accounted for, as they can dilute gas concentrations and affect readings. Accurate measurement also depends on **calibration parameters**, which ensure that instruments are aligned to standard gases and their outputs are reliable. Finally, environmental factors such as flow disturbances and turbulence must be minimised or corrected to maintain measurement precision and reliability.

[1] Rella CW, Chen H, Andrews AE, Filges A, Gerbig C, Hatakka J, Karion A, Miles NL, Richardson SJ, Steinbacher M (2013) High accuracy measurements of dry mole fractions of carbon dioxide and methane in humid air. *Atmospheric Measurement Techniques* **6**(3), 837-860.

Gas measurement systems typically consist of:

- **Primary Devices**: These include flowmeters, which measure the flow rate of gases.
- **Secondary Devices**: Tools that measure supportive parameters such as temperature and pressure, enabling corrections for gas expansion or contraction.
- **Tertiary Devices**: Instruments that assess gas composition and quality (e.g., methane concentration).

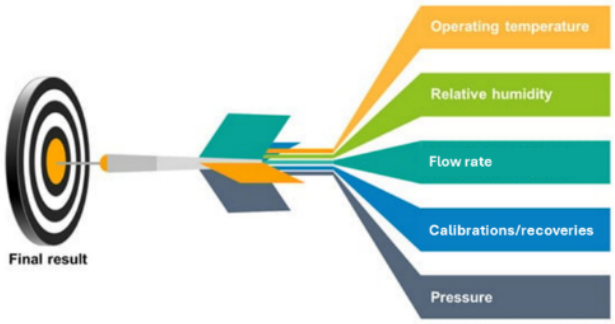


Figure 1. Critical Parameters for Accurate Measurement

Measurement accuracy hinges on the calibration of flowmeters, which rely on the **law of similarity** (geometric and dynamic) to align laboratory conditions with field use. Violations of this law are a common source of errors[2].

Note on units: In gas measurement systems, the units measure by the sensors are usually different from the unit we need for analysis, reporting and/or decision making. Gas sensors typically measure concentrations in units like **ppm**, representing the number of gas molecules in a million molecules of air.

For example, a methane sensor records a concentration of **2,000 ppm** in a barn:

1. **Convert ppm to Molar Fraction**:

   2,000 ppm=0.002

2. **Calculate Volume Using the Ideal Gas Law**: At standard temperature and pressure (STP):

   V=n×RT÷ PV

   Where:

   V: Volume of methane
   n: Number of moles of methane
   R: Ideal gas constant (8.314)
   T: Temperature (in Kelvin)
   P: Pressure (in Pascals)

3. **Determine Mass**: Multiply the methane volume by its molecular weight (16 g/mol) to calculate the mass of methane emitted.
4. **Aggregate Over Time**: To calculate daily emissions, sum the mass of methane emitted over the measurement period.

[2] Boyes W (2009) 'Measurement of flow.' (Butterworth-Heinemann: Instrumentation reference book)

1.2: Where GreenFeed fits among CH_4 Measurement Technologies

This session will explore various CH_4 measurement technologies, comparing their strengths and limitations across several parameters. Participants will gain insights into how GreenFeed fits within the broader landscape of CH_4 monitoring tools and its application for research, policy development, and mitigation strategies.

Tedeschi et al. (2022) provided a comprehensive summary of methane measurement techniques, categorising them based on their context and scale of application. These techniques are grouped into three main categories: **Animal-Based Techniques**, **Facility-Based Techniques**, and **Large-Scale Techniques**.

1. **Animal-Based Techniques**: These methods measure methane emissions directly from individual animals or small groups, making them highly suitable for research purposes, as well as for evaluating feed and treatment studies. They are particularly effective in detecting variations within a population, enabling precise assessments of individual animal emissions or specific dietary interventions. Examples include **respiration chambers**, **GreenFeed systems**, and **tracer techniques** like SF_6.
2. **Facility-Based Techniques**: These methods target methane emissions originating from manure and related storage systems in facilities such as barns or feedlots. Facility-based techniques are ideal for monitoring emissions at the source and are frequently used in **manure management studies** or facility-wide mitigation strategies. Examples include **static chambers**, **ventilation rate methods**, and **sensor-based CO_2 balance approaches**.
3. **Large-Scale Techniques**: Designed for monitoring methane emissions on a broader scale, these methods are used to assess emissions across landscapes or regions. They are crucial for **inventory reporting** and **policy-making**, offering insights into total emissions from agricultural systems. Examples include **satellite imagery**, **aircraft-based sensors**, and **drone technologies**.

The choice of technology depends on the specific use case, whether it is evaluating treatment differences, assessing dietary or management strategies, informing policies, or monitoring emissions in small- or large-scale systems.

We will focus on **animal-based methane measurement technologies**, which vary significantly in methodology, application, cost, labour intensity, and accuracy. Below, we categorise and compare commonly used CH_4 measurement methods, with a particular focus on techniques such as GreenFeed.

Overview of CH_4 Measurement Methods

Method	Cost	Labour Intensity	Accuracy	Precision	Scalability	Advantages	Disadvantages
Respiration Chambers[3][4][5][6]	High	High	High	High	Low	Gold standard for precision and accuracy; controlled environment.	Expensive, labor-intensive, limited scalability, may not represent natural conditions.
Polytunnels[7][8][9][10]	Moderate	Moderate	High	Moderate	Low	Simulates semi-natural grazing; captures group emissions.	Limited to smaller studies, expensive setup.
Restrained in Hood or headbox systems[11][12][13][14][15][16]	Moderate /High	Low	Moderate	High	Moderate	Suits hot climate if no airconditioning	Requires animal restraint
GreenFeed	Moderate	Moderate	Moderate	High	High	Portable, less invasive than chambers. Scalable, practical for large herds; works in grazing and confined systems.	Limited to spot sampling requires animal training; bait feed may influence dietary trials. Multi-sample needed
SF_6 Tracer Technique[17][18]	Moderate /Low	Moderate	High	Moderate	Moderate/ Low	Suitable for grazing animals.	Technical expertise required; potential environmental concerns due to SF_6 gas. Less precise due to variability in air mixing and muzzle positioning

[3] {Pinares, 2014 #65}{Pinares, 2014 #65}
[4] {Johnson, 1995 #66}
[5] {Goopy, 2016 #68}
[6] {Della Rosa, 2021 #73}
[7] {Gaviria-Uribe, 2020 #69}
[8] {Goopy, 2016 #68}
[9] {Murray, 2001 #71}
[10] {Molina, 2016 #70}
[11] {Hristov, 2016 #72}
[12] {Della Rosa, 2021 #73}
[13] {Hegarty, 2013 #75}
[14] {Hammond, 2016 #74}
[15] {Manafiazar, 2017 #77}
[16] {Pinares-Patiño, 2008 #81}
[17] {Johnson, 1994 #78}
[18] {Della Rosa, 2021 #73}

Open-Path Laser[19][20]	High	Low	Moderate	Low	Medium	Good for large herds; works in grazing and intensive settings.	Expensive equipment, influenced by microclimatic conditions.
Portable Accumulation Chamber	Low	Med	low	High	High	20 min measure allows many animals/d. Used in Genetic Evaluation	Short term value does not equal daily mean
***In Vitro* Techniques**[21][22]	Low	Low	Low	Moderate	Low	Effective for evaluating feed additives; replicable conditions.	May not fully represent *in vivo* conditions.

Cost: Includes both setup and operational costs. **Labour Intensity**: Evaluates the human resources required to implement and maintain the technology. **Accuracy**: Reflects the method's ability to measure CH_4 emissions correctly. **Precision**: Highlights the repeatability and consistency of measurements. **Scalability**: How easily the method can be implemented on a larger scale.

No single method is universally ideal due to the wide variation in production systems, management strategies, and the inherent assumptions of each technique. For **policy-making and large-scale monitoring**, satellite imagery, drone measurements, and aircraft-mounted sensors are often the best choices. In contrast, **comparing methane emissions from diets or mitigation strategies** requires more controlled methods like respiration chambers, GreenFeed systems, or tracer techniques.

Methane measurement technologies vary widely in methodology, application, cost, labour intensity, and accuracy. Choosing the appropriate technology depends on the intended use case, such as evaluating treatment differences, informing policies, or monitoring large-scale systems. Below, we categorise and compare commonly used CH_4 measurement methods, including GreenFeed.

1.3: Components and Operation of the GreenFeed

The GreenFeed system is an advanced tool designed for quantifying emissions of methane and other gases (CO_2, H_2, O_2) from ruminants. Its innovative design enables non-invasive data collection while ensuring scalability and adaptability for both research and commercial applications. Below is a summary of what will be covered in this workshop, including a breakdown of its components and operations. During **Practical No. 1**, try to identify and understand each of these components in action.

The key components are listed below and then pictorially described in the slides following (Slide set M1.1; Images courtesy of C-Lock). Note: GreenFeed Setup Part 1 - Component Overview

[19] {Tomkins, 2015 #86}
[20] {Well, 2005 #87}
[21] {Tilley, 1963 #62}
[22] {Yáñez-Ruiz, 2016 #64}

Key Components

1. **Measurement Chamber**
    - Captures and analyses exhaled gases while animals feed
    - Aerodynamically designed to maximize gas capture efficiency, even under windy or variable environmental conditions
2. **Gas Analysers**
    - Employ non-dispersive infrared (NDIR) technology to measure CH_4 and CO_2 concentrations with high sensitivity and accuracy
    - Equipped with calibration mechanisms to maintain accuracy over time
3. **Feed Dispenser**
    - Provides controlled portions of feed to attract animals to the chamber
    - Enables frequent and reliable measurements by encouraging multiple daily visits
4. **Air Flow System**
    - Continuously draws air through the chamber, mixing gases to ensure representative sampling
    - Includes airflow meters to measure the rate of air movement, a critical factor for emission calculations
5. **Data Management System**
    - Logs real-time data, including gas concentrations, airflow rates, and environmental conditions
    - Transmits data wirelessly to cloud platforms for analysis and reporting
6. **Power Supply**
    - Options include solar panels for remote applications, enhancing the system's scalability in diverse environments

Operation

1. **Animal Interaction**
    - Animals are attracted to the GreenFeed unit by bait feed dispensed into a feeding station.
    - During feeding, the system captures breath samples for analysis.
2. **Gas Sampling and Analysis**:
    - The system measures CH_4 and CO_2 concentrations in real-time using high-precision sensors.
    - Data corrections for temperature, pressure, and humidity are applied to ensure accuracy.

3. **Data Processing**
    - Methane flux is calculated by multiplying the measured increase in CH_4 concentration above ambient levels by airflow rates, applying the ideal gas law.
    - Results are presented as daily CH_4 emissions (g/day) or CH_4 yield (g CH_4/kg dry matter intake).
4. **Maintenance and Calibration**
    - Regular calibration with standard gases ensures consistent accuracy.
    - Routine maintenance includes cleaning filters and checking airflow systems.

Advantages

- Provides non-invasive, high-frequency measurements of CH_4 emissions
- Scalable (use on up to 20 animals in pen or grazing in one study) and suitable for diverse farming systems, including grazing and confined setups
- Capable of collecting individual-level data for genetic and environmental studies
- Some greenfeed can provide 2 different supplements to different animals

Challenges

- Requires animal training for consistent interaction with the system
- Short-term measurement periods may introduce variability in emission estimates
- Animals MUST be supplemented with some small pellet or grain to enable measurement to be made

The GreenFeed system combines precision engineering and innovative design, making it a vital tool for advancing methane mitigation strategies and understanding ruminant emissions.

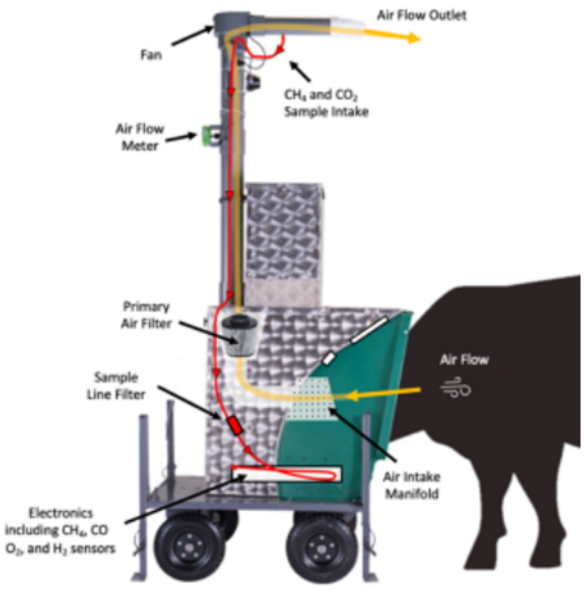


Photo credit: C-Lock Inc.

Basic Greenfeed Components.

1. Feeding Hood.

The feeding hood comprises the ***air intake manifold***, ***a feed dish*** with a ***feed drop shoot***, a ***head proximity sensor*** and an ***EID reader***. A web Cam is located on upper lip of the Feeding Hood.

2. Air Flow

A fan located on the top of the chimney structure draws air at the rate of approximately 40 litres per second through the ***air intake manifold***. A ***primary air filter*** extracts particulate particles from the airflow. The rate of flow is then measured by the ***air flow meter*** and the air expelled from the chimney through the ***air flow outlet***.

3. Sample

A mixed ***sample of air*** is drawn by the ***sample pump,*** located in the electronics box, from a position midway between the fan and the airflow outlet. The sample the passes down through a ***sample line filter*** and into the ***gas sensors.***

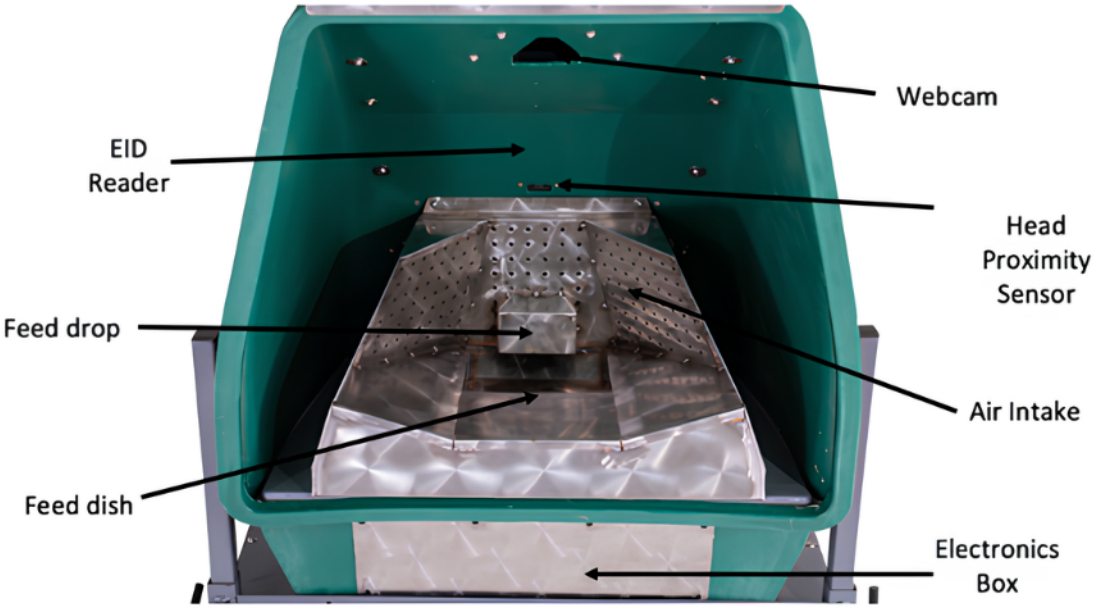


Photo credit: C-Lock Inc.

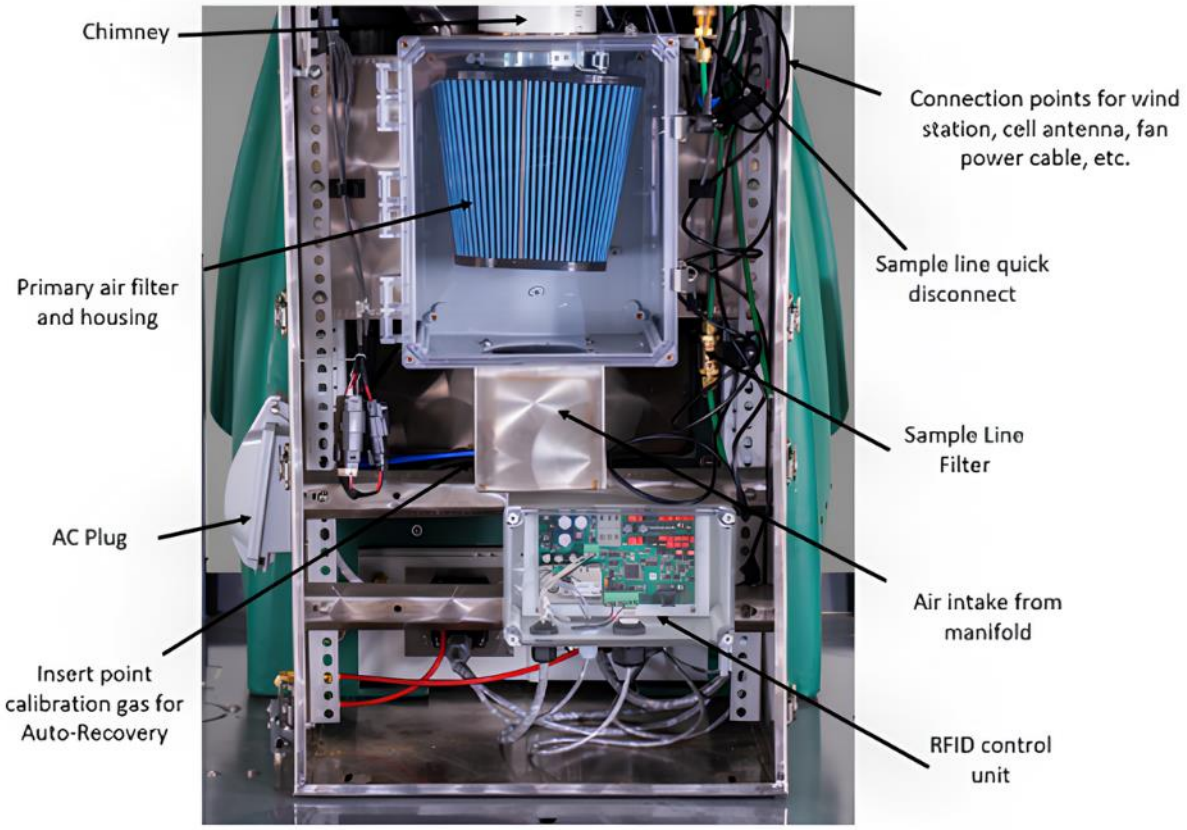


Photo credit: C-Lock Inc.

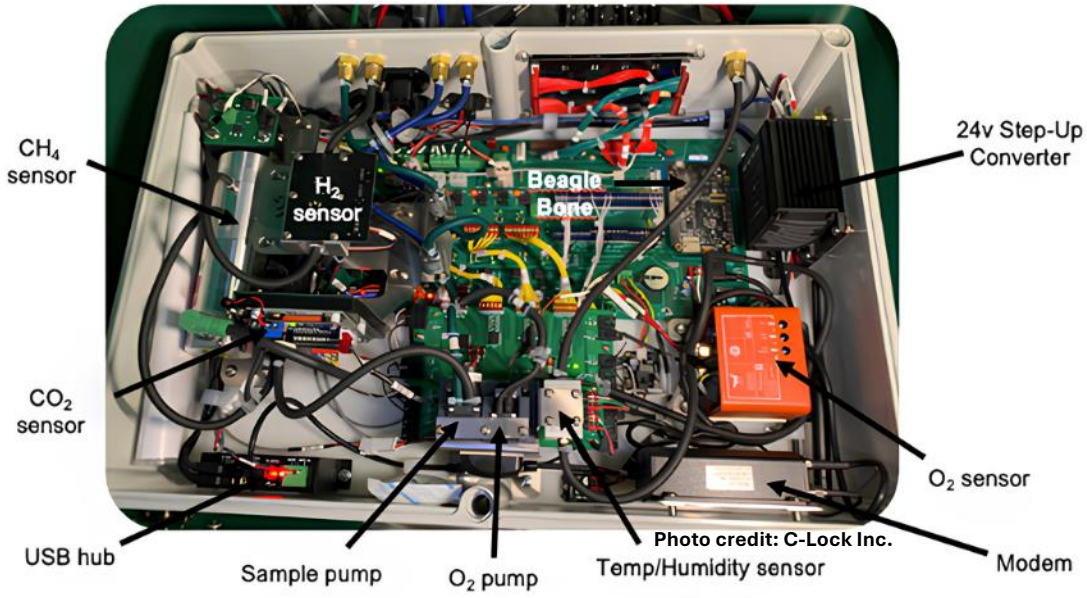


Photo credit: C-Lock Inc.

Module 2: Unpacking and Assembling GreenFeed Units

2.1: Practical 1: Prepare, unpack and commence assembly of the GreenFeed

This is a hands-on group activity to prepare, unpack, and assemble the Greeneed unit. Note: C-Lock the GreenFeed manufacturer also provided video guidance on assembly as in links below:

- GreenFeed Setup Part 1 - Component Overview
- GreenFeed Setup Part 2 - Cart Assembly
- GreenFeed Setup Part 3 - Mounting GreenFeed to the Cart
- GreenFeed Setup Part 4 - Feed Bin
- GreenFeed Setup Part 5 - Pipe/Conduit
- GreenFeed Setup Part 6 - Fan and Airflow Meter

Steps:

1. Inspection and Preparation
    - Verify the package contents against the inventory checklist.
    - Ensure that all necessary components (e.g., feed hopper, air intake manifold, and electronics box) are present.
    - Review safety protocols and proper handling practices for components.

2. Unpacking the GreenFeed Unit
    - Carefully unpack components, paying attention to the electronics box and air intake manifold.
    - Inspect all parts for damage during transit and report any issues immediately.

3. Assembly Process:
    - Follow the assembly instructions for connecting the feed hopper, air filters, and sample line filter.
    - Attach the GreenFeed hood, ensuring the head proximity sensor and RFID reader are securely installed.
    - Set up the airflow system, connecting the fan, sample pump, and air filter housing as directed.

4. Discussion and Classroom Review:
    - Return to the classroom if needed to discuss challenges encountered during assembly.
    - Address theoretical aspects, such as how airflow and proximity sensors contribute to accurate gas measurements.

2.2 Configure & Trouble-shoot communications (Wi-Fi & SIM) Slide set M2.2

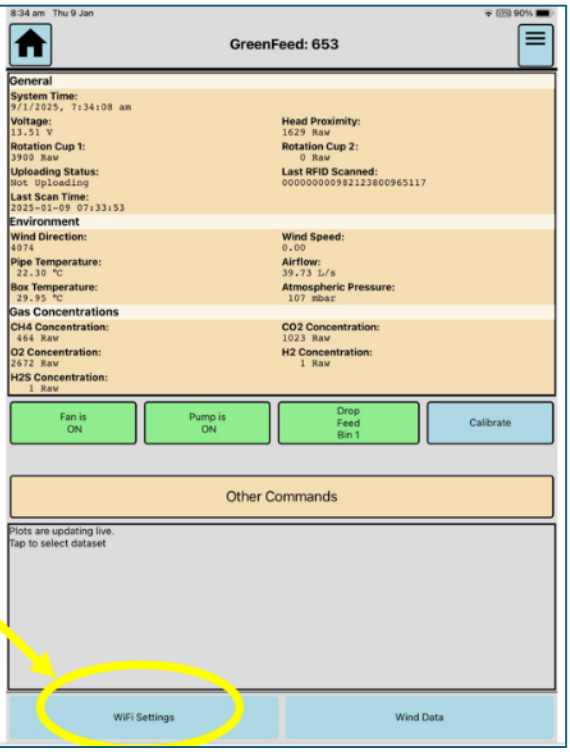
For the Greenfeed to function correctly it is very important that an internet connection be available and maintained between the Greenfeed Unit and C-Lock.
Raw Data is stored in the on-board computer of the Greenfeed unit and is uploaded to the C-lock server every hour where it is processed. With no internet connection c-lock are unable to download data, monitor or control the GF unit, initiate auto-calibration and recoveries, control and monitor feed drops for animals and diagnose and report problems such as changes in airflow, blocked or jammed feeder mechanisms etc.

There are two ways of establishing and internet connection between the GF unit and C-lock.
1. Using a local WIFI with an internet connection and
2. An internet connection via the in-built PEPWAVE modem in the GF unit. This requires an activated Mini SIM (2FF) with a local ISP (Internet Service Provider) and a data plan at least 500MB /Month.

There are a few Firewall Exceptions that maybe required when making the connection
- 22 TCP Outgoing (SSH connection) to greenfeed.c-lockinc.com
- 80 TCP Outgoing (HTTP Connection) to greenfeed.c-lockinc.com
- 80 TCP Outgoing (HTTP Connection) to comm.clockinc.com
- 1883 TCP Outgoing (MQTT Connection) to mqtt.c-lockinc.com
- 123 UDP Incoming/Outgoing (NTP Connection) with ntp.clockinc.com

1. Using a local WIFI with an internet connection

Open your FEEDER APP
Select WiFi Settings



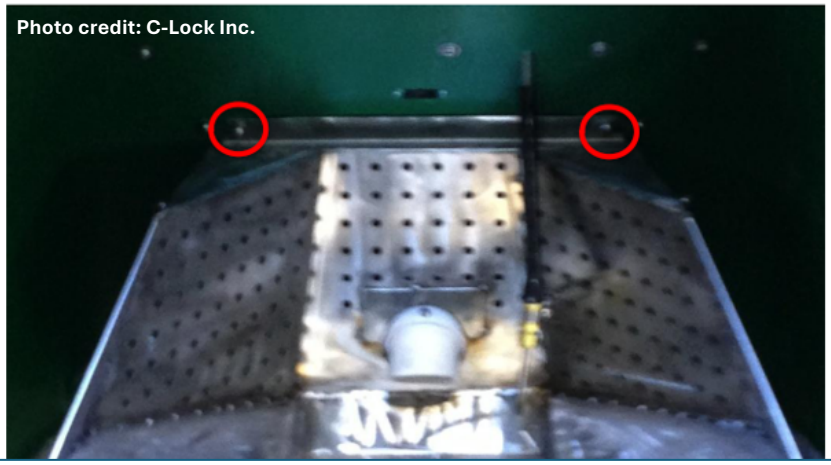
Select Your Local WIFI Network
Select WPA2
If Your Network Has No Password. Select NONE
Otherwise Enter Your Password
Select Add
The System will Automatically Reboot and Connect to the Network
If the FEEDER APP says "Unexpectedly Disconnected" Wait 2 minutes then reconnect

2. An internet connection via the PEPWAVE modem in the GF unit. This requires an activated Mini SIM (2FF) with a local ISP (Internet Service Provider) and a data plan of at least 500MB /Month.

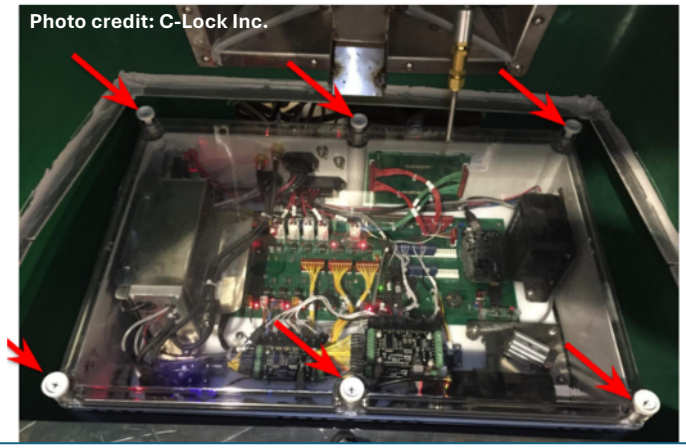
Locate the Modem.
The Modem will be located in the Electronic box under the lid and usually on the right hand side.
The electronic box is located under the feed dish and is encased in a plastic box. Whenever it is necessary to open the electronics box it is VERY IMPORTANT the following precautions are taken.

- The unit is powered down
- The open end of the feed Shute must be covered with a plastic bag to prevent any feed from falling into the box
- Any tools, screws, bolts and nuts must not be allowed to fall into the box
- Keep all liquids away from the area
- Animals must be locked well away from the area

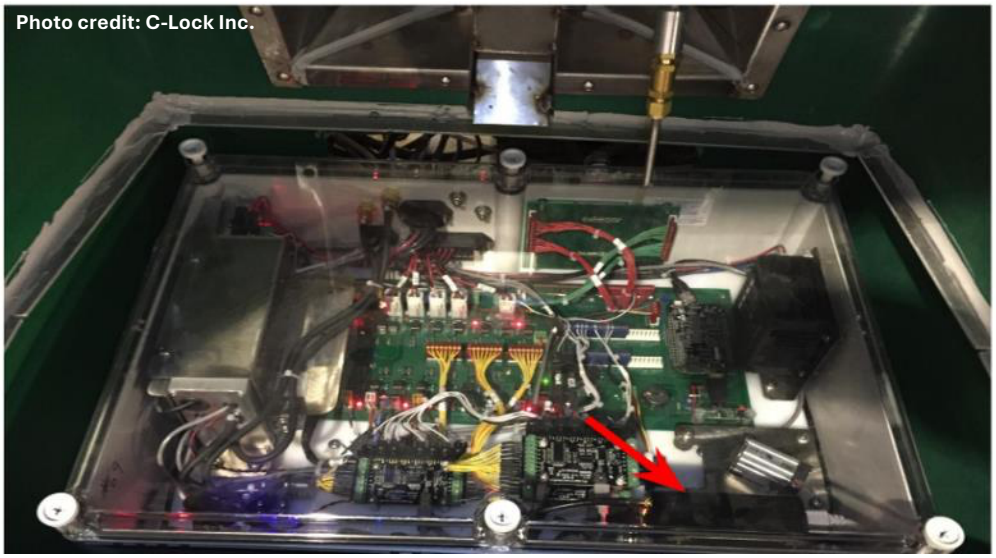
Remove the two(2) screws that hold the feed dish in place. Then Remove the Feed Dish



Place a plastic bag over the feed Shute and fasten with a band or cable tie. Loosen the 6 plastic screws and remove the lid.



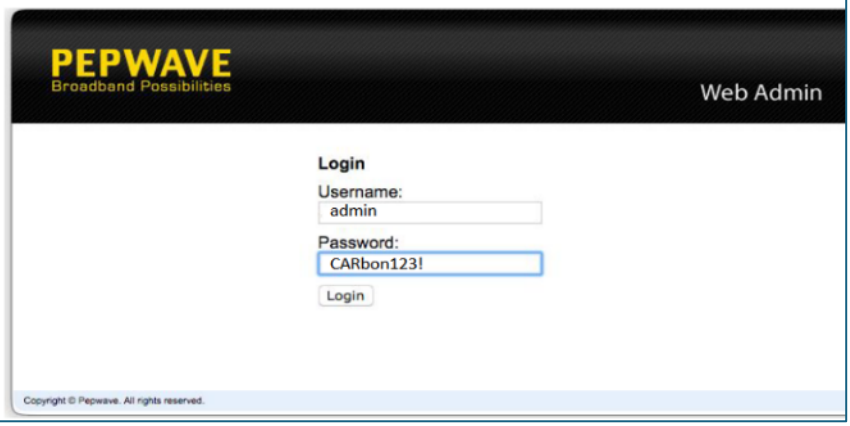
The Modem is usually located at the top right hand corner.

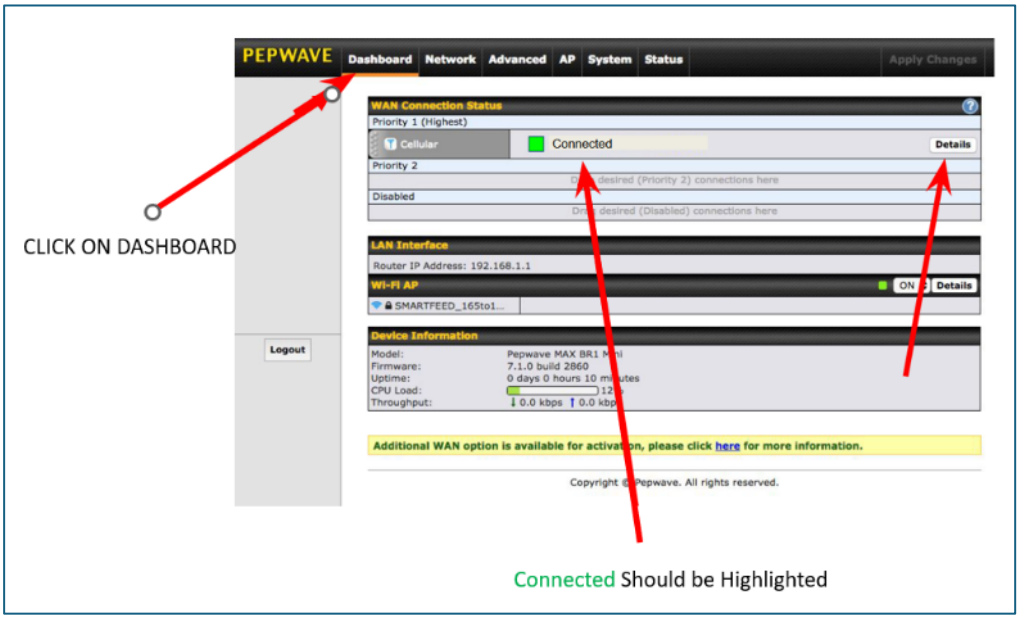


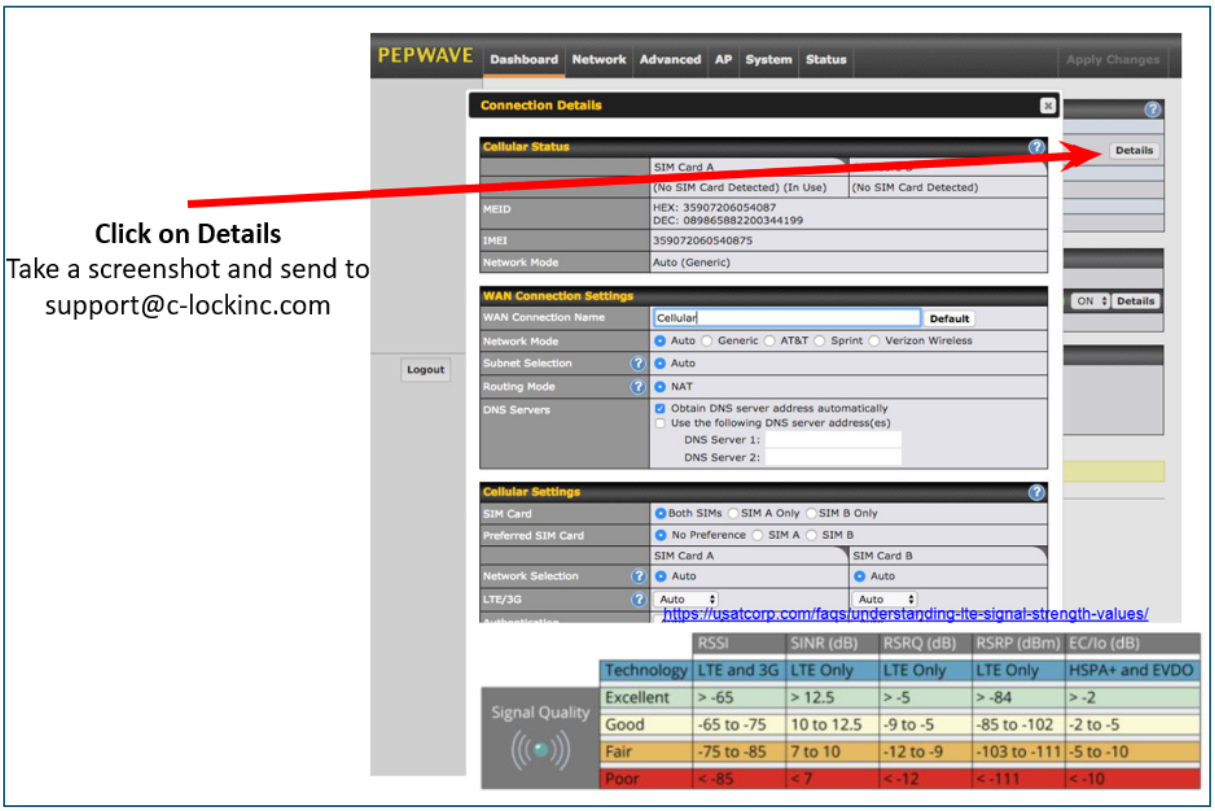
Locate the SIM card slots and Insert the Activated SIM card into port 'A'

Photo credit: C-Lock Inc.

Turn on the power to the Greenfeed
Search for a WIFI called GREENFEED xxx
Connect to this using the password greenfeed
Using a web browser type in http://192.168.1.1
Login using Username :admin and the Password : CARbon123!







2.3: GreenFeed App Download and Introduction

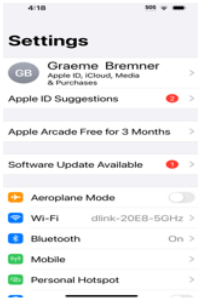
Participants will learn to use the GreenFeed Control Feed App to configure settings and monitor the system's operation in real-time. This is summarised in the 4 points below, then this is explained in detail using the MS PowerPoint (PPT) slides that follow. You can download the app to your phone pre-workshop.

Activities:

1. Connecting the App to the Unit
   - Download the GreenFeed **Control Feed App** from the Apple Store or Google Play.
   - Use Bluetooth or Wi-Fi to connect the app to the GreenFeed unit.
   - Familiarize yourself with the app's user interface and key features.
2. Monitoring in Real-Time
   - Track system metrics such as airflow rate, head proximity, and gas concentrations (CH_4, CO_2, O_2, H_2).
   - Ensure data collection meets the required standards for "Good Data Duration" (≥ 3 minutes per visit).
   - Use the app to trigger commands such as feed drops or initiate calibration processes.
3. Troubleshooting
   - Identify and resolve common errors (e.g., feeder jams or connectivity issues).
   - Practice using the app to reset the unit and check calibration logs.
4. Discussion:
   - Reflect on the challenges and benefits of using the app for remote monitoring.
   - Share best practices for optimizing app connectivity and data accuracy.

2.4 GreenFeed App details (Slide set M2.1)

1. Download the Greenfeed Control Feed App from either the Apple Store or Google store onto your phone or tablet. **Please Download this App to your Mobile Phone**



2. Turn on 'Bluetooth' via 'settings' on your device.

3. Click on the Control Feed App to run.

Important Features of the App to consider

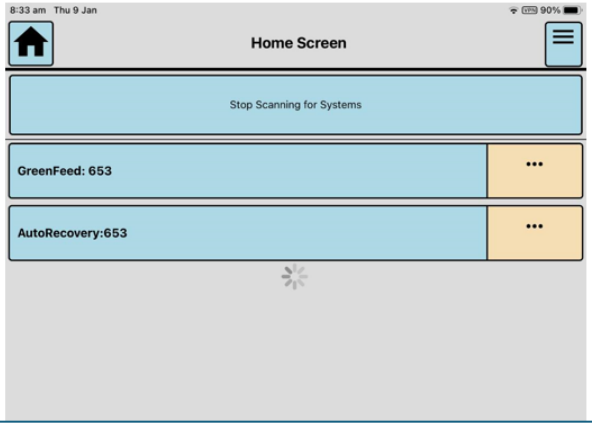
1. No more than one person can be connected at a time.
2. You must be within 10 meters of the Greenfeed unit for the App to connect
3. It is important that the person who carries out the routine maintenance of the Greenfeed unit has access to the App.

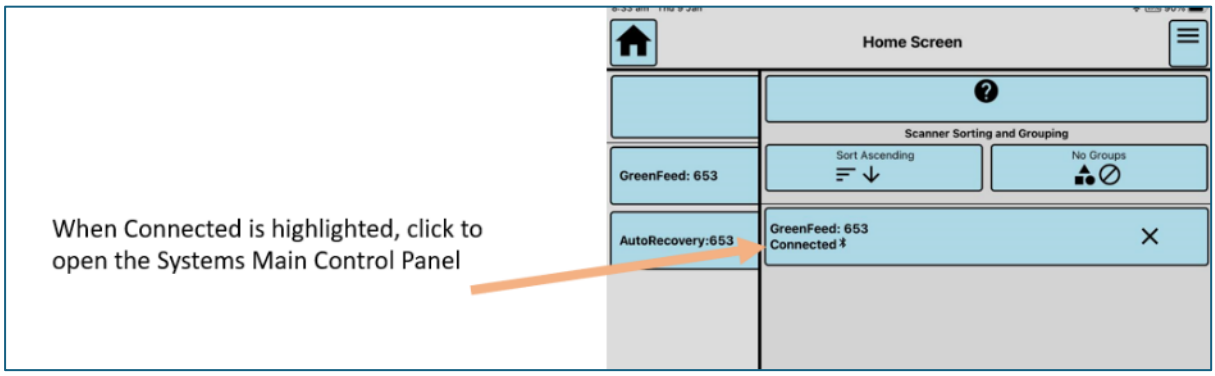
This is the opening page of the App. Click on 'Start Scanning for Systems' to search for Greenfeed Units in range.

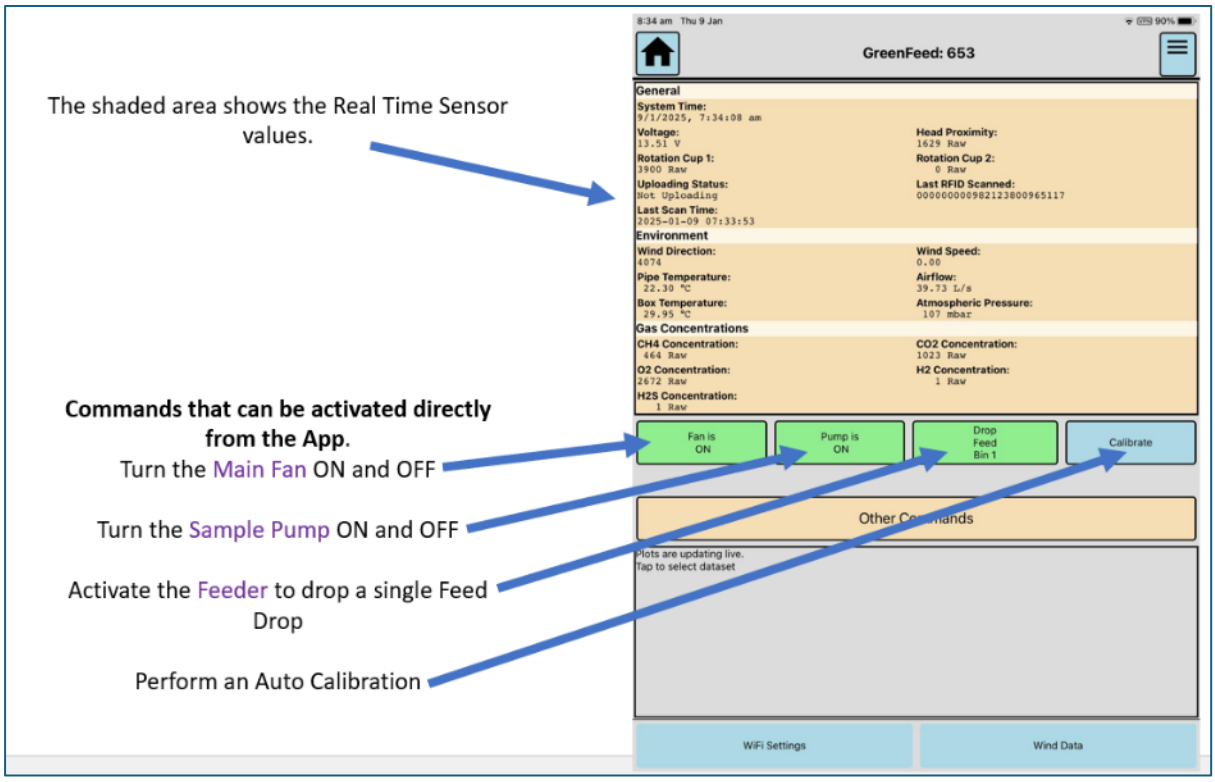
The App will display the Unit Number in range of your device. There will be 2 alternative systems.

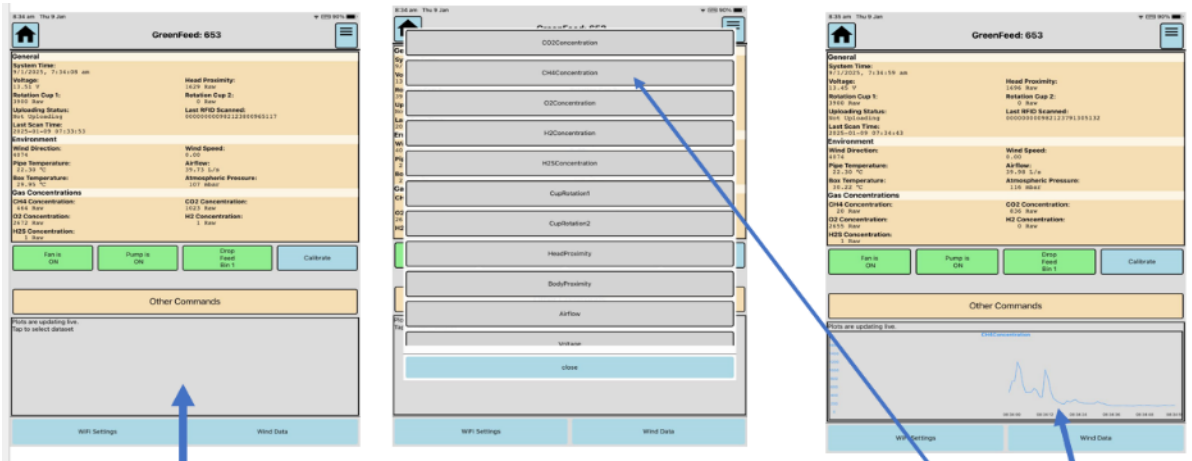
The Greenfeed unit itself, in this case
Greenfeed:653
and
AutoRecovery:653.

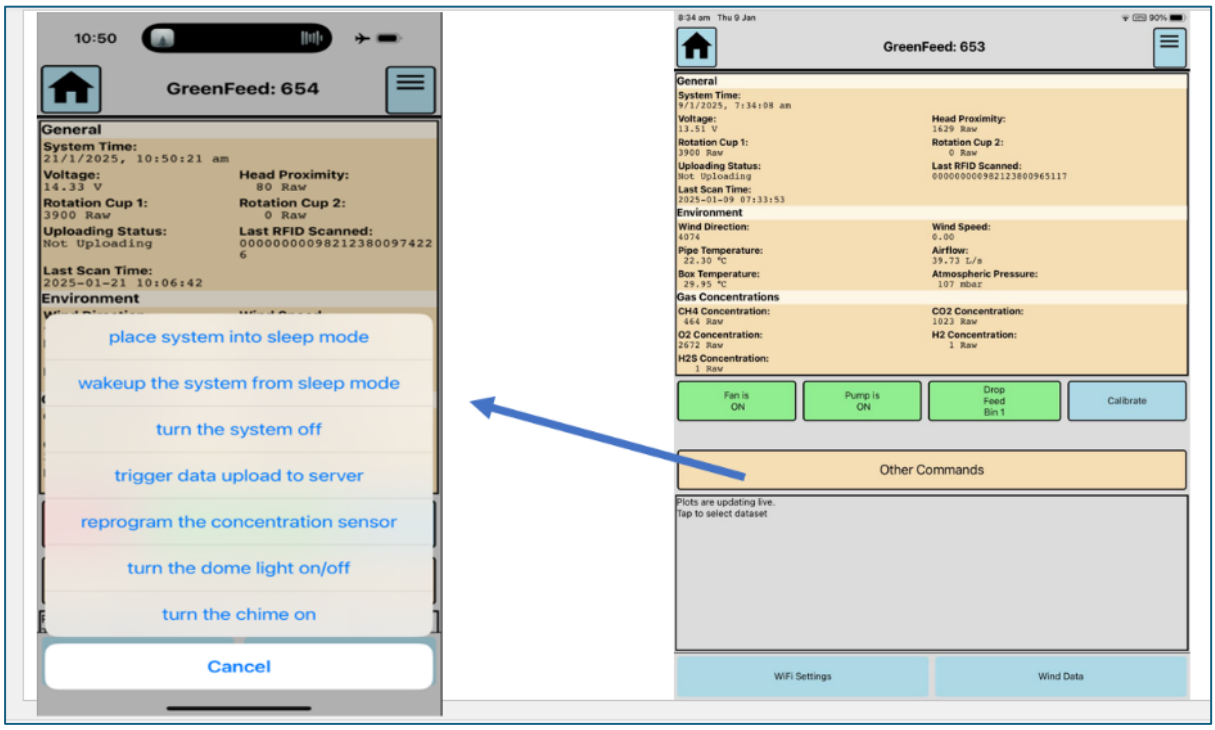
Click on Greenfeed (and the number of your unit) to connect to this system .

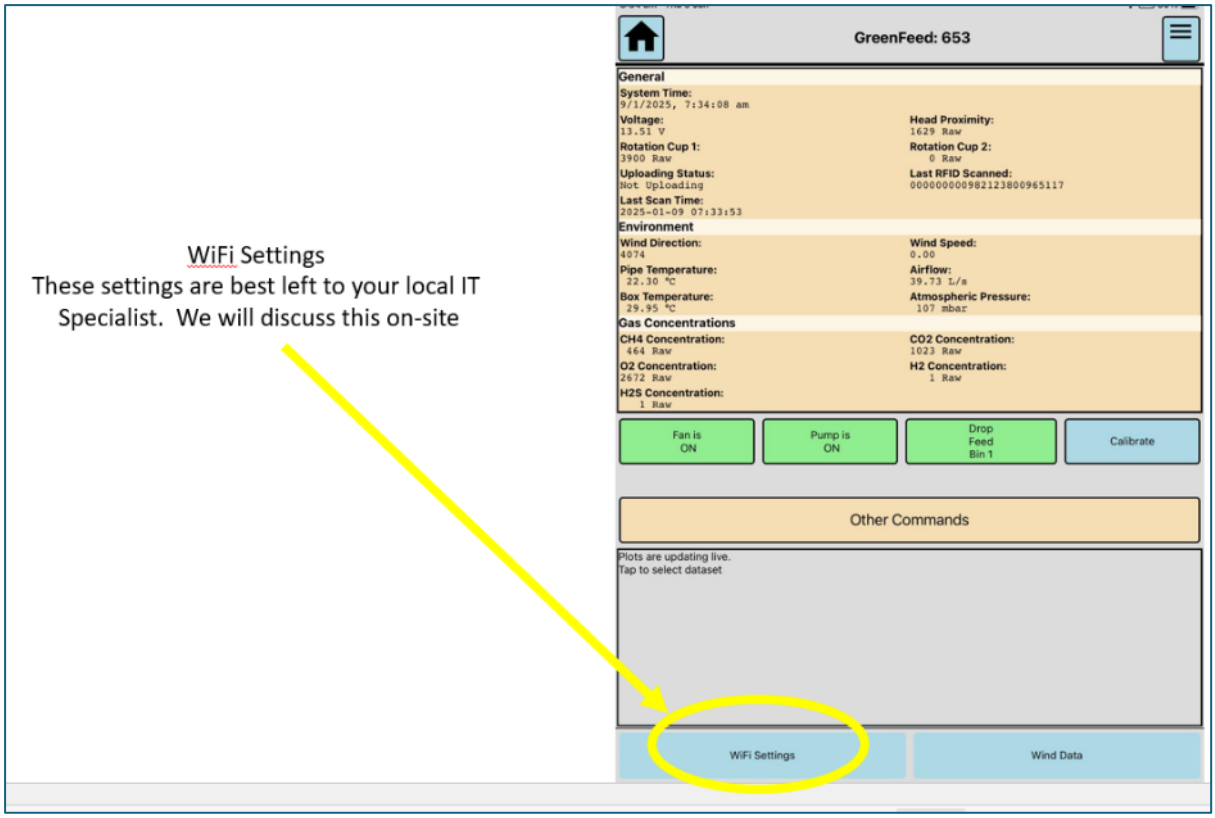



When Connected is highlighted, click to open the Systems Main Control Panel
Home Screen
Scanner Sorting and Grouping
Sort Ascending
No Groups
GreenFeed: 653
AutoRecovery:653
GreenFeed: 653
Connected


The shaded area shows the Real Time Sensor values.
Commands that can be activated directly from the App.
Turn the Main Fan ON and OFF
Turn the Sample Pump ON and OFF
Activate the Feeder to drop a single Feed Drop
Perform an Auto Calibration
GreenFeed: 653
General
System Time:
9/1/2025, 7:34:08 am
Voltage:
13.51 V
Head Proximity:
1629 Raw
Rotation Cup 1:
3900 Raw
Rotation Cup 2:
0 Raw
Uploading Status:
Not Uploading
Last RFID Scanned:
000000000982123800965117
Last Scan Time:
2025-01-09 07:33:53
Environment
Wind Direction:
4074
Wind Speed:
0.00
Pipe Temperature:
22.30 °C
Airflow:
39.73 L/s
Box Temperature:
29.95 °C
Atmospheric Pressure:
107 mbar
Gas Concentrations
CH4 Concentration:
464 Raw
CO2 Concentration:
1023 Raw
O2 Concentration:
2672 Raw
H2 Concentration:
1 Raw
H2S Concentration:
1 Raw
Fan is ON
Pump is ON
Drop Feed Bin 1
Calibrate
Other Commands
Plots are updating live.
Tap to select dataset
WiFi Settings
Wind Data


By clicking anywhere in the grey area above, a selection of the available sensors will be displayed.
By Selecting from the values, a plot of live data will be displayed.


10:50
GreenFeed: 654
General
System Time:
21/1/2025, 10:50:21 am
Voltage:
14.33 V
Head Proximity:
80 Raw
Rotation Cup 1:
3900 Raw
Rotation Cup 2:
0 Raw
Uploading Status:
Not Uploading
Last RFID Scanned:
Last Scan Time:
2025-01-21 10:06:42
Environment
place system into sleep mode
wakeup the system from sleep mode
turn the system off
trigger data upload to server
reprogram the concentration sensor
turn the dome light on/off
turn the chime on
Cancel
GreenFeed: 653
General
System Time:
9/1/2025, 7:34:08 am
Voltage:
13.51 V
Head Proximity:
1629 Raw
Rotation Cup 1:
3900 Raw
Rotation Cup 2:
0 Raw
Uploading Status:
Not Uploading
Last RFID Scanned:
Last Scan Time:
2025-01-09 07:33:53
Environment
Wind Direction:
4074
Wind Speed:
0.00
Pipe Temperature:
22.30 °C
Airflow:
39.73 L/s
Box Temperature:
29.95 °C
Atmospheric Pressure:
107 mbar
Gas Concentrations
CH4 Concentration:
464 Raw
CO2 Concentration:
1023 Raw
O2 Concentration:
2672 Raw
H2 Concentration:
1 Raw
H2S Concentration:
1 Raw
Fan is ON
Pump is ON
Drop Feed Bin 1
Calibrate
Other Commands
Plots are updating live.
Tap to select dataset
WiFi Settings
Wind Data


WiFi Settings
These settings are best left to your local IT Specialist. We will discuss this on-site
GreenFeed: 653
General
System Time:
9/1/2025, 7:34:08 am
Voltage:
13.51 V
Head Proximity:
1629 Raw
Rotation Cup 1:
3900 Raw
Rotation Cup 2:
0 Raw
Uploading Status:
Not Uploading
Last RFID Scanned:
Last Scan Time:
2025-01-09 07:33:53
Environment
Wind Direction:
4074
Wind Speed:
0.00
Pipe Temperature:
22.30 °C
Airflow:
39.73 L/s
Box Temperature:
29.95 °C
Atmospheric Pressure:
107 mbar
Gas Concentrations
CH4 Concentration:
464 Raw
CO2 Concentration:
1023 Raw
O2 Concentration:
2672 Raw
H2 Concentration:
1 Raw
H2S Concentration:
1 Raw
Fan is ON
Pump is ON
Drop Feed Bin 1
Calibrate
Other Commands
Plots are updating live.
Tap to select dataset
WiFi Settings
Wind Data

2.5 Practice with App. [Practical 2]

In the classroom with the GreenFeed unit, we will have individuals run through some assigned tasks on the app cast on the big screen so we all learn the app functionality. These exercises are provided in a separate booklet.

2.6 Power Options (Slide set 2.6)

GreenFeed units can operate using the following power sources:

1. Standard AC Power
    - Requires a grounded outlet (110V or 220V)
    - Recommended for indoor or confined settings where access to AC power is readily available
2. Solar Power
    - Equipped with solar panels for outdoor use in remote or pasture settings
    - Includes a battery storage system to ensure continuous operation even during low sunlight periods
    - Important considerations:
        - Adjust solar panel angles based on latitude and season
        - Regularly clean the panels to maximize efficiency
3. Battery Backup
    - Supports uninterrupted operation during power outages
    - Recommended for critical trials where data integrity is paramount
4. Tips for Power Setup
    - Position the power source safely away from cattle and other animals
    - Secure cables to prevent damage and ensure proper grounding to avoid electrical hazards
    - **Do not** use power sources not approved by C-lock as this can hinder the warranty.

Module 3: System Setup, Tests, and Troubleshooting

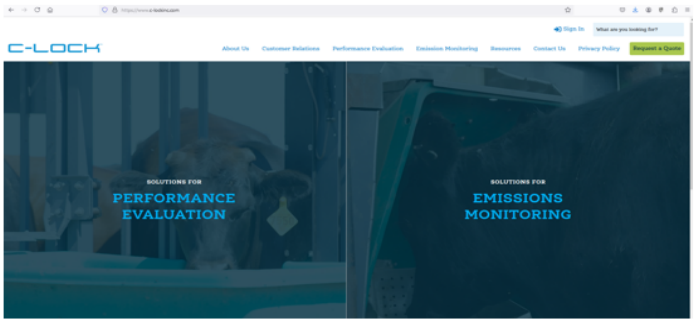
3.1 Using the GreenFeed User Interface (Slide set 3.1)

The Greenfeed User Interface is accessed via the C-lock home page *https://www.c-lockinc.com/*

The Greenfeed User interface is used to monitor Greenfeed units and set certain parameters, control system functions and review and download raw and processed data.

Owners of Greenfeed units have a their own unique user name and password . If an individual or organisation owns more than one unit, all units will be available on the same username account.

The Greenfeed User Interface is accessed via the C-lock home page *https://www.c-lockinc.com/*



Owners of Greenfeed units have a their own unique user name and password . If an individual or organisation owns more than one unit, all units will be available on the same username account.

GREENFEED SMARTFEED

Click here to start a GreenFeed Experiment (Pre-Experiment Checklist)

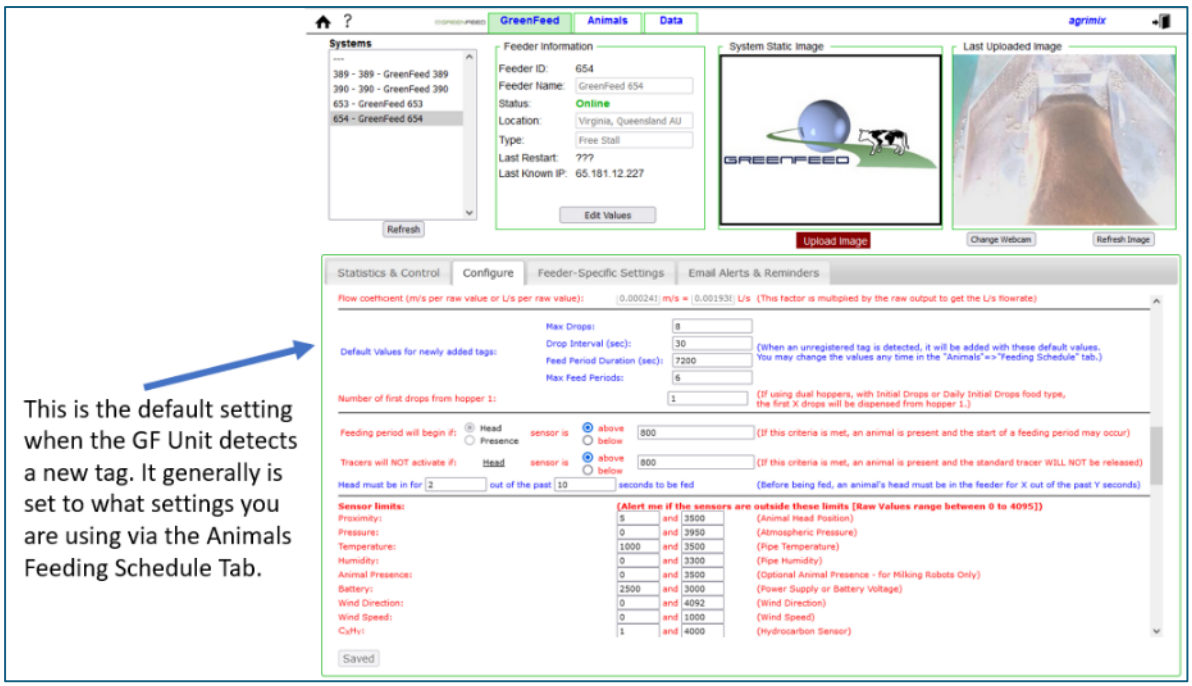
Account Notes

Delete	Entry Time (UTC)	Note
	Add	Enter a note
X	2023-01-08 21:14:45	support@c-lockinc.com

The opening screen displays all available units belonging to the particular User Account. Units highlighted in GREEN mean the units have recently been seen by the system. Units highlighted in RED mean the unit has not been seen for a short period and those shaded black, means the unit has not been sited for a length of time.
The bracketed time is the elapsed time since the system was last seen.

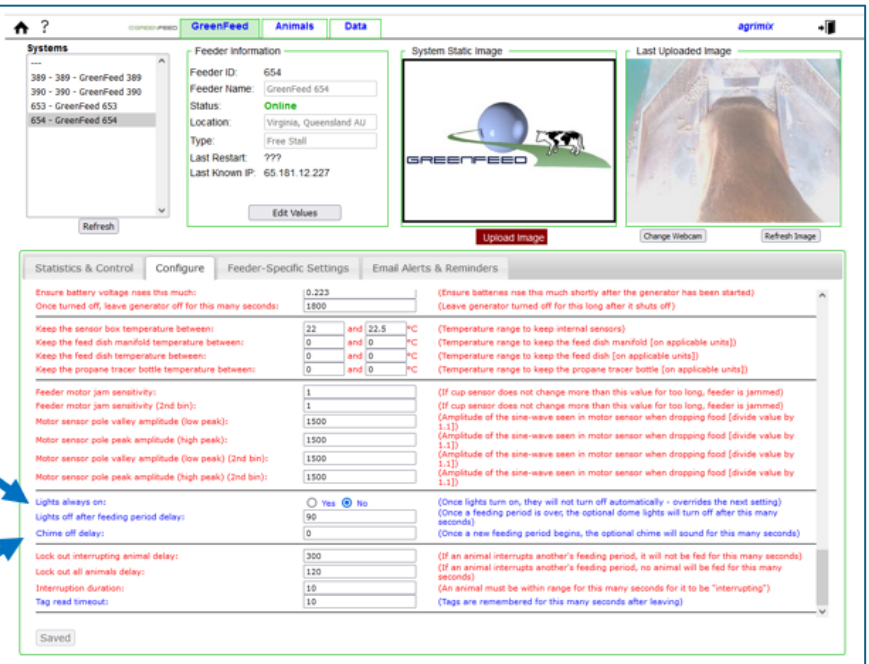
This will vary according to the type of feed used in the feeder. It should be changed when required

Under the Configure dropdown menu the items in Blue are the only options that should be changed by the user. The user should contact C-Lock support should they wish to change the options in Red.

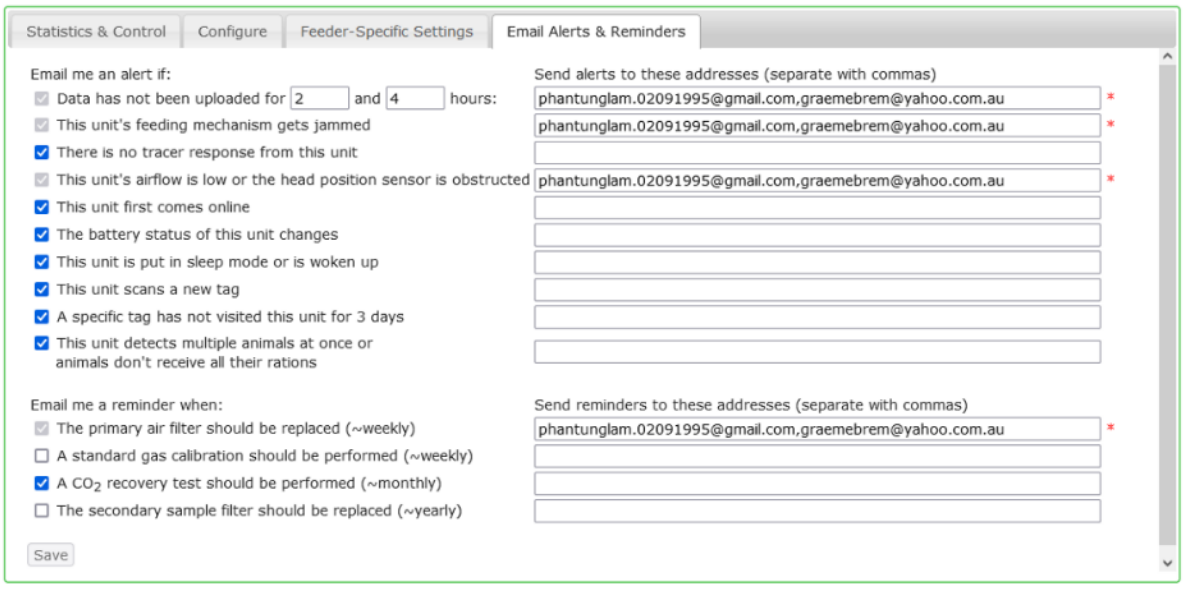


This is the default setting when the GF Unit detects a new tag. It generally is set to what settings you are using via the Animals Feeding Schedule Tab.

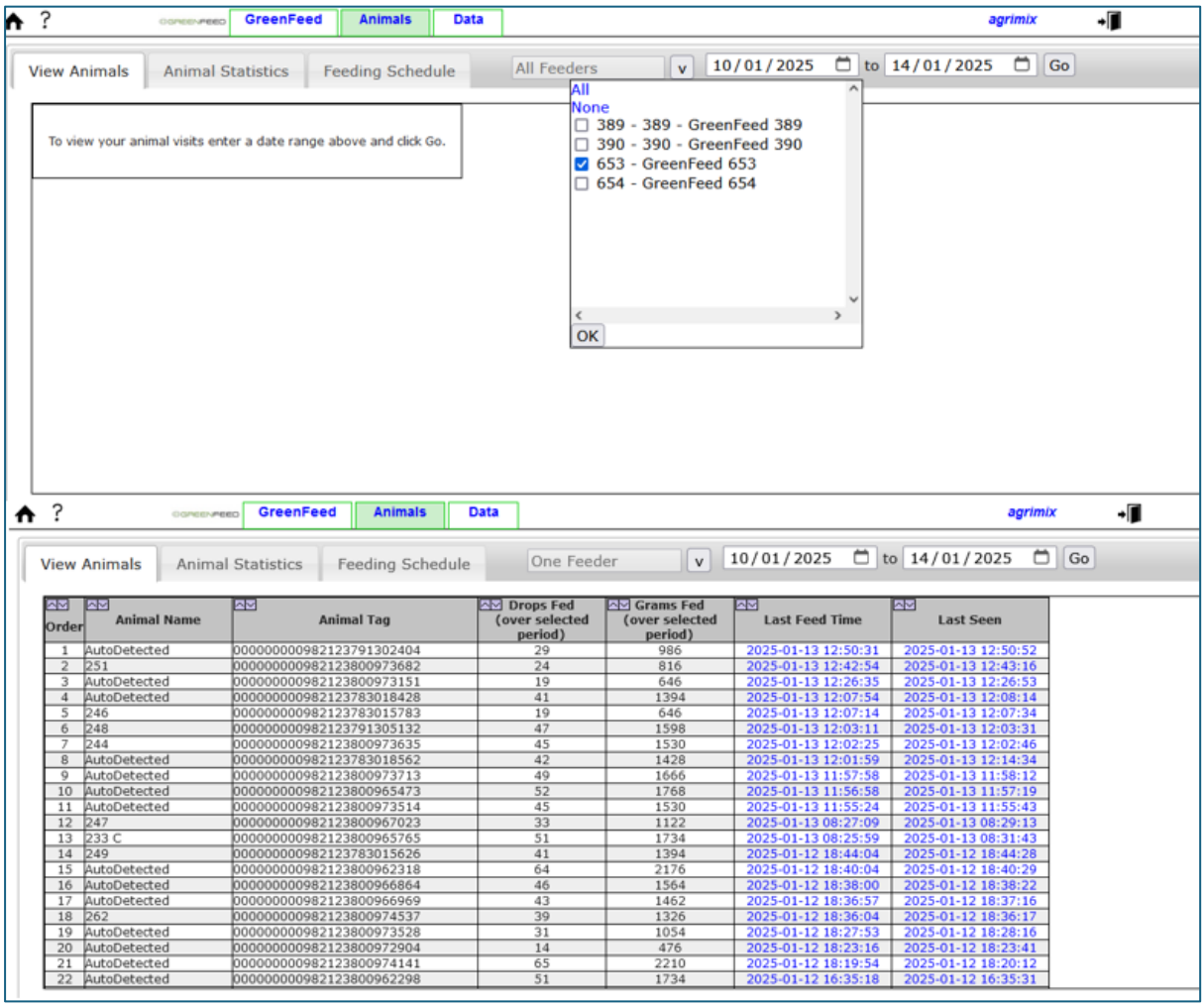
Having the lights on may help in the initial stages of training however, some users find the lights attract bugs at night which tend to block the airflow manifold



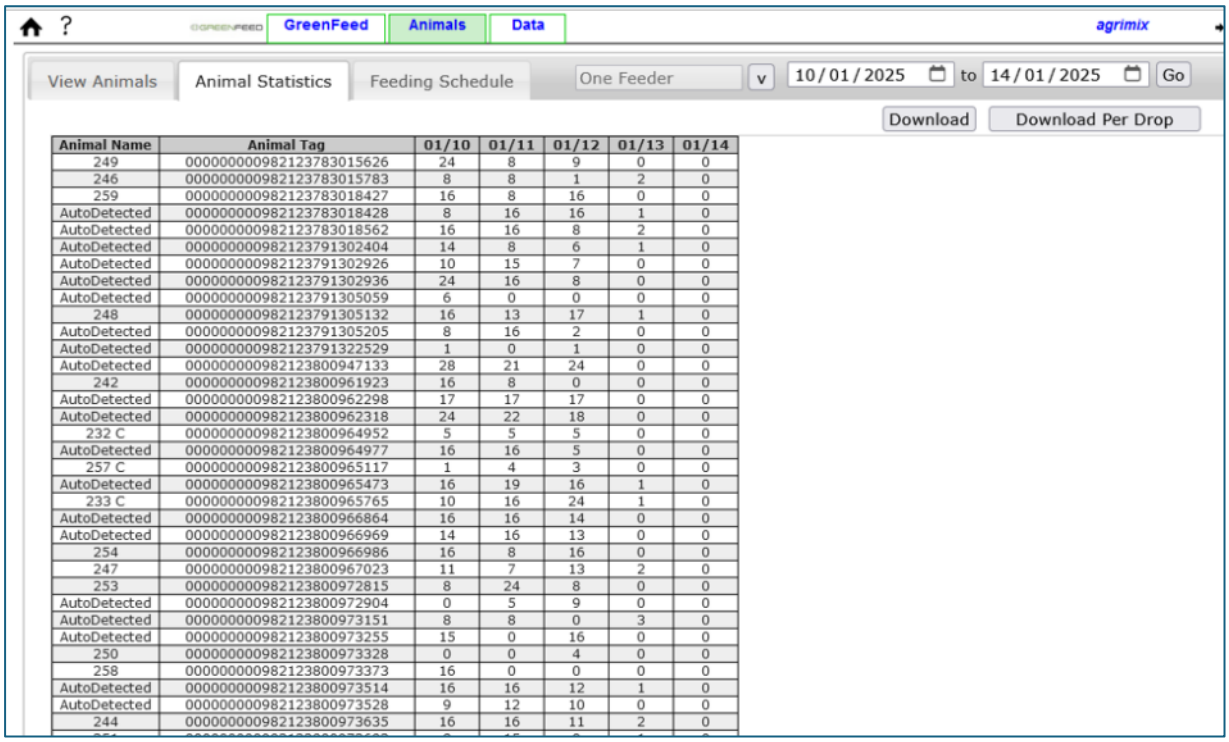
The sounding of the chime is used to attached animals to the GF unit when they become accustomed to the sound being associated with feeding. However, some users do find that certain animals are frightened by the chime.



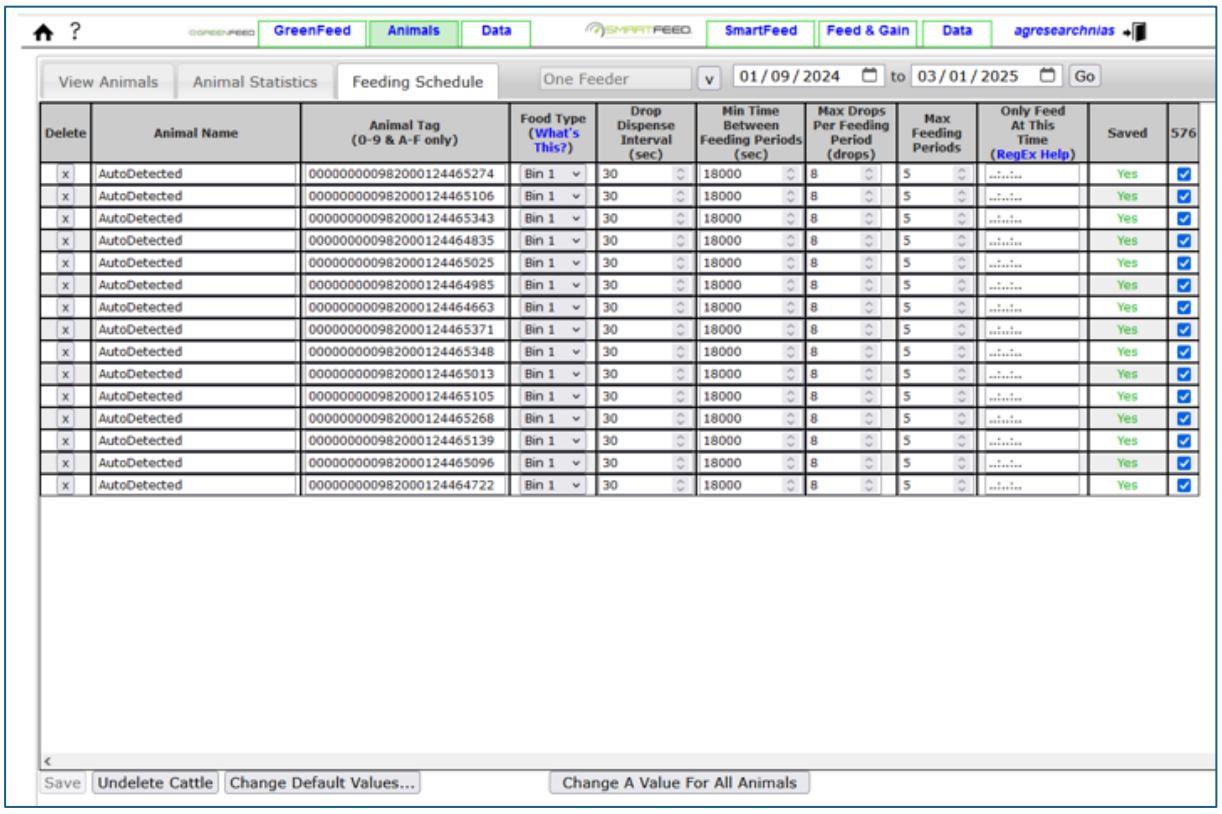
The user can be sent a number of Email Alerts and reminders and who they are sent to.

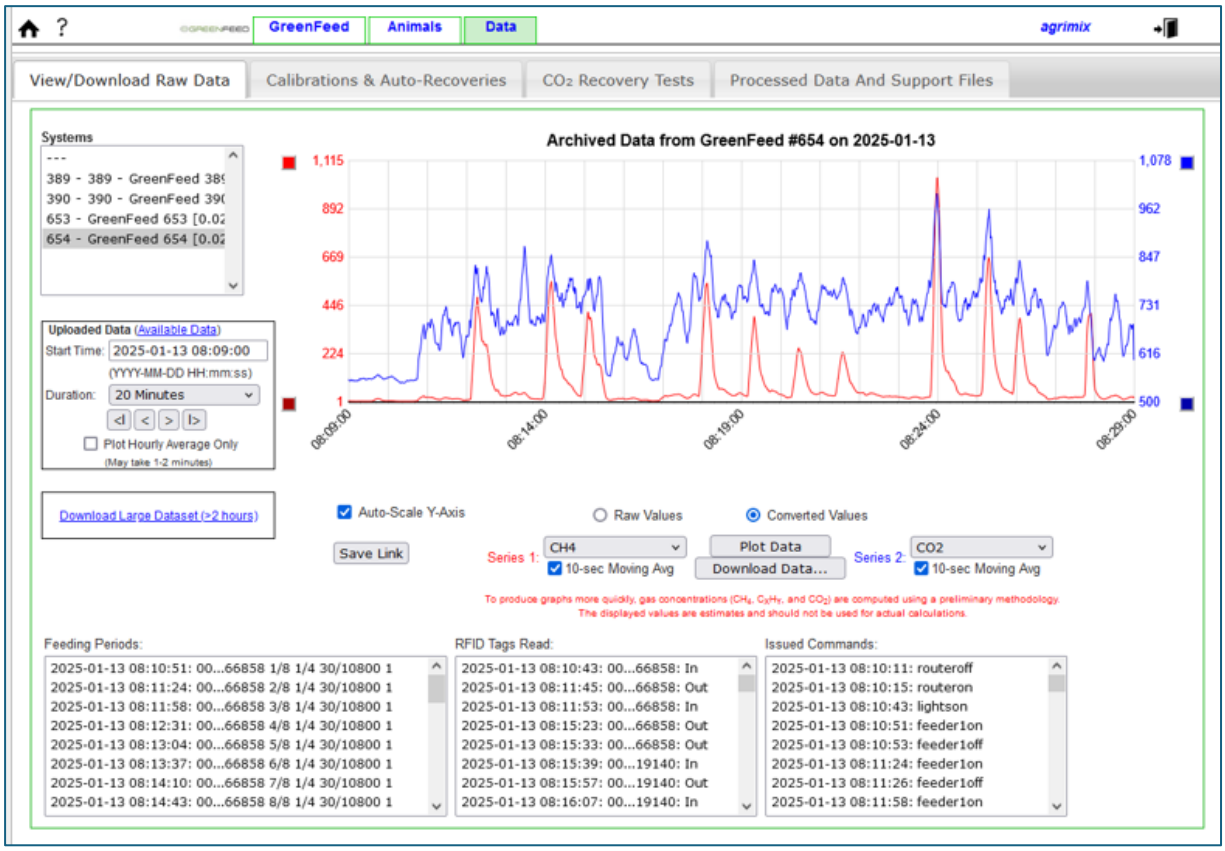


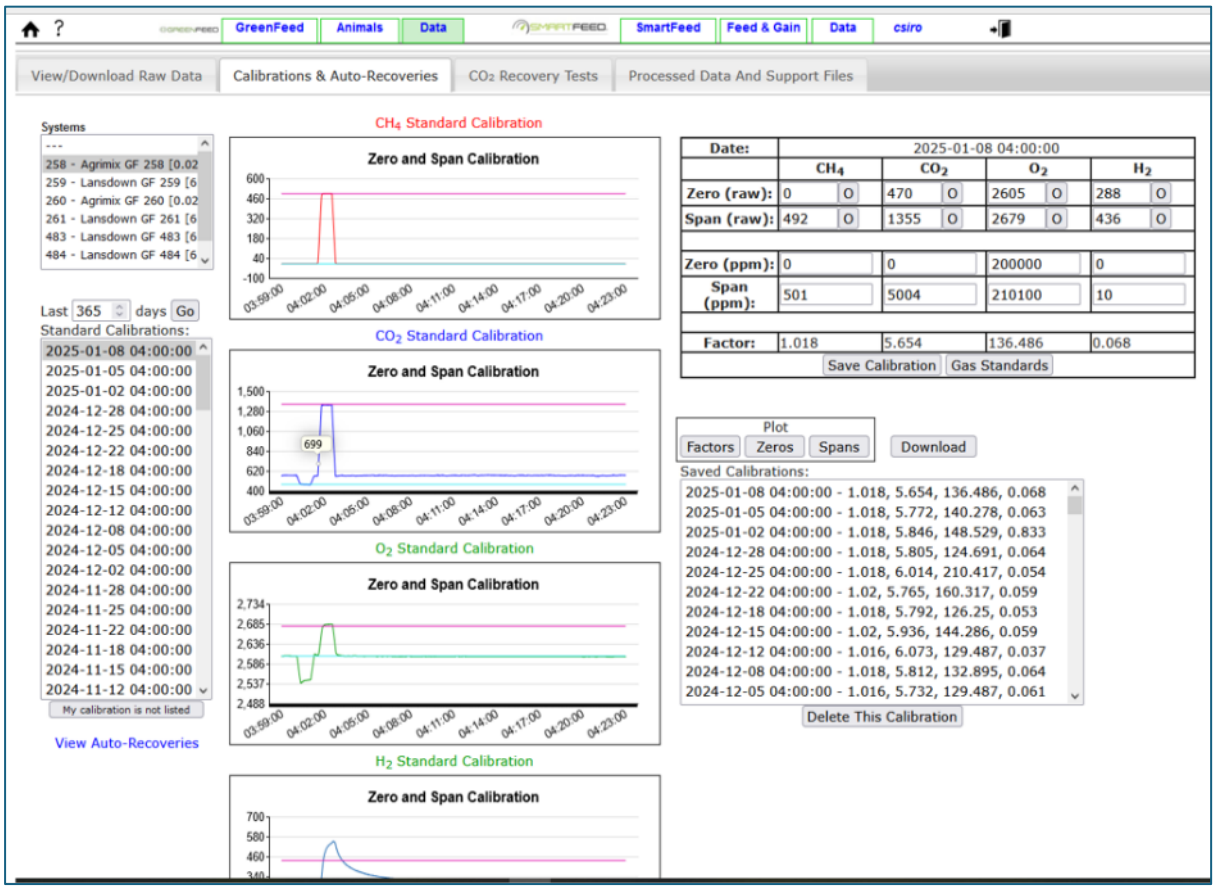
Order	Animal Name	Animal Tag	Drops Fed (over selected period)	Grams Fed (over selected period)	Last Feed Time	Last Seen
1	AutoDetected	0000000009821237913024O4	29	986	2025-01-13 12:50:31	2025-01-13 12:50:52
2	251	000000000982123800973682	24	816	2025-01-13 12:42:54	2025-01-13 12:43:16
3	AutoDetected	000000000982123800973151	19	646	2025-01-13 12:26:35	2025-01-13 12:26:53
4	AutoDetected	000000000982123783018428	41	1394	2025-01-13 12:07:54	2025-01-13 12:08:14
5	246	000000000982123783015783	19	646	2025-01-13 12:07:14	2025-01-13 12:07:34
6	248	000000000982123791305132	47	1598	2025-01-13 12:03:11	2025-01-13 12:03:31
7	244	000000000982123800973635	45	1530	2025-01-13 12:02:25	2025-01-13 12:02:46
8	AutoDetected	000000000982123783018562	42	1428	2025-01-13 12:01:59	2025-01-13 12:14:34
9	AutoDetected	000000000982123800973713	49	1666	2025-01-13 11:57:58	2025-01-13 11:58:12
10	AutoDetected	000000000982123800965473	52	1768	2025-01-13 11:56:58	2025-01-13 11:57:19
11	AutoDetected	000000000982123800973514	45	1530	2025-01-13 11:55:24	2025-01-13 11:55:43
12	247	000000000982123800967023	33	1122	2025-01-13 08:27:09	2025-01-13 08:29:13
13	233 C	000000000982123800965765	51	1734	2025-01-13 08:25:59	2025-01-13 08:31:43
14	249	000000000982123783015626	41	1394	2025-01-12 18:44:04	2025-01-12 18:44:28
15	AutoDetected	000000000982123800962318	64	2176	2025-01-12 18:40:04	2025-01-12 18:40:29
16	AutoDetected	000000000982123800966864	46	1564	2025-01-12 18:38:00	2025-01-12 18:38:22
17	AutoDetected	000000000982123800966969	43	1462	2025-01-12 18:36:57	2025-01-12 18:37:16
18	262	000000000982123800974537	39	1326	2025-01-12 18:36:04	2025-01-12 18:36:17
19	AutoDetected	000000000982123800973528	31	1054	2025-01-12 18:27:53	2025-01-12 18:28:16
20	AutoDetected	000000000982123800972904	14	476	2025-01-12 18:23:16	2025-01-12 18:23:41
21	AutoDetected	000000000982123800974141	65	2210	2025-01-12 18:19:54	2025-01-12 18:20:12
22	AutoDetected	000000000982123800962298	51	1734	2025-01-12 16:35:18	2025-01-12 16:35:31

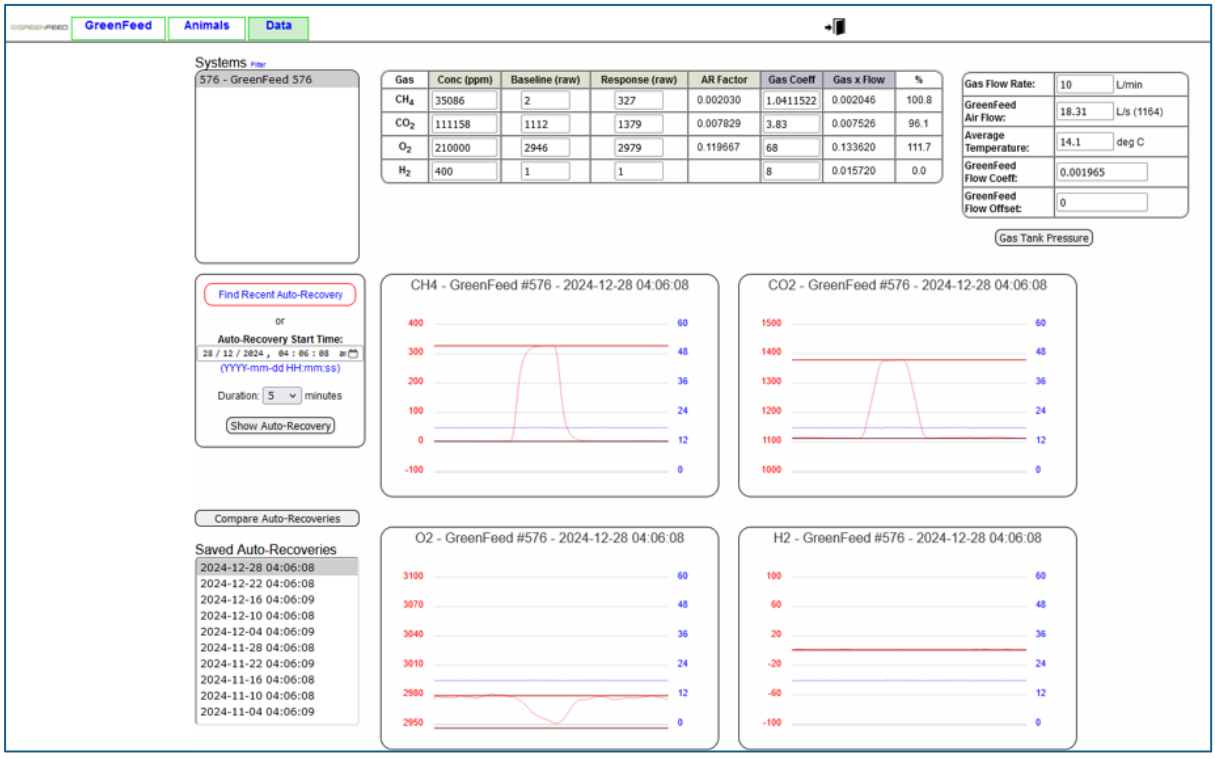


Animal Name	Animal Tag	01/10	01/11	01/12	01/13	01/14
249	000000000982123783015626	24	8	9	0	0
246	000000000982123783015783	8	8	1	2	0
259	000000000982123783018427	16	8	16	0	0
AutoDetected	000000000982123783018428	8	16	16	1	0
AutoDetected	000000000982123783018562	16	16	8	2	0
AutoDetected	000000000982123791302404	14	8	6	1	0
AutoDetected	000000000982123791302926	10	15	7	0	0
AutoDetected	000000000982123791302936	24	16	8	0	0
AutoDetected	000000000982123791305059	6	0	0	0	0
248	000000000982123791305132	16	13	17	1	0
AutoDetected	000000000982123791305205	8	16	2	0	0
AutoDetected	000000000982123791322529	1	0	1	0	0
AutoDetected	000000000982123800947133	28	21	24	0	0
242	000000000982123800961923	16	8	0	0	0
AutoDetected	000000000982123800962298	17	17	17	0	0
AutoDetected	000000000982123800962318	24	22	18	0	0
232 C	000000000982123800964952	5	5	5	0	0
AutoDetected	000000000982123800964977	16	16	5	0	0
257 C	000000000982123800965117	1	4	3	0	0
AutoDetected	000000000982123800965473	16	19	16	1	0
233 C	000000000982123800965765	10	16	24	1	0
AutoDetected	000000000982123800966864	16	16	14	0	0
AutoDetected	000000000982123800966969	14	16	13	0	0
254	000000000982123800966986	16	8	16	0	0
247	000000000982123800967023	11	7	13	2	0
253	000000000982123800972815	8	24	8	0	0
AutoDetected	000000000982123800972904	0	5	9	0	0
AutoDetected	000000000982123800973151	8	8	0	3	0
AutoDetected	000000000982123800973255	15	0	16	0	0
250	000000000982123800973328	0	0	4	0	0
258	000000000982123800973373	16	0	0	0	0
AutoDetected	000000000982123800973514	16	16	12	1	0
AutoDetected	000000000982123800973528	9	12	10	0	0
244	000000000982123800973635	16	16	11	2	0

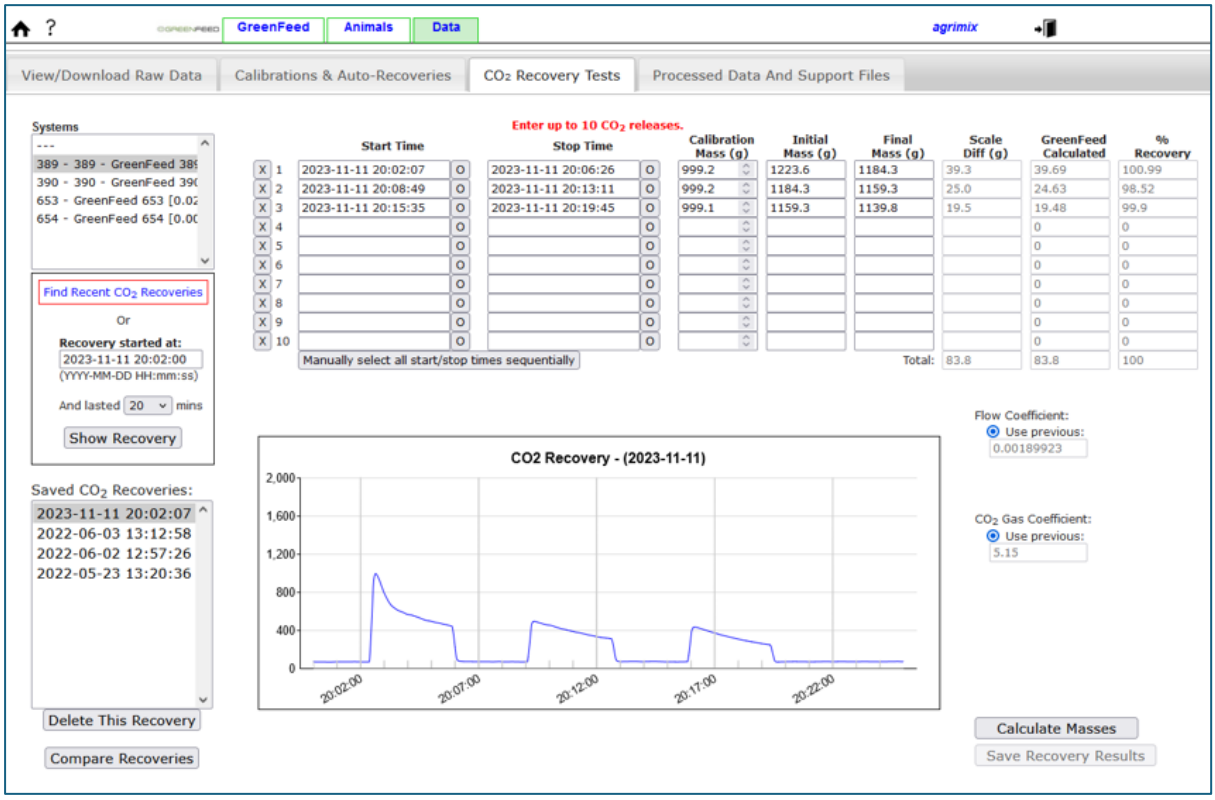

GreenFeed
Animals
Data
SmartFeed
Feed & Gain
Data
agresearchnias
View Animals
Animal Statistics
Feeding Schedule
One Feeder
01/09/2024
to
03/01/2025
Go
Delete
Animal Name
Animal Tag (0-9 & A-F only)
Food Type (What's This?)
Drop Dispense Interval (sec)
Min Time Between Feeding Periods (sec)
Max Drops Per Feeding Period (drops)
Max Feeding Periods
Only Feed At This Time (RegEx Help)
Saved
576
AutoDetected
Bin 1
30
18000
8
5
Yes
Save
Undelete Cattle
Change Default Values...
Change A Value For All Animals

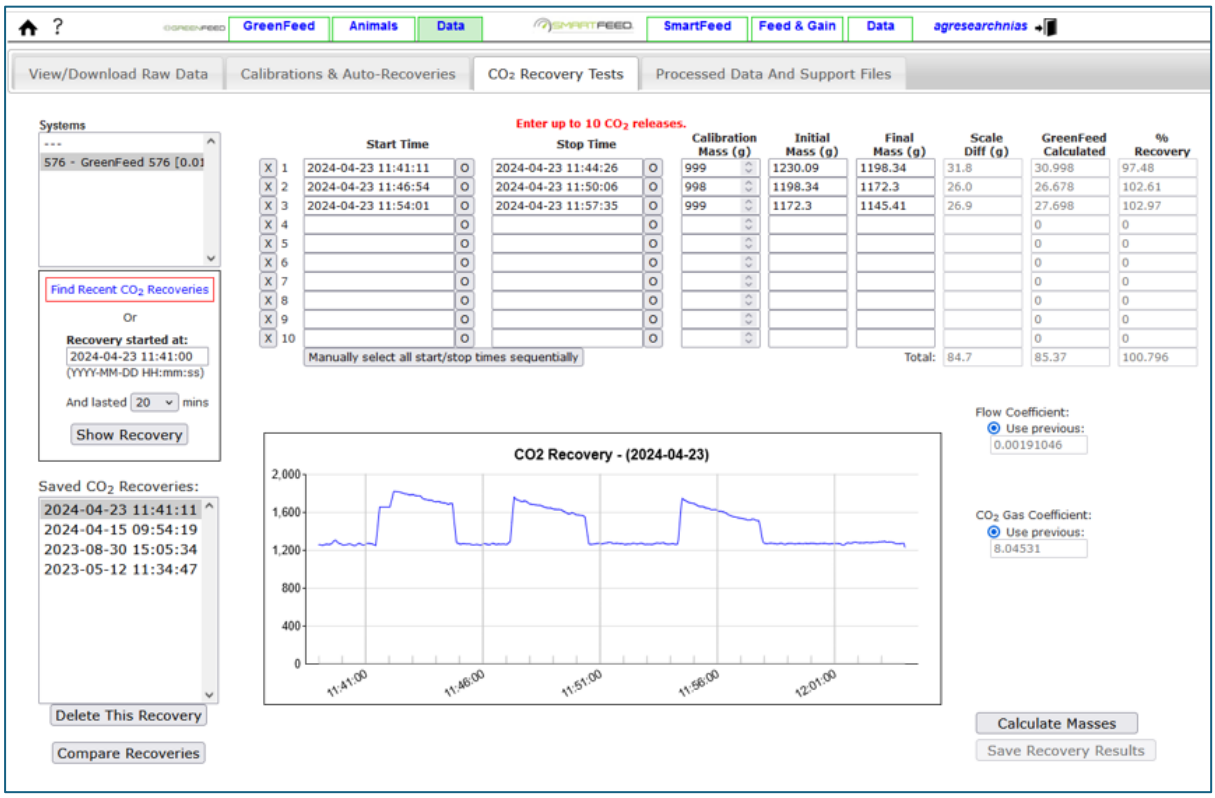

GreenFeed
Animals
Data
agrimix
View/Download Raw Data
Calibrations & Auto-Recoveries
CO2 Recovery Tests
Processed Data And Support Files
Systems
389 - 389 - GreenFeed 389
390 - 390 - GreenFeed 390
653 - GreenFeed 653 [0.02
654 - GreenFeed 654 [0.02
Archived Data from GreenFeed #654 on 2025-01-13
1,115
892
669
446
224
1
1,078
962
847
731
616
500
08:09:00
08:14:00
08:19:00
08:24:00
08:29:00
Uploaded Data (Available Data)
Start Time: 2025-01-13 08:09:00
(YYYY-MM-DD HH:mm:ss)
Duration: 20 Minutes
Plot Hourly Average Only
(May take 1-2 minutes)
Download Large Dataset (>2 hours)
Auto-Scale Y-Axis
Raw Values
Converted Values
Save Link
Series 1: CH4
10-sec Moving Avg
Plot Data
Download Data...
Series 2: CO2
10-sec Moving Avg
To produce graphs more quickly, gas concentrations (CH_4, C_3H_8, and CO_2) are computed using a preliminary methodology.
The displayed values are estimates and should not be used for actual calculations.
Feeding Periods:
2025-01-13 08:10:51: 00...66858 1/8 1/4 30/10800 1
2025-01-13 08:11:24: 00...66858 2/8 1/4 30/10800 1
2025-01-13 08:11:58: 00...66858 3/8 1/4 30/10800 1
2025-01-13 08:12:31: 00...66858 4/8 1/4 30/10800 1
2025-01-13 08:13:04: 00...66858 5/8 1/4 30/10800 1
2025-01-13 08:13:37: 00...66858 6/8 1/4 30/10800 1
2025-01-13 08:14:10: 00...66858 7/8 1/4 30/10800 1
2025-01-13 08:14:43: 00...66858 8/8 1/4 30/10800 1
RFID Tags Read:
2025-01-13 08:10:43: 00...66858: In
2025-01-13 08:11:45: 00...66858: Out
2025-01-13 08:11:53: 00...66858: In
2025-01-13 08:15:23: 00...66858: Out
2025-01-13 08:15:33: 00...66858: Out
2025-01-13 08:15:39: 00...19140: In
2025-01-13 08:15:57: 00...19140: Out
2025-01-13 08:16:07: 00...19140: In
Issued Commands:
2025-01-13 08:10:11: routeroff
2025-01-13 08:10:15: routeron
2025-01-13 08:10:43: lightson
2025-01-13 08:10:51: feeder1on
2025-01-13 08:10:53: feeder1off
2025-01-13 08:11:24: feeder1on
2025-01-13 08:11:26: feeder1off
2025-01-13 08:11:58: feeder1on

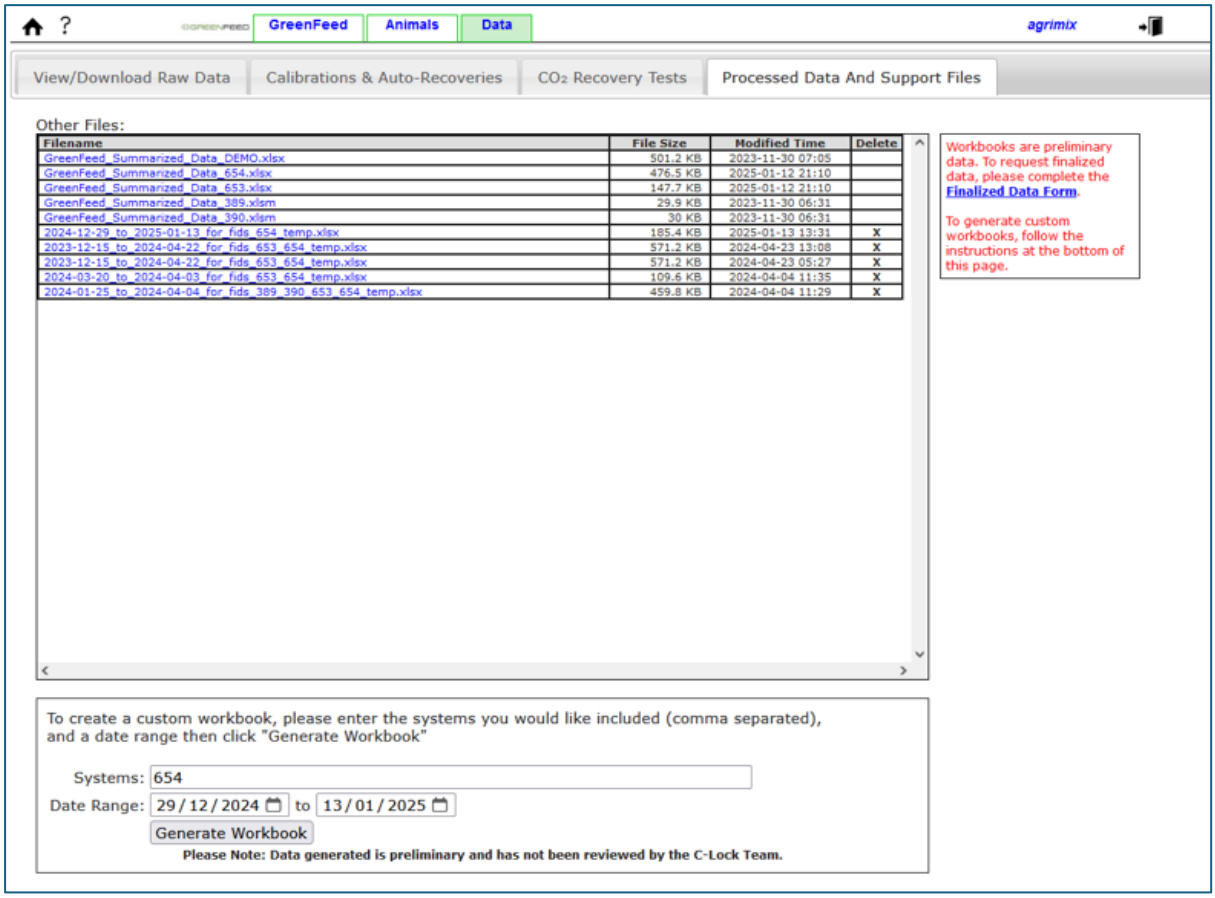

GreenFeed
Animals
Data
SmartFeed
Feed & Gain
Data
csiro
View/Download Raw Data
Calibrations & Auto-Recoveries
CO2 Recovery Tests
Processed Data And Support Files
Systems
258 - Agrimix GF 258 [0.02
259 - Lansdown GF 259 [6
260 - Agrimix GF 260 [0.02
261 - Lansdown GF 261 [6
483 - Lansdown GF 483 [6
484 - Lansdown GF 484 [6
Last 365 days Go
Standard Calibrations:
2025-01-08 04:00:00
2025-01-05 04:00:00
2025-01-02 04:00:00
2024-12-28 04:00:00
2024-12-25 04:00:00
2024-12-22 04:00:00
2024-12-18 04:00:00
2024-12-15 04:00:00
2024-12-12 04:00:00
2024-12-08 04:00:00
2024-12-05 04:00:00
2024-12-02 04:00:00
2024-11-28 04:00:00
2024-11-25 04:00:00
2024-11-22 04:00:00
2024-11-18 04:00:00
2024-11-15 04:00:00
2024-11-12 04:00:00
My calibration is not listed
View Auto-Recoveries
CH4 Standard Calibration
Zero and Span Calibration
CO2 Standard Calibration
Zero and Span Calibration
699
O2 Standard Calibration
Zero and Span Calibration
H2 Standard Calibration
Zero and Span Calibration
Date: 2025-01-08 04:00:00
CH4 CO2 O2 H2
Zero (raw): 0 470 2605 288
Span (raw): 492 1355 2679 436
Zero (ppm): 0 0 200000 0
Span (ppm): 501 5004 210100 10
Factor: 1.018 5.654 136.486 0.068
Save Calibration
Gas Standards
Plot
Factors
Zeros
Spans
Download
Saved Calibrations:
2025-01-08 04:00:00 - 1.018, 5.654, 136.486, 0.068
2025-01-05 04:00:00 - 1.018, 5.772, 140.278, 0.063
2025-01-02 04:00:00 - 1.018, 5.846, 148.529, 0.833
2024-12-28 04:00:00 - 1.018, 5.805, 124.691, 0.064
2024-12-25 04:00:00 - 1.018, 6.014, 210.417, 0.054
2024-12-22 04:00:00 - 1.02, 5.765, 160.317, 0.059
2024-12-18 04:00:00 - 1.018, 5.792, 126.25, 0.053
2024-12-15 04:00:00 - 1.02, 5.936, 144.286, 0.059
2024-12-12 04:00:00 - 1.016, 6.073, 129.487, 0.037
2024-12-08 04:00:00 - 1.018, 5.812, 132.895, 0.064
2024-12-05 04:00:00 - 1.016, 5.732, 129.487, 0.061
Delete This Calibration

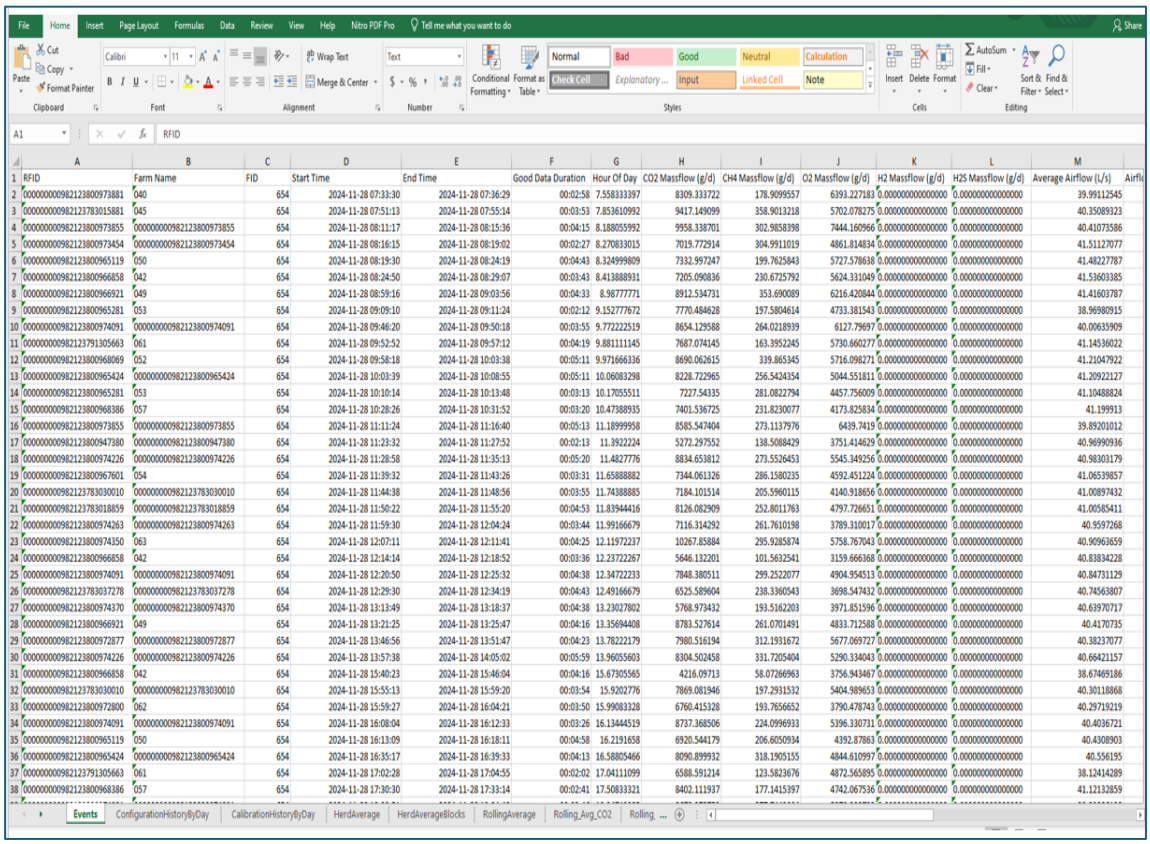

GreenFeed
Animals
Data
Systems
576 - GreenFeed 576
Gas Conc (ppm) Baseline (raw) Response (raw) AR Factor Gas Coeff Gas x Flow %
CH4 35086 2 327 0.002030 1.0411522 0.002046 100.8
CO2 111158 1112 1379 0.007829 3.83 0.007526 96.1
O2 210000 2946 2979 0.119667 68 0.133620 111.7
H2 400 1 1 8 0.015720 0.0
Gas Flow Rate: 10 L/min
GreenFeed Air Flow: 18.31 L/s (1164)
Average Temperature: 14.1 deg C
GreenFeed Flow Coeff: 0.001965
GreenFeed Flow Offset: 0
Gas Tank Pressure
Find Recent Auto-Recovery
or
Auto-Recovery Start Time:
28 / 12 / 2024 , 04 : 06 : 08
(YYYY-mm-dd HH.mm.ss)
Duration: 5 minutes
Show Auto-Recovery
CH4 - GreenFeed #576 - 2024-12-28 04:06:08
CO2 - GreenFeed #576 - 2024-12-28 04:06:08
Compare Auto-Recoveries
Saved Auto-Recoveries
2024-12-28 04:06:08
2024-12-22 04:06:08
2024-12-16 04:06:09
2024-12-10 04:06:08
2024-12-04 04:06:09
2024-11-28 04:06:08
2024-11-22 04:06:09
2024-11-16 04:06:08
2024-11-10 04:06:08
2024-11-04 04:06:09
O2 - GreenFeed #576 - 2024-12-28 04:06:08
H2 - GreenFeed #576 - 2024-12-28 04:06:08


GreenFeed
Animals
Data
Systems
389 - 389 - GreenFeed 389
390 - 390 - GreenFeed 390
653 - GreenFeed 653
654 - GreenFeed 654
Gas | Conc (ppm) | Baseline (raw) | Response (raw) | AR Factor | Gas Coeff | Gas x Flow | %
CH4 | 35205 | 1 | 142 | 0.002092 | 1.0497925 | 0.002035 | 97.3
CO2 | 115671 | 539 | 624 | 0.011402 | 7 | 0.013567 | 119.0
O2 | 10000 | 2779 | 2800 | 0.003990 | 78.996632 | 0.153112 | 3837.7
H2 | 400 | 0 | 1 | 0.003351 | 0 | 0.000000 | 0.0
Gas Flow Rate: 10 L/min
GreenFeed Air Flow: 41.87 L/s (2698)
Average Temperature: 23.5 deg C
GreenFeed Flow Coeff: 0.001938204
GreenFeed Flow Offset: 0
Gas Tank Pressure
Find Recent Auto-Recovery
or
Auto-Recovery Start Time:
08 / 01 / 2025 , 06 : 44 : 06
(YYYY-mm-dd HH:mm:ss)
Duration: 5 minutes
Show Auto-Recovery
CH4 - GreenFeed #654 - 2025-01-08 06:44:06
CO2 - GreenFeed #654 - 2025-01-08 06:44:06
Compare Auto-Recoveries
Saved Auto-Recoveries
2025-01-08 06:44:06
2025-01-02 06:44:06
2024-12-27 06:44:06
2024-12-21 06:44:06
2024-12-15 06:44:06
2024-12-09 06:44:06
2024-12-03 06:44:06
2024-11-27 06:44:07
2024-11-21 06:44:08
2024-11-15 06:44:07
O2 - GreenFeed #654 - 2025-01-08 06:44:06
H2 - GreenFeed #654 - 2025-01-08 06:44:06


GreenFeed
Animals
Data
agrimix
View/Download Raw Data
Calibrations & Auto-Recoveries
CO2 Recovery Tests
Processed Data And Support Files
Systems
389 - 389 - GreenFeed 38
390 - 390 - GreenFeed 39
653 - GreenFeed 653 [0.0
654 - GreenFeed 654 [0.0
Find Recent CO2 Recoveries
Or
Recovery started at:
2023-11-11 20:02:00
(YYYY-MM-DD HH:mm:ss)
And lasted 20 mins
Show Recovery
Saved CO2 Recoveries:
2023-11-11 20:02:07
2022-06-03 13:12:58
2022-06-02 12:57:26
2022-05-23 13:20:36
Delete This Recovery
Compare Recoveries
Enter up to 10 CO2 releases.
Start Time | Stop Time | Calibration Mass (g) | Initial Mass (g) | Final Mass (g) | Scale Diff (g) | GreenFeed Calculated | % Recovery
1 | 2023-11-11 20:02:07 | 2023-11-11 20:06:26 | 999.2 | 1223.6 | 1184.3 | 39.3 | 39.69 | 100.99
2 | 2023-11-11 20:08:49 | 2023-11-11 20:13:11 | 999.2 | 1184.3 | 1159.3 | 25.0 | 24.63 | 98.52
3 | 2023-11-11 20:15:35 | 2023-11-11 20:19:45 | 999.1 | 1159.3 | 1139.8 | 19.5 | 19.48 | 99.9
4 | 5 | 6 | 7 | 8 | 9 | 10
Manually select all start/stop times sequentially
Total: 83.8 83.8 100
CO2 Recovery - (2023-11-11)
20:02:00
20:07:00
20:12:00
20:17:00
20:22:00
Flow Coefficient:
Use previous:
0.00189923
CO2 Gas Coefficient:
Use previous:
5.15
Calculate Masses
Save Recovery Results


GreenFeed
Animals
Data
SmartFeed
Feed & Gain
Data
agresearchnias
View/Download Raw Data
Calibrations & Auto-Recoveries
CO2 Recovery Tests
Processed Data And Support Files
Systems
576 - GreenFeed 576 [0.0]
Find Recent CO2 Recoveries
Or
Recovery started at:
2024-04-23 11:41:00
(YYYY-MM-DD HH:mm:ss)
And lasted 20 mins
Show Recovery
Saved CO2 Recoveries:
2024-04-23 11:41:11
2024-04-15 09:54:19
2023-08-30 15:05:34
2023-05-12 11:34:47
Delete This Recovery
Compare Recoveries
Enter up to 10 CO2 releases.
Start Time
Stop Time
Calibration Mass (g)
Initial Mass (g)
Final Mass (g)
Scale Diff (g)
GreenFeed Calculated
% Recovery
1 2024-04-23 11:41:11 2024-04-23 11:44:26 999 1230.09 1198.34 31.8 30.998 97.48
2 2024-04-23 11:46:54 2024-04-23 11:50:06 998 1198.34 1172.3 26.0 26.678 102.61
3 2024-04-23 11:54:01 2024-04-23 11:57:35 999 1172.3 1145.41 26.9 27.698 102.97
4 0 0
5 0 0
6 0 0
7 0 0
8 0 0
9 0 0
10 0 0
Manually select all start/stop times sequentially
Total: 84.7 85.37 100.796
CO2 Recovery - (2024-04-23)
2,000
1,600
1,200
800
400
0
11:41:00
11:46:00
11:51:00
11:56:00
12:01:00
Flow Coefficient:
Use previous:
0.00191046
CO2 Gas Coefficient:
Use previous:
8.04531
Calculate Masses
Save Recovery Results


GreenFeed
Animals
Data
agrimix
View/Download Raw Data
Calibrations & Auto-Recoveries
CO2 Recovery Tests
Processed Data And Support Files
Other Files:
Filename
File Size
Modified Time
Delete
GreenFeed_Summarized_Data_DEMO.xlsx 501.2 KB 2023-11-30 07:05
GreenFeed_Summarized_Data_654.xlsx 476.5 KB 2025-01-12 21:10
GreenFeed_Summarized_Data_653.xlsx 147.7 KB 2025-01-12 21:10
GreenFeed_Summarized_Data_389.xlsm 29.9 KB 2023-11-30 06:31
GreenFeed_Summarized_Data_390.xlsm 30 KB 2023-11-30 06:31
2024-12-29_to_2025-01-13_for_fids_654_temp.xlsx 185.4 KB 2025-01-13 13:31 X
2023-12-15_to_2024-04-22_for_fids_653_654_temp.xlsx 571.2 KB 2024-04-23 13:08 X
2023-12-15_to_2024-04-22_for_fids_653_654_temp.xlsx 571.2 KB 2024-04-23 05:27 X
2024-03-20_to_2024-04-03_for_fids_653_654_temp.xlsx 109.6 KB 2024-04-04 11:35 X
2024-01-25_to_2024-04-04_for_fids_389_390_653_654_temp.xlsx 459.8 KB 2024-04-04 11:29 X
Workbooks are preliminary data. To request finalized data, please complete the Finalized Data Form.
To generate custom workbooks, 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: 654
Date Range: 29/12/2024 to 13/01/2025
Generate Workbook
Please Note: Data generated is preliminary and has not been reviewed by the C-Lock Team.



RFID	Farm Name	FID	Start Time	End Time	Good Data Duration	Hour Of Day	CO2 Massflow (g/d)	CH4 Massflow (g/d)	O2 Massflow (g/d)	H2 Massflow (g/d)	H2S Massflow (g/d)	Average Airflow (L/s)
000000000982123800973881	040	654	2024-11-28 07:33:30	2024-11-28 07:36:29	00:02:58	7.558333397	8309.333722	178.9099557	6393.227183	0.000000000000000	0.000000000000000	39.99112545
000000000982123783015881	045	654	2024-11-28 07:51:13	2024-11-28 07:55:14	00:03:53	7.853610992	9417.149099	358.9013218	5702.078275	0.000000000000000	0.000000000000000	40.35089323
000000000982123800973855	000000000982123800973855	654	2024-11-28 08:11:17	2024-11-28 08:15:36	00:04:15	8.188055992	9958.338701	302.9858398	7444.160966	0.000000000000000	0.000000000000000	40.41073586
000000000982123800973454	000000000982123800973454	654	2024-11-28 08:16:15	2024-11-28 08:19:02	00:02:27	8.270833015	7019.772914	304.9911019	4861.814834	0.000000000000000	0.000000000000000	41.51127077
000000000982123800965119	050	654	2024-11-28 08:19:30	2024-11-28 08:24:19	00:04:43	8.324999809	7332.997247	199.7625843	5727.578638	0.000000000000000	0.000000000000000	41.48227787
000000000982123800966858	042	654	2024-11-28 08:24:50	2024-11-28 08:29:07	00:03:43	8.413888931	7205.090836	230.6725792	5624.331049	0.000000000000000	0.000000000000000	41.53603385
000000000982123800966921	049	654	2024-11-28 08:59:16	2024-11-28 09:03:56	00:04:33	8.98777771	8912.534731	353.690089	6216.420844	0.000000000000000	0.000000000000000	41.41603787
000000000982123800965281	053	654	2024-11-28 09:09:10	2024-11-28 09:11:24	00:02:12	9.152777672	7770.484628	197.5804614	4733.381543	0.000000000000000	0.000000000000000	38.96980915
000000000982123800974091	000000000982123800974091	654	2024-11-28 09:46:20	2024-11-28 09:50:18	00:03:55	9.772222519	8654.129588	264.0218939	6127.79697	0.000000000000000	0.000000000000000	40.00635909
000000000982123791305663	061	654	2024-11-28 09:52:52	2024-11-28 09:57:12	00:04:19	9.881111145	7687.074145	163.3952245	5730.660277	0.000000000000000	0.000000000000000	41.14536022
000000000982123800968069	052	654	2024-11-28 09:58:18	2024-11-28 10:03:38	00:05:11	9.971666336	8690.062615	339.865345	5716.098271	0.000000000000000	0.000000000000000	41.21047922
000000000982123800965424	000000000982123800965424	654	2024-11-28 10:03:39	2024-11-28 10:08:55	00:05:11	10.06083298	8228.722965	256.5424354	5044.551811	0.000000000000000	0.000000000000000	41.20922127
000000000982123800965281	053	654	2024-11-28 10:10:14	2024-11-28 10:13:48	00:03:13	10.17055511	7227.54335	281.0822794	4457.756009	0.000000000000000	0.000000000000000	41.10488824
000000000982123800968386	057	654	2024-11-28 10:28:26	2024-11-28 10:31:52	00:03:20	10.47388935	7401.536725	231.8230077	4173.825834	0.000000000000000	0.000000000000000	41.199913
000000000982123800973855	000000000982123800973855	654	2024-11-28 11:11:24	2024-11-28 11:16:40	00:05:13	11.18999958	8585.547404	273.1137976	6439.7419	0.000000000000000	0.000000000000000	39.89201012
000000000982123800947380	000000000982123800947380	654	2024-11-28 11:23:32	2024-11-28 11:27:52	00:02:13	11.3922224	5272.297552	138.5088429	3751.414629	0.000000000000000	0.000000000000000	40.96990936
000000000982123800974226	000000000982123800974226	654	2024-11-28 11:28:58	2024-11-28 11:35:13	00:05:20	11.4827776	8834.653812	273.5526453	5545.349256	0.000000000000000	0.000000000000000	40.98303179
000000000982123800967601	054	654	2024-11-28 11:39:32	2024-11-28 11:43:26	00:03:31	11.65888882	7344.061326	286.1580235	4592.451224	0.000000000000000	0.000000000000000	41.06539857
000000000982123783030010	000000000982123783030010	654	2024-11-28 11:44:38	2024-11-28 11:48:56	00:03:55	11.74388885	7184.101514	205.5960115	4140.918656	0.000000000000000	0.000000000000000	41.00897432
000000000982123783018859	000000000982123783018859	654	2024-11-28 11:50:22	2024-11-28 11:55:20	00:04:53	11.83944416	8126.082909	252.8011763	4797.726651	0.000000000000000	0.000000000000000	41.00585411
000000000982123800974263	000000000982123800974263	654	2024-11-28 11:59:30	2024-11-28 12:04:24	00:03:44	11.99166679	7116.314292	261.7610198	3789.310017	0.000000000000000	0.000000000000000	40.9597268
000000000982123800974350	063	654	2024-11-28 12:07:11	2024-11-28 12:11:41	00:04:25	12.11972237	10267.85884	295.9285874	5758.767043	0.000000000000000	0.000000000000000	40.90963659
000000000982123800966858	042	654	2024-11-28 12:14:14	2024-11-28 12:18:52	00:03:36	12.23722267	5646.132201	101.5632541	3159.666368	0.000000000000000	0.000000000000000	40.83834228
000000000982123800974091	000000000982123800974091	654	2024-11-28 12:20:50	2024-11-28 12:25:32	00:04:38	12.34722233	7848.380511	299.2522077	4904.954513	0.000000000000000	0.000000000000000	40.84731129
000000000982123783037278	000000000982123783037278	654	2024-11-28 12:29:30	2024-11-28 12:34:19	00:04:43	12.49166679	6525.589604	238.3360543	3698.547432	0.000000000000000	0.000000000000000	40.74563807
000000000982123800974370	000000000982123800974370	654	2024-11-28 13:13:49	2024-11-28 13:18:37	00:04:38	13.23027802	5768.973432	193.5162203	3971.851596	0.000000000000000	0.000000000000000	40.63970717
000000000982123800966921	049	654	2024-11-28 13:21:25	2024-11-28 13:25:47	00:04:16	13.35694408	8783.527614	261.0701491	4833.712588	0.000000000000000	0.000000000000000	40.4170735
000000000982123800972877	000000000982123800972877	654	2024-11-28 13:46:56	2024-11-28 13:51:47	00:04:23	13.78222179	7980.516194	312.1931672	5677.069727	0.000000000000000	0.000000000000000	40.38237077
000000000982123800974226	000000000982123800974226	654	2024-11-28 13:57:38	2024-11-28 14:05:02	00:05:59	13.96055603	8304.502458	331.7205404	5290.334043	0.000000000000000	0.000000000000000	40.66421157
000000000982123800966858	042	654	2024-11-28 15:40:23	2024-11-28 15:46:04	00:04:16	15.67305565	4216.09713	58.07266963	3756.943467	0.000000000000000	0.000000000000000	38.67469186
000000000982123783030010	000000000982123783030010	654	2024-11-28 15:55:13	2024-11-28 15:59:20	00:03:54	15.9202776	7869.081946	197.2931532	5404.989653	0.000000000000000	0.000000000000000	40.30118868
000000000982123800972800	062	654	2024-11-28 15:59:27	2024-11-28 16:04:21	00:03:50	15.99083328	6760.415328	193.7656652	3790.478743	0.000000000000000	0.000000000000000	40.29719219
000000000982123800974091	000000000982123800974091	654	2024-11-28 16:08:04	2024-11-28 16:12:33	00:03:26	16.13444519	8737.368506	224.0996933	5396.330731	0.000000000000000	0.000000000000000	40.4036721
000000000982123800965119	050	654	2024-11-28 16:13:09	2024-11-28 16:18:11	00:04:58	16.2191658	6920.544179	206.6050934	4392.87863	0.000000000000000	0.000000000000000	40.4308903
000000000982123800965424	000000000982123800965424	654	2024-11-28 16:35:17	2024-11-28 16:39:33	00:04:13	16.58805466	8090.899932	318.1905155	4844.610997	0.000000000000000	0.000000000000000	40.556195
000000000982123791305663	061	654	2024-11-28 17:02:28	2024-11-28 17:04:55	00:02:02	17.04111099	6588.591214	123.5823676	4872.565895	0.000000000000000	0.000000000000000	38.12414289
000000000982123800968386	057	654	2024-11-28 17:30:30	2024-11-28 17:33:14	00:02:41	17.50833321	8402.111937	177.1415397	4742.067536	0.000000000000000	0.000000000000000	41.12132859

3.2 GreenFeed User Interface: Working examples. Practical 3.

Image credit Rouca Souza on Pexels

The exercises will be provided in a separate exercise book.

3.3 Gas Recovery and calibration: Principles

Auto-Calibration/Recovery System

All GF units above number 483 use the new Auto Calibration/Recovery system. This new system incorporates the use of a single high-pressure gas cylinder with gas concentrations of 3.5% CH4, 11.5% CO2, 400ppm H2 with the balance being N2. There is no Zero gas. The gas injection is controlled by a Gas Flow Controller and injects the gas directly behind the manifold. The system is programmed to release gas at 10L/min for 120 seconds. The known release rate is compared to the Greenfeeds measured mass flux. The release is programmed by C-lock to run about every 7 days but will not run if any animal is present.

Manual CO2 Recovery

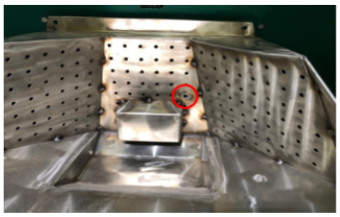
C-Lock recommends a manual monthly CO2 Recovery. **We will carry out a manual recovery as an exercise in this workshop.** This involves the release of a gravimetrically measured mass of CO2 into the system which is compared to the Greenfeed calculated value.

CO2 Recovery Method

The GF Unit is shipped with a Recovery gas release mechanism **(this will need to be assembled as part of the practical)**, a small electronic balance, a calibration weight (1000g), and a quantity of 90g CO2 canisters.

1. Setup the electronic balance on a flat stable surface protected from vibration and air movement. A bubble level on the balance assists in getting the balance level. Turn on the balance and set it to read in grams.
2. **Release 1**: Zero the balance
3. Place the calibration weight on the balance and read to the nearest 0.1g and record on the sheet provided.
4. Attach a new 90g CO2 canister to the release mechanism and weigh the release mechanism with the gas canister attached. Record the weight to the nearest 0.1g under **initial weight (1)** on the recovery sheet.

Ideally we would like to get three(3) releases from the one canister, so we aim to release just under 30g per release.
All animals need to be removed from the proximity of the GF unit, preferably at least 10 meters away.
During the process of the recovery avoid breathing near to the GF unit and have any onlookers well away from the unit.



5. Under the feed hood and just to the right of feeder Shute there will be a marked hole in the airflow manifold. This is where the end of the release mechanism will be inserted (we will observe this as part of the component descriptions).

6. The operator will take the release mechanism and insert the tube into the manifold. At this point the GF unit will sense the release mechanism and the chime will sound. Slowly turn on the valve, you will hear the gas start to release. Slowly back away from the GF unit. The operator should hold their breath during the time they are in close proximity to the Greenfeed. At the same time as the release has started a stop watch will be used to time the duration of the release. Record the time the release started on the recording sheet. The **first release should be stopped at 2.5 minutes**.

7. When the 2.5 minutes has elapsed the operator will enter the back of the GF unit and turn off the release valve, wait about 5 seconds before removing the release mechanism and backing away from the GF unit.
8. It is likely that there will be some condensation on the mechanism caused by the flow of CO2. This should be dried with a towel as it will affect the weight.
9. Weigh the release mechanism and recording the weight in the **final weight (1)** column of the recording sheet.
10. **Release 2:** Again Zero the balance
11. Place the calibration weight on the balance and read to the nearest 0.1g and record on the sheet provided.
12. Again weigh the release mechanism with the gas canister attached . Record the weight to the nearest 0.1g under **initial weight (2)** on the recording sheet.
13. The operator will again take the release mechanism and insert the tube into the manifold. At this point the GF unit will sense the release mechanism and the chime will sound. Slowly turn on the valve, you will hear the gas start to release. Slowly back away from the GF unit. The operator should hold their breath during the time they are in close proximity to the Greenfeed. At the same time as the release has started a stop watch will be used to time the duration of the release. Record the time the release started on the recording sheet. The **second release should be stopped at 3.0 minutes**
14. When the 3.0 minutes has elapsed the operator will enter the back of the GF unit and turn off the release valve, wait about 5 seconds before removing the release mechanism and backing away from the GF unit.
15. It is likely that there will be some condensation on the mechanism caused by the flow of CO2. This should be dried with a towel as it will affect the weight.
16. Weigh the release mechanism and record the weight in the **final weight (2)** column of the recording sheet.
17. **Release 3** :Repeat steps 10 through 17. The time for this release is again increased by 30 seconds to 3.5 minutes. This increase in time is to account for a slower airflow from the apparatus as the canister empties.

The CO2 Recovery Sheet

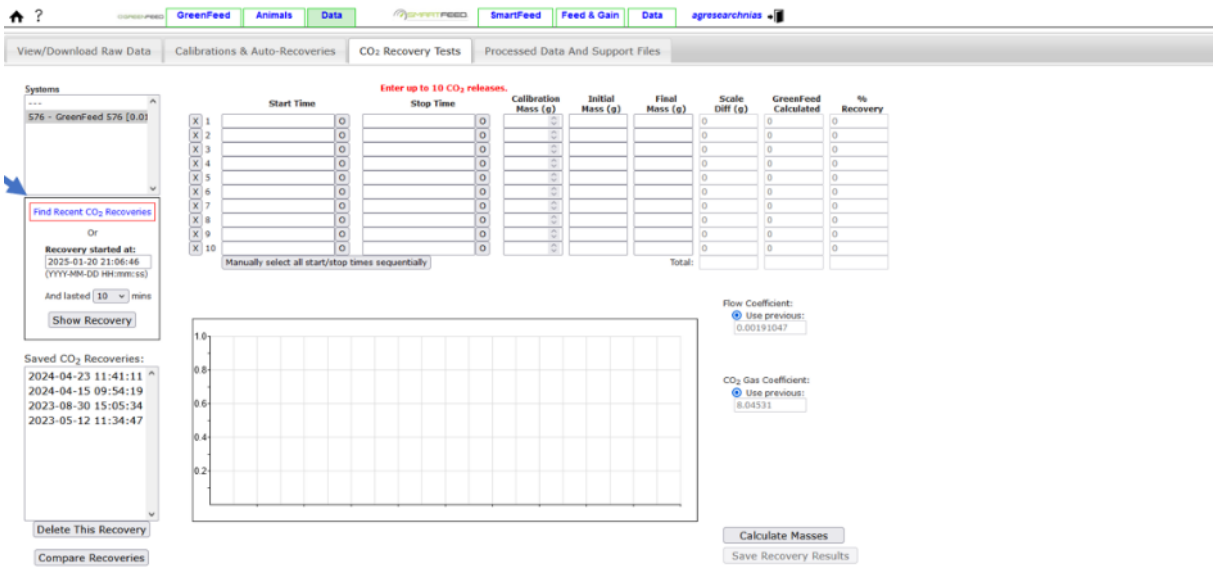
CO2 Recovery

Date:	
GreenFeed Unit:	
Recovery Start Time:	
Recovery End Time:	
Performed By:	

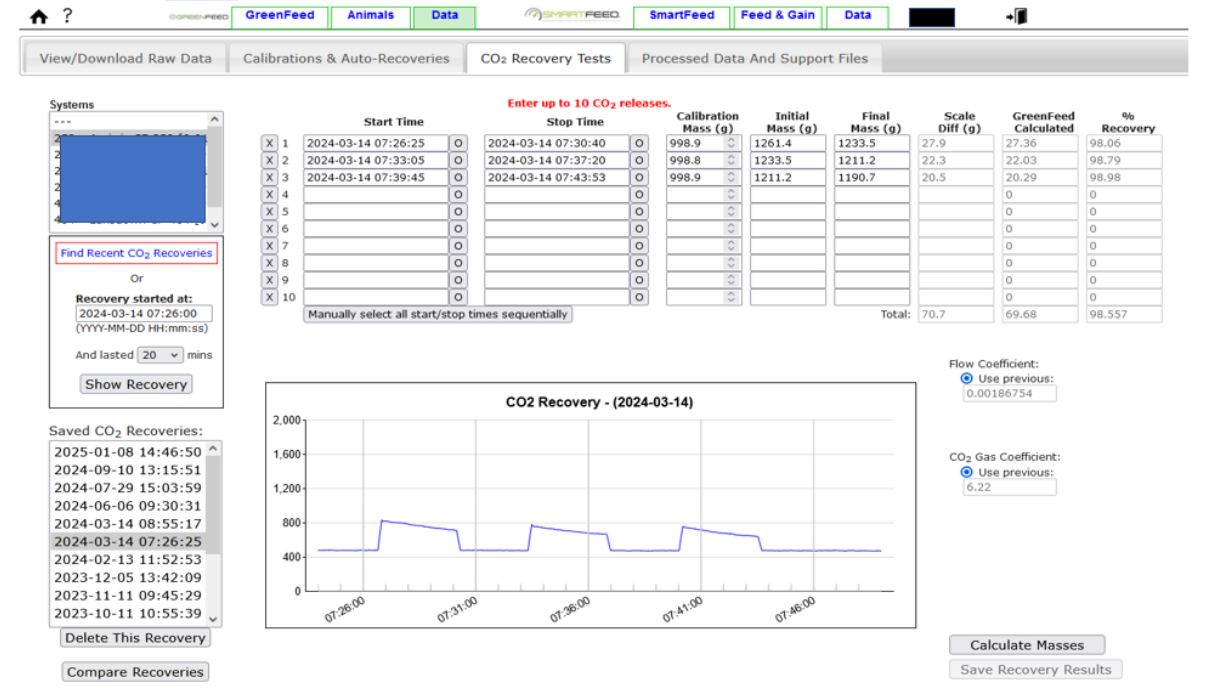
Enter up to 6 CO2 releases

Release Number	Start Time	End Time	Calibration Mass (g)	Initial Mass (g)	Final Mass (g)	Difference (g)
1						
2						
3						
4						
5						
6						

After the Recovery is has been completed, allow time for the recovery data to be downloaded to the C-lock server. Open the user interface and navigate to CO2 Recovery Tests Tab on the Data pulldown menu. Click on Find Recent Recoveries. The 'Start Time and 'End Time' of the Recovery releases will be displayed.



Enter the Initial Mass(g) and the Final Mass(g) for each of the three recovery releases. Enter the Calibration Mass for each of the three releases. The Scale Diff (g) will be calculated. Click on Calculate Masses and you're Greenfeed Calculated masses and % Recovery will be displayed.



3.4 Gas Recovery and Calibration: Practical 4

In this practical we will work in small teams to complete CO_2 recovery tests so you are confident in doing these. Participants not actively involved may go back and practice with the GreenFeed user interface desktop.

Module 4: Data Access and Integrity

In this workshop, we describe a manual way to extract the important data from the C-Lock website and summarize it using pivot tables in MS Excel. However, recently there has been 'R-code' created that has similar functionality and the user is referred to this published communication in the Journal of Dairy Science if you wish to automate data extraction.

Martinez-Boggio, G., Lutz, P., Harrison, M., Weigel, K. A., & Peñagaricano, F. (2025). Greenfeedr: An R package for processing and reporting GreenFeed data. *JDS Communications*, *6*(2), 227-230. https://doi.org/10.3168/jdsc.2024-0662

Data download and summaries (Slide set 4.1)

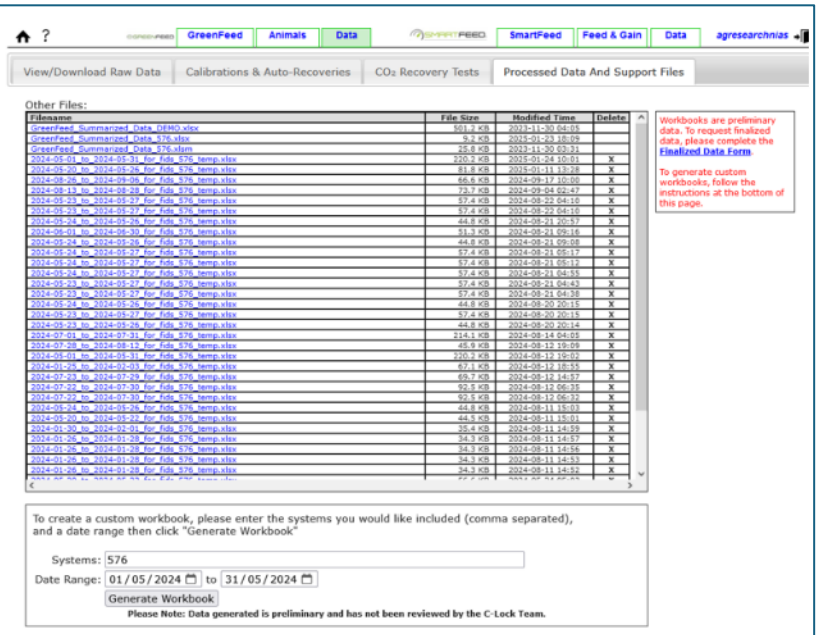
The GreenFeed User Interface allows a large number of data attributes to be observed in tabular and graphical forms, but it is important to be able to download the data into Excel files for closer examination and to summarise the moment by moment data into averages that can be used for statistical analysis.

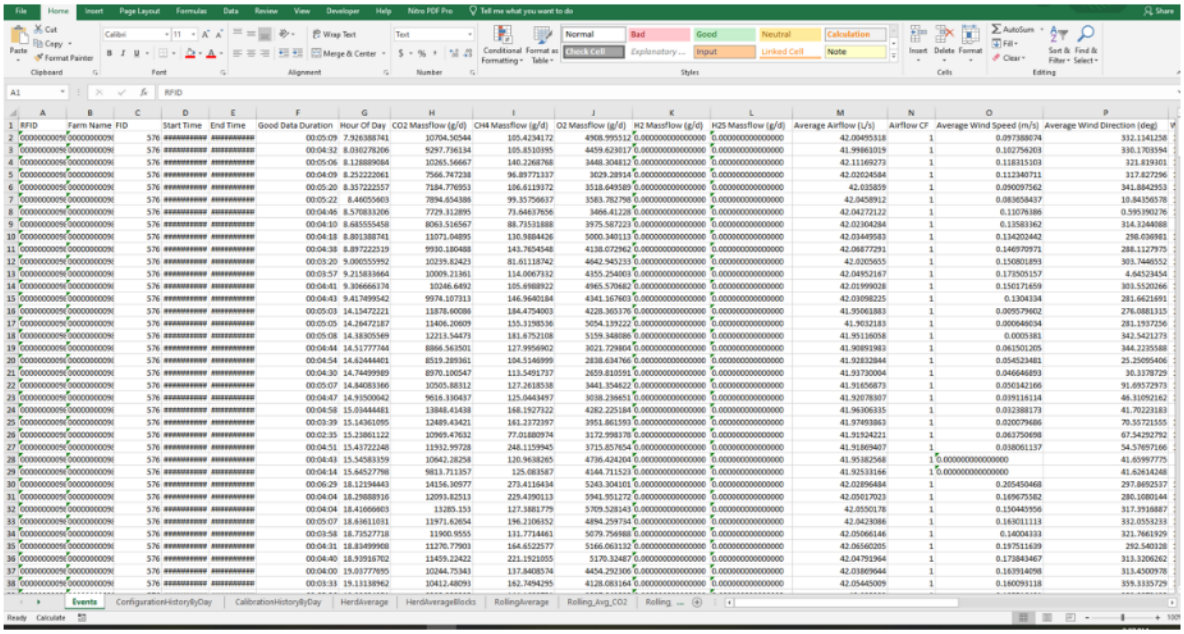
Users are strongly advised to lodge a **'Pre Experiment Check list'** with C-lock, prior to starting any new trial.

Data generated by all the sensors in the Greenfeed unit are captured and stored in a computer inside the Greenfeed . Every hour, this data is downloaded to the c-lock server. Data is processed by C-lock daily and made available to the user via the User Interface as **'Preliminary Processed Data'**.

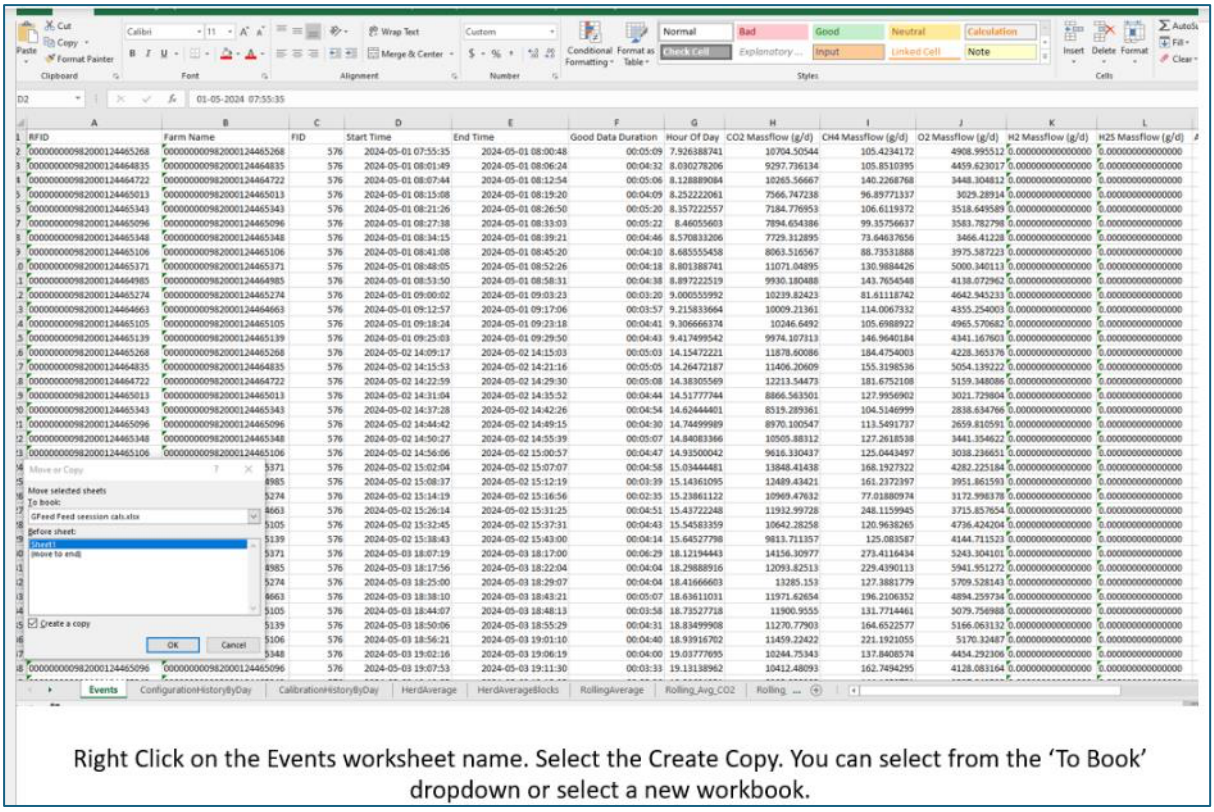
Upon receipt of a **Post Experimental Check List"** C-lock will perform a final data review and evaluate the data. This data will then be posted on the User Interface as **'Final'**

From the User Interface Click on the Data Tab then on the Processed Data Tab.
Create a custom workbook by entering GF unit number, or multiple units in your account. Enter the Date range and select Generate Workbook. When the workbook has been created select from the List of Filenames
The workbook will be created and downloaded to your computer as an Excel File

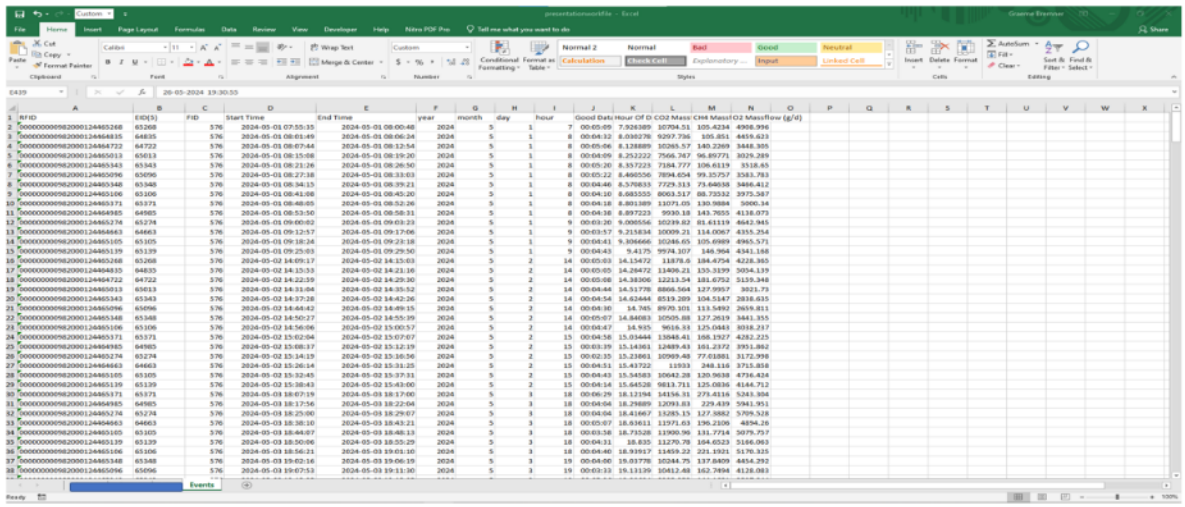




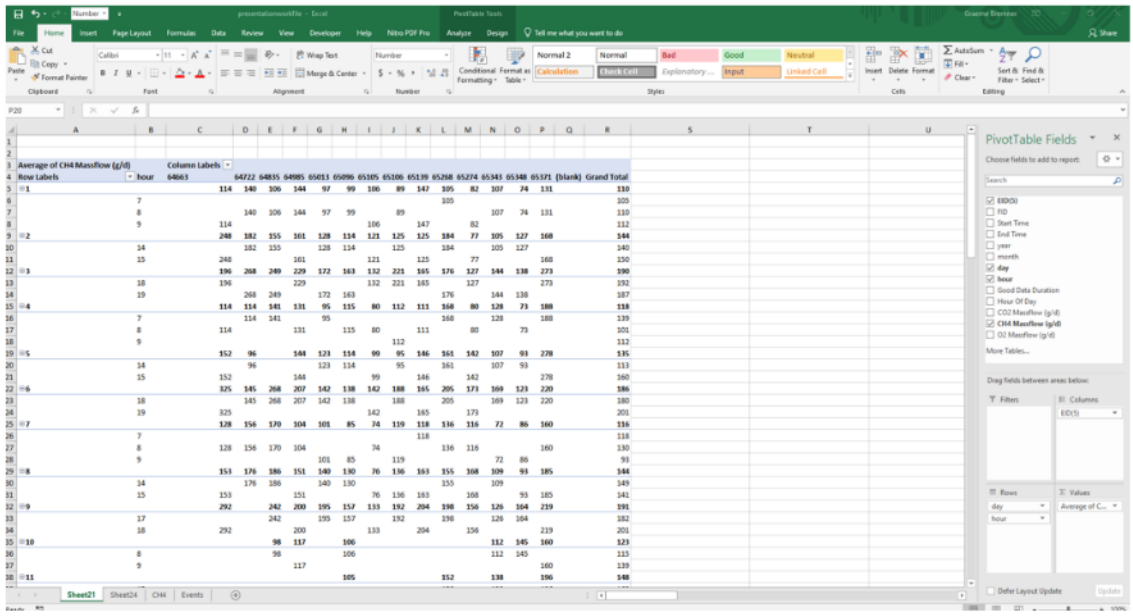
The Workbook contains a large number of worksheets. The one we are most interested in, is the Events sheet. In this tutorial we will only use this sheet. Most of the other sheet are generated by data from this sheet.



Right Click on the Events worksheet name. Select the Create Copy. You can select from the 'To Book' dropdown or select a new workbook.

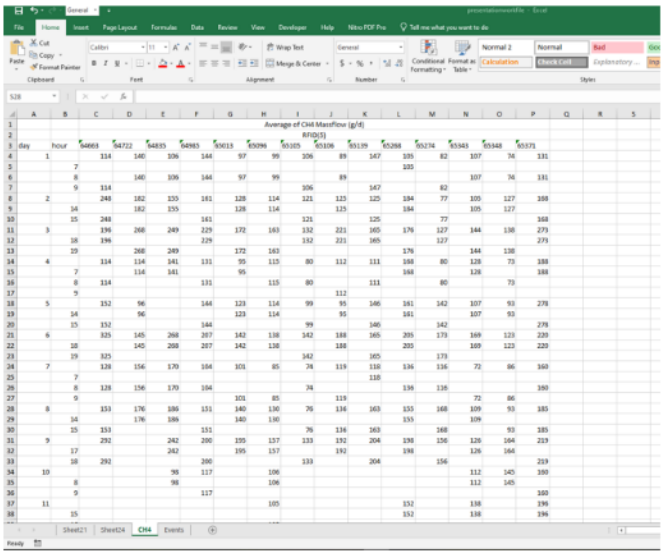


The new workbook will contain only one worksheet called Events. The Worksheet shown above has been edited as follows; I have removed some of columns of data and created some new data that will assist us to summarise the data using a Pivot Table. I will explain this as we go through the hands on Tutorial.



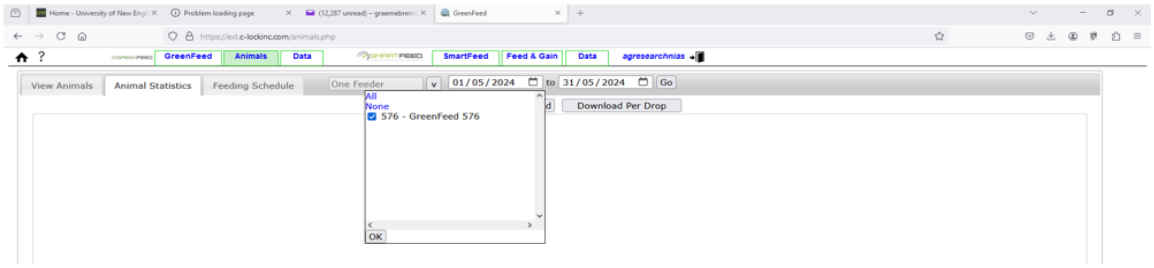
Pivot Table That Summarises CH4 Mean Mass flow (g/day) for each animal for each day.

Data generated by the Pivot table is then copied into a new sheet for editing. The user can then go back to the Pivot Table and select different data sets.

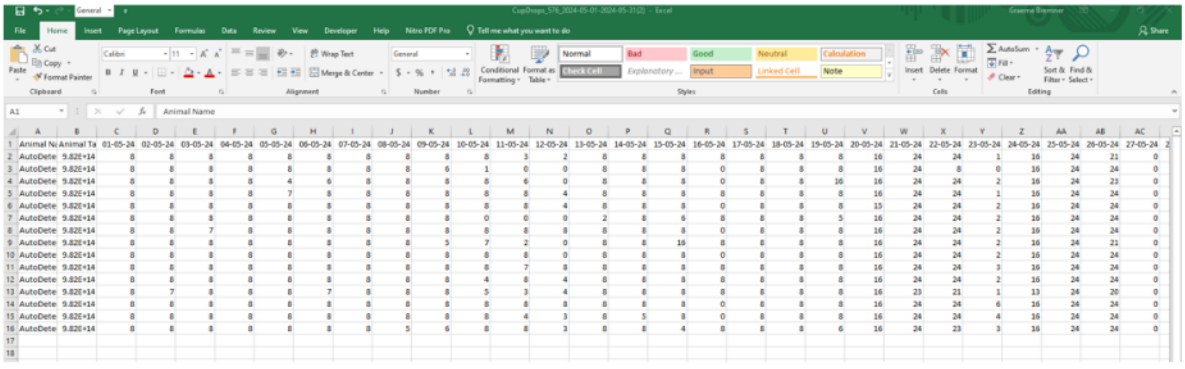


Often data such as the feeding data statistics is downloaded and analysed along -side Gas Massflow averages.

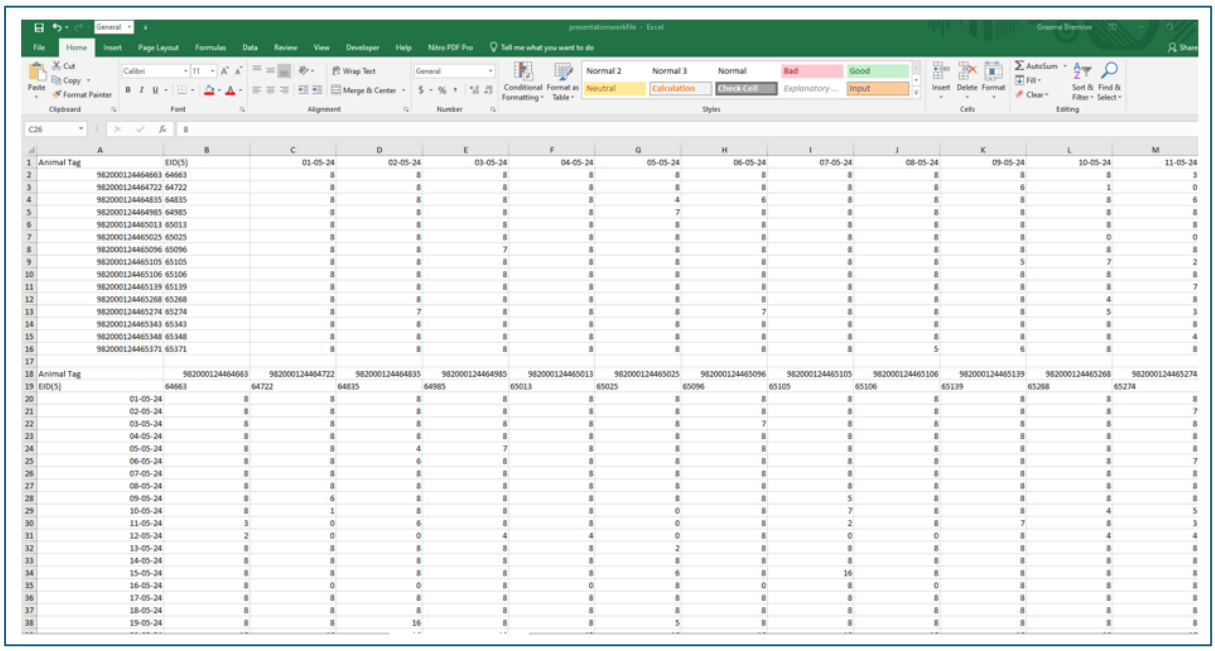
In the example below, data is downloaded from the User Interface by selecting the Animal Tab, Selecting the Feeder Number and Entering the relevant dates of interest.



A new Excel file will be Generated and Downloaded



Above is the Excel sheet with the number of Feed Drops against Animal Tag Number and Date



Animal Tag	EID(5)	01-05-24	02-05-24	03-05-24	04-05-24	05-05-24	06-05-24	07-05-24	08-05-24	09-05-24	10-05-24	11-05-24
982000124464663	64663	8	8	8	8	8	8	8	8	8	8	3
982000124464722	64722	8	8	8	8	8	8	8	8	6	1	0
982000124464835	64835	8	8	8	8	4	6	8	8	8	8	6
982000124464985	64985	8	8	8	8	7	8	8	8	8	8	8
982000124465013	65013	8	8	8	8	8	8	8	8	8	8	8
982000124465025	65025	8	8	8	8	8	8	8	8	8	0	0
982000124465096	65096	8	8	7	8	8	8	8	8	8	8	8
982000124465105	65105	8	8	8	8	8	8	8	8	5	7	2
982000124465106	65106	8	8	8	8	8	8	8	8	8	8	8
982000124465139	65139	8	8	8	8	8	8	8	8	8	8	7
982000124465268	65268	8	8	8	8	8	8	8	8	8	4	8
982000124465274	65274	8	7	8	8	8	7	8	8	8	5	3
982000124465343	65343	8	8	8	8	8	8	8	8	8	8	8
982000124465348	65348	8	8	8	8	8	8	8	8	8	8	4
982000124465371	65371	8	8	8	8	8	8	8	5	6	8	8

Animal Tag	982000124464663	982000124464722	982000124464835	982000124464985	982000124465013	982000124465025	982000124465096	982000124465105	982000124465106	982000124465139	982000124465268	982000124465274
EID(5)	64663	64722	64835	64985	65013	65025	65096	65105	65106	65139	65268	65274
01-05-24	8	8	8	8	8	8	8	8	8	8	8	8
02-05-24	8	8	8	8	8	8	8	8	8	8	8	7
03-05-24	8	8	8	8	8	8	7	8	8	8	8	8
04-05-24	8	8	8	8	8	8	8	8	8	8	8	8
05-05-24	8	8	4	7	8	8	8	8	8	8	8	8
06-05-24	8	8	6	8	8	8	8	8	8	8	8	7
07-05-24	8	8	8	8	8	8	8	8	5	8	8	8
08-05-24	8	8	8	8	8	8	8	8	8	8	8	8
09-05-24	8	6	8	8	8	8	8	8	5	8	8	8
10-05-24	8	1	8	8	8	0	8	7	8	8	4	5
11-05-24	3	0	6	8	8	0	8	2	8	7	8	3
12-05-24	2	0	0	4	4	0	8	0	0	8	4	4
13-05-24	8	8	8	8	8	2	8	8	8	8	8	8
14-05-24	8	8	8	8	8	8	8	8	8	8	8	8
15-05-24	8	8	8	8	8	6	8	16	8	8	8	8
16-05-24	8	0	0	8	8	0	8	0	8	0	8	8
17-05-24	8	8	8	8	8	8	8	8	8	8	8	8
18-05-24	8	8	8	8	8	8	8	8	8	8	8	8
19-05-24	8	8	16	8	8	5	8	8	8	8	8	8

Data download: Practical 5

The data download exercises will be provided in a different booklet.

Module 5: Experimental Design and Management

The GreenFeed system functions as a modified open-circuit respiration chamber, designed to collect spot samples of fore-gut gas emissions when animals visit for feed. This versatile system is adaptable to a range of settings, including pastures, feedlots, and tie-stalls, and is suitable for use with various livestock species, such as cattle, sheep, and goats. Each approach requires careful consideration of **replication, randomization, and hypothesis formulation** to ensure the validity and reliability of the results. Given the immense variety of uses and species, we are going to focus on tie-stalls which allow the most efficient use of GreenFeed units, particularly important when we have few or even one unit to work with.

In **free-stall systems** (pens or grazing environments), animals have unrestricted access to the GreenFeed unit, and both the **timing and frequency of measurements** are entirely dictated by their voluntary visits. Since animal interactions with the unit are not controlled, these experiments typically require longer monitoring periods (weeks rather than days) and more animals to obtain enough data for reliable analysis.

In **tie-stall systems**, each animal is individually walked to a **central location** in the shed for **controlled methane emission measurements**, typically lasting **3–5 minutes per session**. Alternatively, the GreenFeed unit can be brought to the animal. To ensure representative sampling, measurements are repeated **multiple times per day**, ideally balanced across the **24-hour cycle** to capture diurnal variation in methane production. Additionally, the operator should allow a **~2-minute background measurement** between animals to prevent residual gas from influencing subsequent readings.

A critical distinction in statistical design is between **replication** and **repetition**:

- **Repetition** refers to multiple measurements taken on the same animal over time. While repeated measures improve within-animal precision, they do not provide independent biological replication.
- **Replication** requires multiple independent animals (i.e., true experimental units) receiving the same treatment under similar conditions.

The unit of replication is the **individual animal**, not the number of repeated measurements taken per animal. Therefore, statistical analyses must account for the **hierarchical structure** of the data, treating repeated measures as **within-subject factors** rather than independent observations. However, while repeated measurements **do not increase replication**, they are **critical** for accurately capturing **fluctuations in methane emissions** throughout the day. Methane production varies due to factors such as **feeding patterns, digestion dynamics, and circadian rhythms**, making **evenly distributed sampling across the 24-hour cycle** essential for robust data interpretation.

The hypotheses of the study will also determine the experiment design. Some common hypotheses are based on:

- **Treatment effects**: Evaluating whether dietary or management interventions significantly alter methane production.
- **Diurnal variation**: Testing whether methane emissions differ based on the **time of day** due to feeding and metabolic cycles.

- **Inter-individual variability**: Assessing the consistency of methane emissions across individuals within the same treatment group.

As with all investigations, it is important to consider the power of the experiment being undertaken and whether it is adequate to detect significant differences if they exist. Your own statistician may advise on this, but you may also choose to access the University of California, Davis power calculator for enteric methane studies available at https://samplesizecalculator.ucdavis.edu/.

5.1 Animals per Unit

The recommended number of animals per GreenFeed unit varies by system. For free stall environments, it is advisable to have 20 to 40 animals per unit, though higher numbers may be accommodated depending on the goals of the analysis, such as phenotyping versus herd averages. In pasture-based systems, 15 to 30 animals per unit are recommended. However, higher stocking densities may result in fewer animals being sampled effectively, influenced by factors like pasture size.

Maximum attempted animal numbers exceed 100 per unit in production dairy systems, which is typically too high to maintain accuracy. For pasture systems, numbers as high as 300 per unit have been attempted, but many animals did not utilize the GreenFeed machine, likely due to herd dynamics in grazing systems. As the number of animals per unit increases, visitation rates per animal tend to decrease.

Indoor and Outdoor Protocols set ups

Category	Indoor (Free-stalls, Tie-stalls, Robotic Systems)	Outdoor (Feedlot Pens, Grazing Systems)
Drop Dispense Interval	10–60 seconds	10–30 seconds
Minimum Time Between Feeding Periods	7,200–21,600 seconds (2–6 hours)	3,600–14,400 seconds (1–4 hours)
Maximum Drops per Feeding Time	4–25	4–25
Maximum Feeding Periods	4–12	4–12

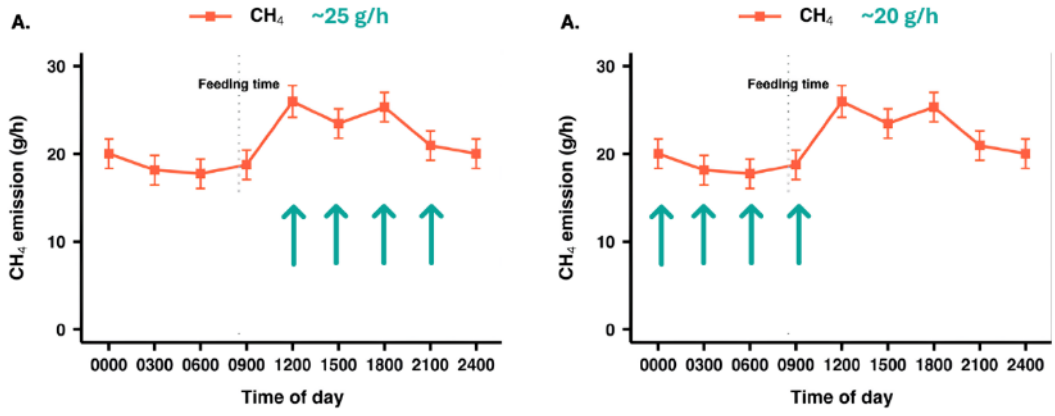
Due to its wide range of applications, this discussion will focus on tie-stall setups, which provide the most efficient use of GreenFeed units, especially when only a few or even a single unit is available.

5.2 Number of Animal Visits – Tie-stall

Most studies using tie-stalls involve **3–6 spot measurements per day**. Proper timing of these measurements is crucial to capture the **hourly variation in methane production** driven by feed fermentation in the rumen. The quality of these spot samples depends heavily on operator management and animal training—placid animals generally yield better results.

Spot sampling is typically conducted over **4–6 days**. Sampling methane emissions **exclusively after feeding** is likely to result in an **overestimation** of daily emissions, as methane production increases during the post-feeding fermentation period (*See Figures on the next page*). Conversely, sampling **only before feeding** may lead to an **underestimation** of daily emissions due to reduced methane production at that time.

To ensure accurate and representative estimates of daily emissions, it is essential to balance the timing of measurements across the entire feeding cycle.



Impact of sampling timing on daily methane emission estimates

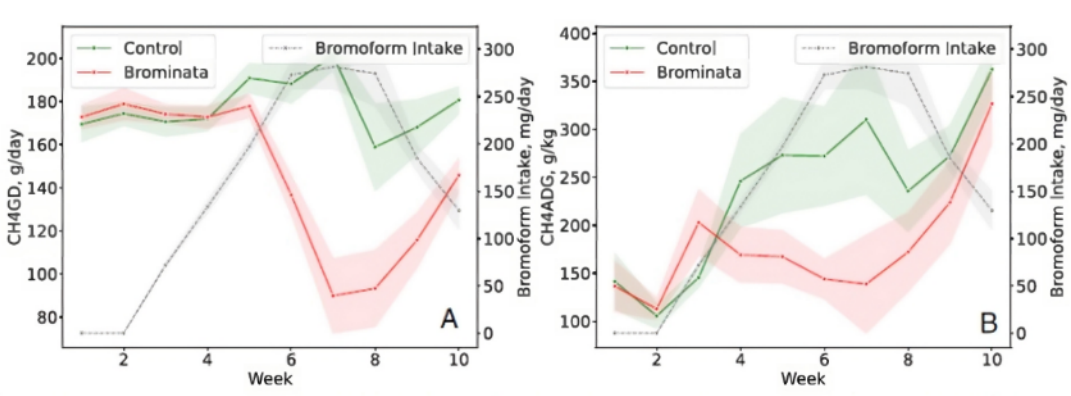
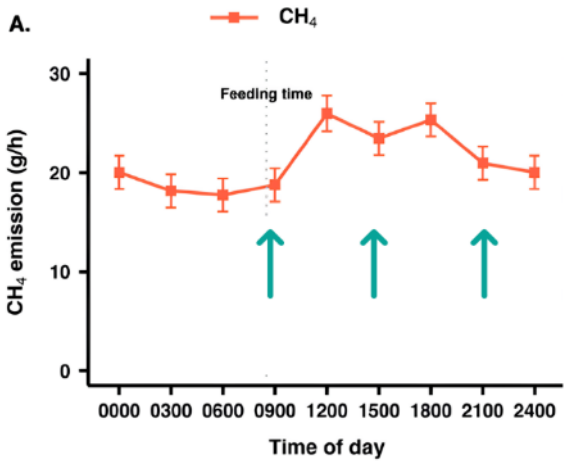


Fig. 1. Enteric CH_4 emissions and bromoform intake of grazing beef steers treated with *A. taxiformis*. (*A*) CH_4 emissions (CH_4GD, g/d) and (*B*) CH_4 emissions per average daily gain (CH_4ADG, g/kg). Control = 0 mg/kg bromoform, and bromoform treatment = average 193 mg/d. CH_4 emissions were measured using the GreenFeed system (C-Lock, Inc.). Data are presented as treatment means with SEM; n = 9 (number of independent data points for each mean value).

Special consideration should be given to selecting the number and timing of measurements when using interventions that drastically reduce methane emissions (e.g., bromoform, bromoform-containing algae, and 3-NOP).

5.3: Experimental Designs

Islam et al. (2023) - ETH Zürich



Measurement Points:

- 8 time points over 3 consecutive days
- Representing every 3 hours of a 24-hour period

Sampling Schedule:

- **Day 1:** 0900, 1500, 2100 h
- **Day 2:** 0300, 1200, 1800 h
- **Day 3:** 0000, 0600 h

[1]Denmead O, Harper L, Freney J, Griffith D, Leuning R, Sharpe R (1998) A mass balance method for non-intrusive measurements of surface-air trace gas exchange. *Atmospheric Environment* **32**(21), 3679-3688.

Module 6: Managing Animals and GreenFeeds during Experiments

6.1 Routine Service Steps (Slide set 6.1)

Maintaining your Greenfeed Unit

1. Air Filters

There are two types of air filters in the Greenfeed units. The primary filter which is located in the main airflow stream immediately after and behind the manifold. A secondary filter is located in the sample line after the sample collection point and before the gas sensors.

Greenfeed units are initially supplied with two (2) new primary filters. These filters require regular cleaning (usually between 4 to 7 days depending on the local conditions). It is recommended that these filters are renewed every 12 months.

The second filter is the sample line filter. This filter can not be cleaned. It is good practice to replace this filter every 12 months. These filters should be purchased from C-lockinc. Using locally sourced filters could nullify your Greenfeed units warranty.

Changing the Primary Air filter

- Using the FEEDER APP put the GF unit into sleep mode. Wait until the fan stops. It is very important that the fan is not running during the process of changing the primary filter.
- At the back of the GF unit, unlatch the back top cover and lift the cover up until the spring holds it in a raised position.
- This will expose the filter in its plastic enclosure (see diagram)
- Unlatch the front cover of the case .
- Undo the clamp on the top of filter. Slide the filter downwards to remove.
- Take the clean filter and put the opened clamp over the collar of the filter
- Fit the clean filter in place and close the clamp. Make sure the filter is seated all the way.
- Close the filter box.
- Using the FEEDER APP take the GF unit out of sleep mode.

Cleaning Primary Filters

Filters may be cleaned with compressed air or washed in water.
Using the compressed air method, blow the filter from the inside to the outside. NOT OUTSIDE TO INSIDE. We will demonstrate this in the practical session.

If you use the water cleaning method. Wash from the inside to the outside. Do no use any detergent.
IT IS VERY IMPORTANT THAT THE FILTER IS COMPLETELY DRY BEFORE USING.
Rotate the two filters so that you always have a clean filter on hand.

Changing the Sample line Filter

- Using the FEEDER APP put the unit into sleep mode
- Remove both back panels on the GF Unit
- Loosen the top and bottom nuts on the filter body, with the supplied 3/4 and 9/16 spanners
- Remove the filter leaving the hose fittings in place
- Take the new filter making sure the arrow on the filter is facing downwards
- Reconnect the top and bottom tubes to the new filter and finger tighten the nuts
- Tighten the nuts with the ¾ and 9/16 spanners
- Using the FEEDER APP take the GF unit out of sleep mode

Photo credit: C-Lock Inc.

2. Proximity Sensor

The proximity sensor is located under the feeder hood just above the feeder Shute. The two small glass lenses get a build up of dust from the feed and saliva from cattle that will effect the accuracy of the sensor and in turn the flux calculations and the "Good Data Calculations". It is recommended that the sensors be cleaned at the same frequency as the primary filter change. The best method is using a cotton bud. This can be either dry or slightly moistened with alcohol.

3. Feed Blockages

Blockages may occur periodically. They are usually caused by damp or poorly pelleted feed. **Pelleted feed must be no larger than 7mm in diameter**. If the GF unit detects that the feed drop mechanism is not rotating, it will send an alert to C-lock support, and subsequently the user, that the feeder is jammed. However, in some cases, especially when the blockage is located further down the feed shute, the GF unit will not detect the blockage. It is recommended, that periodically, the person responsible for the units maintenance perform a feed drop manually to ensure feed is being delivered.

The task of unblocking the feeder maybe as simple as unblocking the lower end of the feed shoot, but may require all the feed to be removed from the feed bin until the area around the rotating cup can be observed and unblocked. An industrial vacuum is very useful for this purpose.

6.2 Moving GreenFeed Units (Slide set 6.2)

Preparation of Greenfeed for Relocation

If the Greenfeed is to be relocated that requires transportation, follow the instructions below. If the relocation is within its current facility it can be left assembled and carefully wheeled on its trolley.

- Put the Greenfeed into SLEEP mode using the Feeder APP
- Shut down the Greenfeed using the Feeder App. Wait 30 Seconds
- Disconnect the power cable to the Greenfeed from the power source.
- Empty all the feed from the Feed Hopper (it is a good idea to use a workshop Vacuum to thoroughly remove any dust or feed particles)
- Remove the Feed Dish and thoroughly clean behind the dish and on the top and side of the Electronics Box.
- Turn Off the Gas on the Auto Cal/ Recovery System gas cylinder/s
- Disconnect all gas lines to either the Auto Cal box or Gas Flow Controller Box (depending on your system)
- Disconnect all gas lines from the gas regulator/s
- Remove the Regulator/s from the gas cylinder/s – Carefully bubble Wrap the regulators
- Remove the gas cylinder/s.
- Disconnect the Weather Station
- Remove the Weather Station and store with retained foam from unpacking
- Carefully Remove the Air Velocity Transmitter- Disconnect the wiring first and then the transmitter itself. Replace the sensor cover, retained during unpacking.

- Remove the main fan by gentle separating from the chimney
- Disconnect the conduit connectors via the rear door of the Greenfeed
- Remove the conduit pipe
- Remove the Upper Chimney pipe
- Remove the Lower Chimney Pipe
- Install the Chimney and Conduit covers retained in unpacking the Greenfeed

6.3 Animal Adaptation and Training

The overall duration of the training and adaptation period last from 7 to 20 days, both indoor and outdoor. Animals that are already used to feeding boxes in the barn are generally easier to train to use the GreenFeed. For all the adaptation period it is essential to locate the GreenFeed within the eyesight of the animals.

During training the "drop dispense interval" can be slightly adjusted, for example reduced to 10 seconds in first days of adaptation, then increased to 20 seconds and then it is possible to use the experimental protocol. Outdoor could be useful to provide a small amount of feed around the GreenFeed unit or near to the GreenFeed chute.

In some cases, there might be animals that are more difficult to train. In this case it is good practice to guide them into the GreenFeed and evaluate their behaviour. If they are reluctant, it is advisable not to involve them in the experimental trial. Generally, 50% of the animals adapt autonomously, 25% of the animals need an intervention, and the remaining 25% are more reluctant. A good training and adaptation period provides for the success of at least 70% of indoor animals and at least 50% of grazing animals.

Having non-users located beside users of machines has proven to be helpful when later training those non-users. Spread concentrates in the chute or using salt licks may help entice animals to use the machine. When based on grazing, it is important that the machine is moved to the edge of the fresh pasture once strip wire is moved – animals should not have to move far to reach the machine as this will impact number of visits.

The recommended minimum time for methane reading by GreenFeed is around 30-40 s to reduce (or avoid) the impact of wind speed and direction in the gas sampling (C-lock, 2016).

In pastoral environments, the number of GreenFeed visits are lower than in feedlot systems (Cottle et al., 2015; Gunter & Bradford, 2015; Hammond et al., 2015a). This is explained by the fact that in feedlot systems, much of the diet is provided through the equipment, which encourages animals to visit the GreenFeed. However, in grazing systems, the forage is the feed to be evaluated, and any feed offered via the GreenFeed system is understood as an attractant to enable enteric methane measurement, which reduces visit frequency.

An alternative to overcome difficulties of methane emission measurement in a grazing production system would be the extension of evaluation periods, thereby increasing the frequency of GreenFeed visits.

Slide set 6.3

Training animals to use the Greenfeed

Key Issues with training in all types of Greenfeed

The Greenfeed is designed to measure **one animal at a time**.

Dairy Cattle are generally easier to train than Beef Cattle

Avoid using severe restraining devices such as nose rings. Animals should not associate the Greenfeed with hurtful experiences.

Training may take up to 2 weeks or longer in paddock systems. Probably 10% of animals in the Free Stall system will never be trained.

Use a good, tasty pellet (the pellet should not be more than 7mm in diameter). Hay can not be used in the Greenfeed.

Free Stall /Pasture

Start by encouraging animals to approach the Greenfeed Unit by scattering feed pellets in front of and up to the Greenfeed Unit.

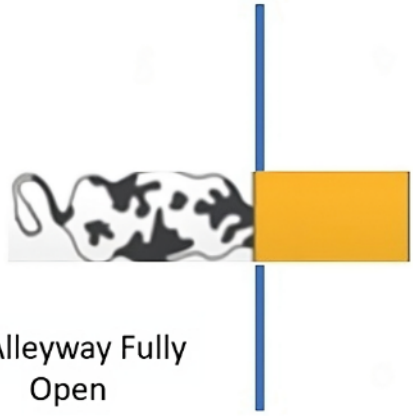
The chime may prove to be a deterrent in Fee Stall Systems. Turn off the Chimes until animals are familiar with the Greenfeed. After training the chime can be used in some circumstances.

Building a temporary yard or enclosure around the Greenfeed may help to get the animals familiar with the look and sound of the Greenfeed.

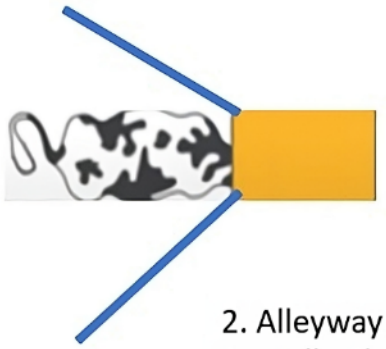
Rely on some inquisitive animals in the group that will approach the unit. Gentle persuasion can be used (ie walking quietly around the animals, bringing them in close proximity to the Greenfeed).

Have some pellets on the front edge of the Feed Dish.

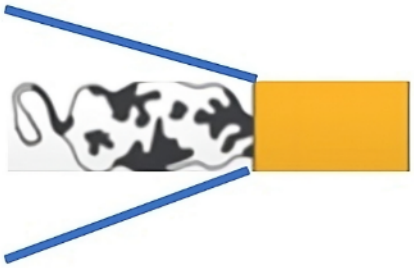
After animals become familiar with the unit and are regularly visiting, introduce an alleyway. Start with a panel each side of the front of the Greenfeed and gradually, over several days, narrow the lane until only one animal at a time can access the sampling area of Greenfeed. (see diagrams on the following pages)



1. Alleyway Fully Open

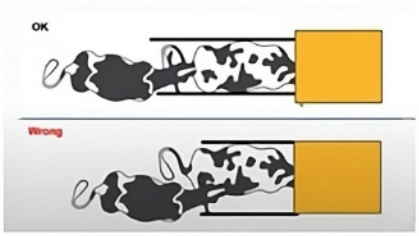


2. Alleyway Partially Closed



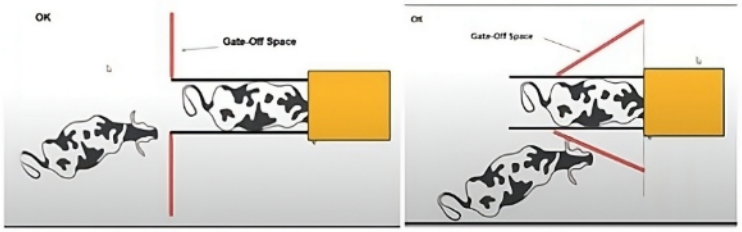
3. Alleyway ¾ Closed

4. Alleyway Fully Closed

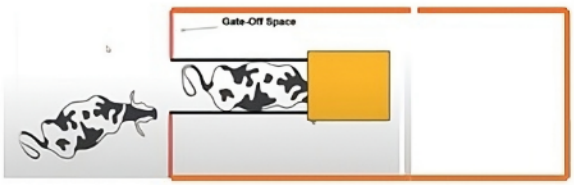


Ok Alleyway long enough for animal behind can not push past

Wrong Alley too wide and too short



Animals are prevented from getting close to measurement area



The Greenfeed is encapsulated preventing animals pushing past, getting close to measurement area and rear of Greenfeed. Safe area for operator to work behind Greenfeed

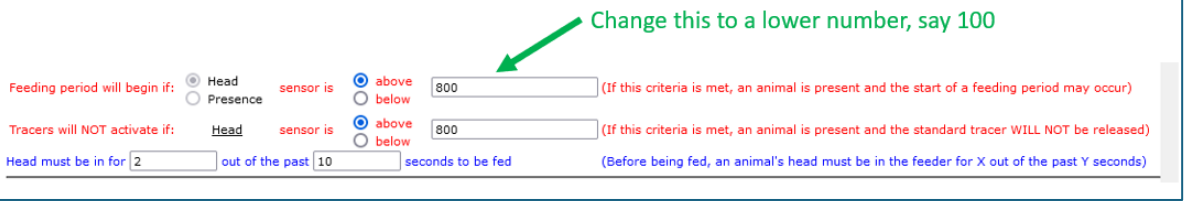
Tie Stall Units

Place the Greenfeed in close proximity to where the animals are housed and get them used to the look and sound of the greenfeed

Gently entice animals with food rewards.

Start by offering individual animals feed in their stall or in a laneway in a bucket they can recognise. Gradually, over several days, entice the animal to follow you with a bucket of feed to the Greenfeed (do not force them and DO NOT USE Nose Rings). Gradually start to lift the bucket up to the height of the Greenfeed feed dish, have some pellets on the front edge of the feed dish. **Be patient**. Repeat this until the animals are comfortable with approaching the Greenfeed. Start to manually drop feed using the Feeder App. They will quickly learn to eat from the feed dish. At this point the animals will be getting their heads close enough to activate the feeder themselves. You can now adjust the feed drop interval and quantity to your specific requirements of sample (event) time.

Some of the settings on the Greenfeed may be temporarily altered to make visiting the Greenfeed more attractive. These include reducing the head proximity sensor so that feed drops earlier.



6.4: The Role of Pellets in Enhancing GreenFeed Use

The use of attractants in GreenFeed systems is crucial for ensuring consistent animal visitation without significantly altering their total feed intake. Pelleted feeds, in particular, have proven to be an effective attractant, encouraging voluntary visits while minimizing disruptions to primary diet composition. While this concern is **less critical in tie-stall systems**, where individual feeding is controlled, it remains relevant and worth considering across different experimental setups.

Importance of Pellets as an Attractant

Pellets offer several advantages in GreenFeed-based methane measurement studies. Research has shown that flavoured pellets can improve visitation rates and extend the duration of head positioning in the GreenFeed system, which is essential for obtaining reliable methane emission data. Mombach et al. (2018) found that pelleted **Tifton bermudagrass hay flavoured with vanilla** increased both **the frequency and duration of animal visits** compared to a protein supplement, leading to longer methane sampling times. Specifically, their study reported a **30% increase in visit duration** and a **70% increase in pellet intake per feeding period** when flavoured pellets were used.

Similarly, flavoured concentrate premixes in dairy cows have demonstrated that Flavors such as **vanilla and fenugreek** enhance palatability and intake. The strategic use of such flavours can be beneficial in ensuring that animals engage with the GreenFeed system frequently enough to provide **representative emissions data** while avoiding excessive energy intake that could bias results.

Balancing Attractant Intake and Diet Integrity

A key challenge in using pellets as an attractant is **preventing overconsumption**, which could influence total feed intake and, consequently, methane production. This is particularly relevant in **free-stall and grazing systems**, where animals have unrestricted access to GreenFeed. To mitigate this risk, studies suggest **limiting pellet intake** as a proportion of the total daily diet. For example, **Hammond et al. (2016)** noted that excessive high-energy attractants could alter **rumen fermentation patterns**, leading to unintended effects on methane emissions. Instead, they recommend restricting pellet intake to avoid significant dietary shifts.

One effective approach is to **cap the maximum amount of pellets dispensed per visit and per day**. In the **Mombach et al. (2018)** study, pellet drops were limited per feeding period, ensuring that intake remained minimal relative to the total diet.

Optimizing Pellet Distribution in GreenFeed Systems

The implementation of pellet dispensing protocols should be tailored based on the feeding system:

- **Tie-stall systems**: While **less of a concern**, pellet intake should still be controlled to maintain consistency in feeding patterns. Since tie-stall animals have **scheduled feeding times**, the use of pellets is primarily to **facilitate compliance** with GreenFeed sampling rather than as a dietary attractant.
- **Free-stall and grazing systems**: Maximum daily pellet intake should be **strictly capped** to prevent animals from substituting their regular diet with GreenFeed pellets.

To further refine the use of pellets, future studies could explore:

- The effect of **different pellet formulations** (e.g., fiber vs. energy-based pellets) on GreenFeed visitation behaviour.
- **Long-term adaptation** to flavoured pellets and potential shifts in animal preference over time.
- The impact of **restricted pellet intake** on methane emissions consistency across trials.

References

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