

Application of GreenDA for GreenFeed® data processing and analysis: a bovine case study

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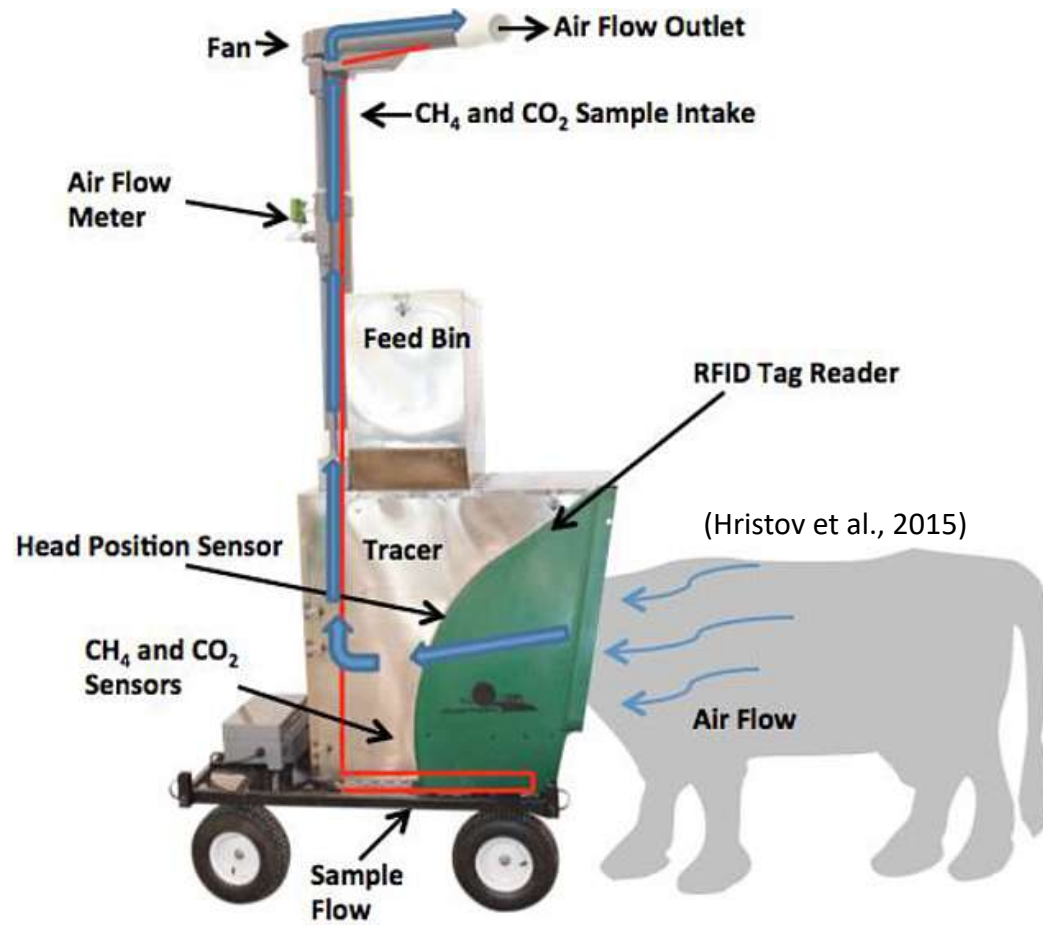
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^dInstitut de l'Élevage, France



01 GreenFeed® System



GreenFeed system (C-Lock Inc., USA)

The animals visit the machine to eat the bait

Gas capture and analysis during ingestion

Data is recorded for each visit

e.g.) 20 animals * 4 visits/day * 30 days
= **2,400 lines**

Data analysis tools (e.g. R, Python, etc.) is needed

Not everyone can handle data effectively

+

Lack of standardized analysis guidelines



01 GreenDA: GreenFeed® Data Analyzer

Not everyone can handle data effectively !!



- ✓ Period
- ✓ Machine
- ✓ Treatment
- ✓ Animal



- ✓ Stay duration
- ✓ Airflow
- ✓ No. of visit
- ✓ Statistical approach



- ✓ Diurnal variation



- ✓ Repeatability
- ✓ Daily kinetics
- ✓ Descriptive statistics

02 Data Selection

Data
Selection

1. Period

Select data only from the
experimental period



3. Factor

Exclude treatment not
selected for analysis



Upload validated final data file from C-Lock®

Manual STEP 1 STEP 2 **STEP 3** STEP 4 STEP 5 STEP 6

3. Dataset Screening

DATA RANGE
Select date range:
2024-01-16 to 2024-04-29

GREENFEED MACHINE
Include GF units (default: All)
111, 112

FACTOR
Select TRT1 (default: All)
A, B
Select TRT2 (default: All)
C, D

ANIMAL
Include animals (default: All)
53 items selected

Go to next step

Enter animal treatment information

2. Machine

Select data only from well
functioning machines



4. Animal

Remove problematic animals



02 Data Cleaning – Outlier removal

[STEP 1] Observation level cleaning

Standard	Default
Stay duration	≥ 2 minutes
Airflow	≥ 26 L/s
No. of visit	No default

Changeable by user

[STEP 2] Variable level cleaning

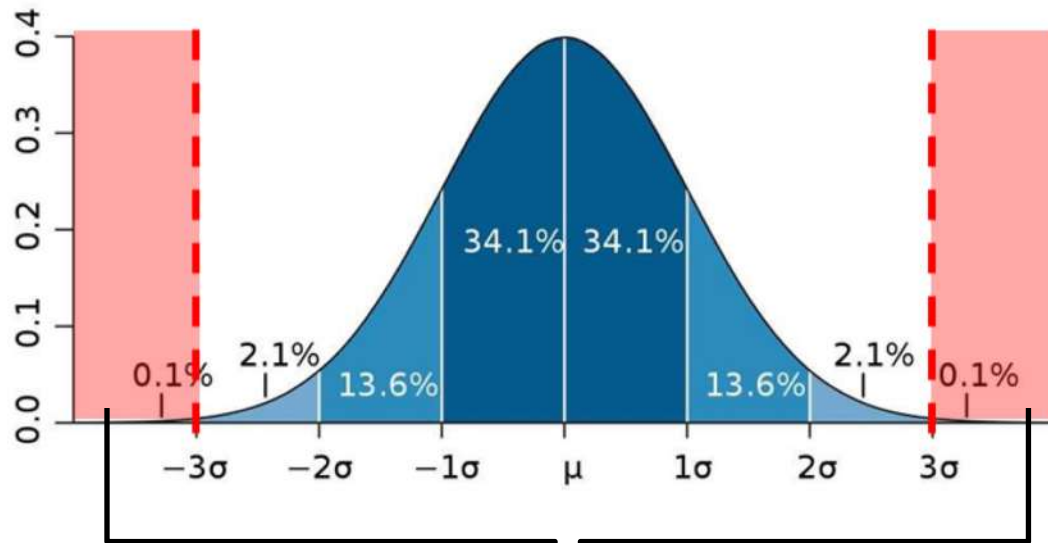
Gas	Method	Default
CO ₂ & CH ₄	Correlation based method	-
	Standard deviation	Avg. ± 3 SD
O ₂	Standard deviation	Avg. ± 3 SD
H ₂	Interquartile range	Avg. ± 1.5 IQR

Optional values

Changeable by user

02 Data Cleaning – Variable level

Standard deviation based method – CO₂ & CH₄



> 3 SD : Outliers

STATISTICALLY - CO₂ & CH₄

Select a method to remove CO₂, CH₄ outlier

Standard_deviation

CH₄ Distribution check

Split dataset by factor before cleaning?

☒ No ☐ Yes

SD multiplier (default = 3)

3

CH₄ Distribution check

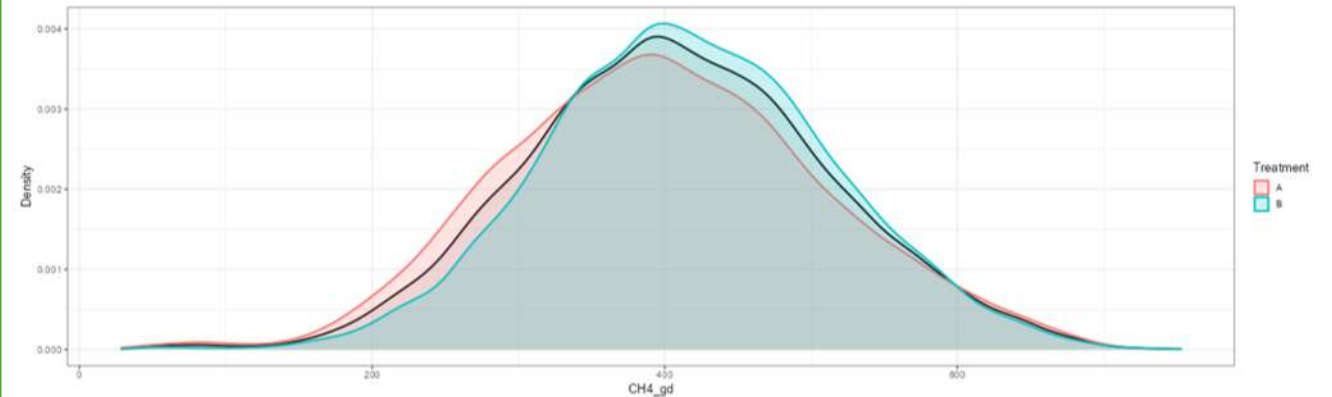
☒ Show overall CH₄ distribution

Factor column

TRT1

Factor levels

A B



Pairwise distinguish test among selected treatment levels

Distinguishable pair(s): 0 / 1

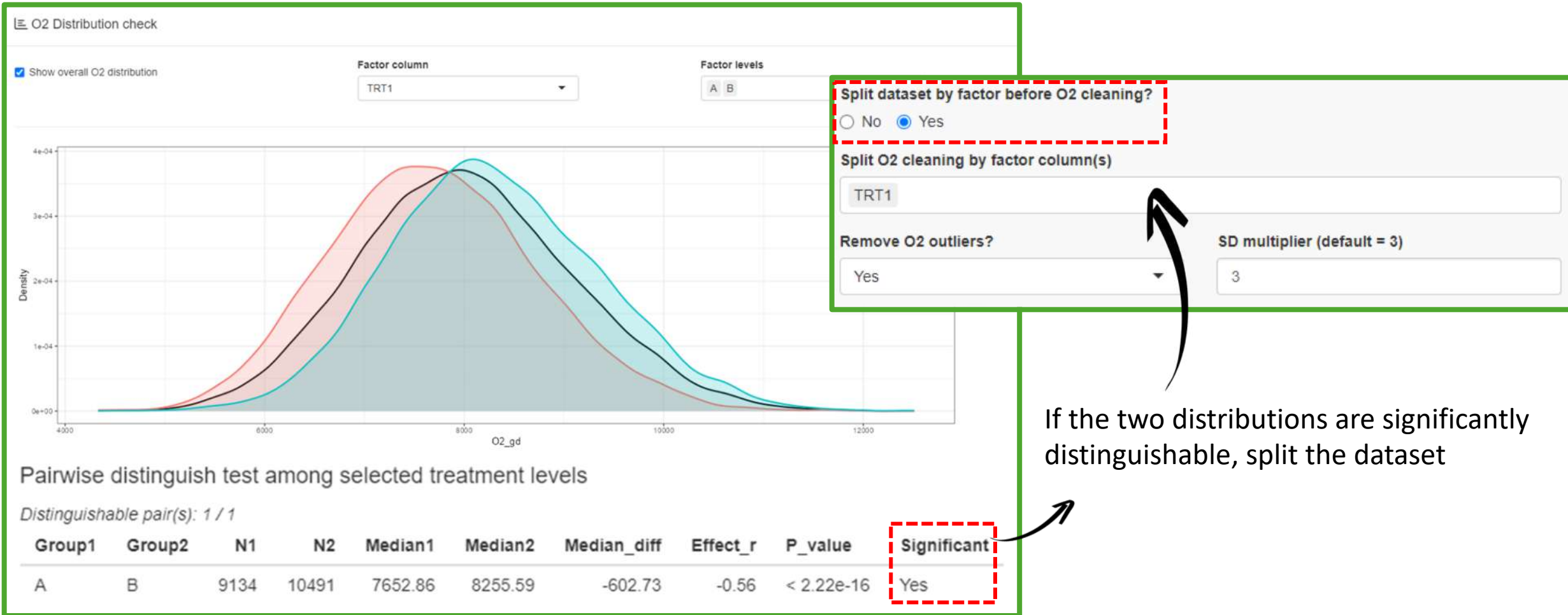
Group1	Group2	N1	N2	Median1	Median2	Median_diff	Effect_r	P_value	Significant
A	B	9192	10524	396.33	414.42	-18.09	-0.17	< 2.22e-16	No

Check CH₄ distribution based on treatment

Adjust threshold as needed

02 Data Cleaning – Variable level

Standard deviation based method – O₂



02 Data Cleaning – Variable level

Interquartile based method – H₂



02 Data Correction – Diurnal variation

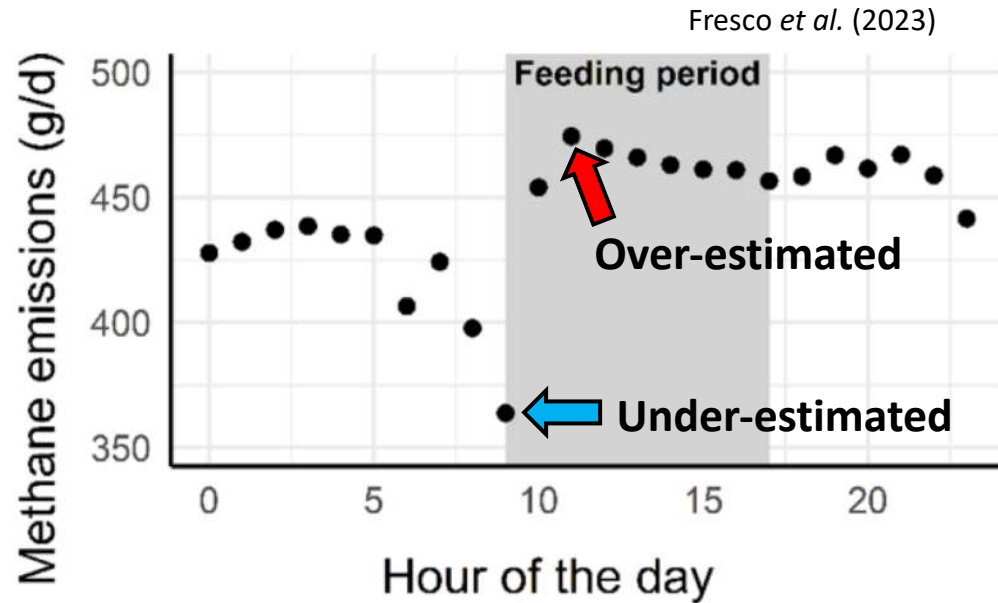


Table 1. Effect of diurnal variation correction (CH_4 , g/d)

	Animal 1	Animal 2	Animal 3
Raw	194 ± 68.9	216 ± 94.1	231 ± 85.5
Adjusted	182 ± 66.2	215 ± 89.9	238 ± 81.3
Difference	- 12.6	-0.1	+7.2
	Over-estimated	Unchanged	Under-estimated

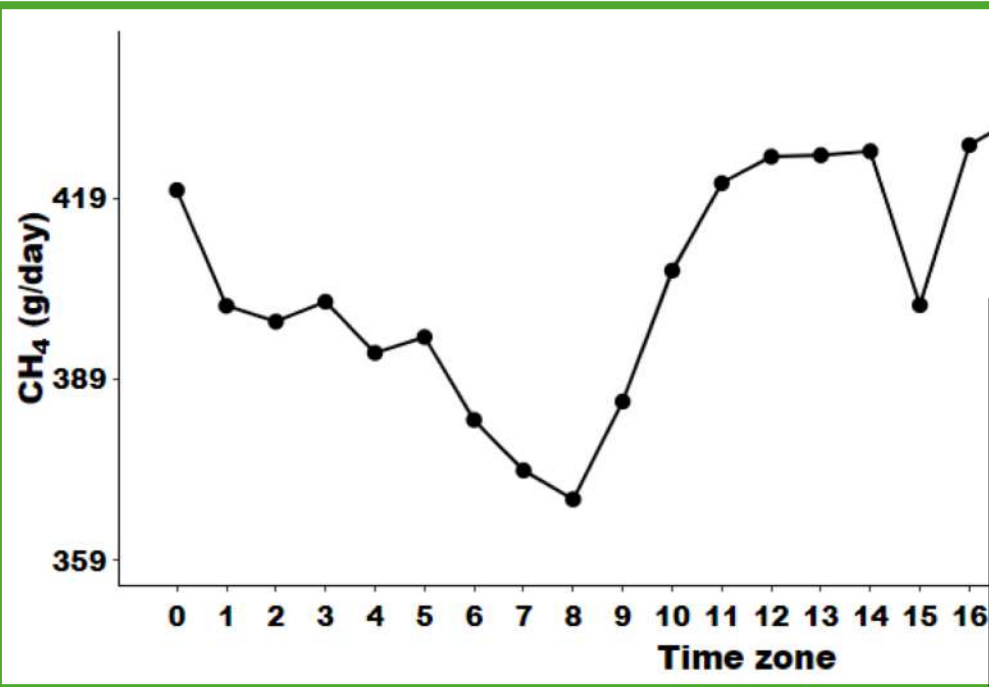
Spot samples are **converted to [g/d]** using an algorithm (*not average or sum of spot samples*)

→ CH_4 values are influenced by **feeding patterns**

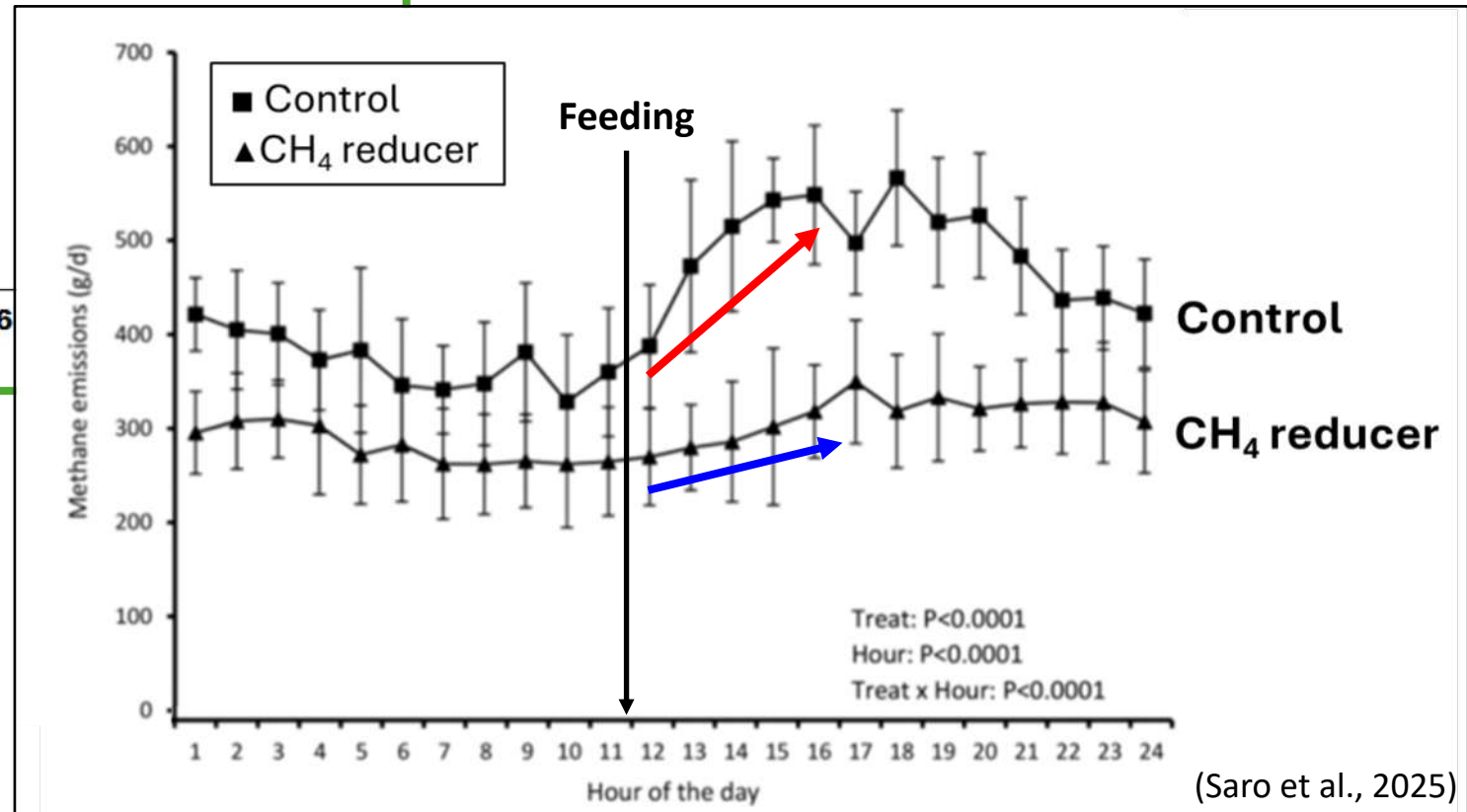
→ CH_4 values vary depending on **animals visit timing**

➔ ***Smoothing is applied to remove the visit timing effect and adjust CH_4 value for each animal***

02 Hourly CH₄ emission



Particularly useful for understanding the mode of action of CH₄ reducers



(Saro et al., 2025)

02 Repeatability Calculation

Repeatability ?

- ✓ The consistency of repeated measurements within the same animal
- ✓ Proportion of animal random variation to total random variation

$$\text{repeatability} = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_p^2 + \sigma_e^2}$$

REPEATABILITY RANGE

Date indexing method

☒ Calendar date ☐ Ordinal day

Select date range for repeatability only

2024-01-16

to

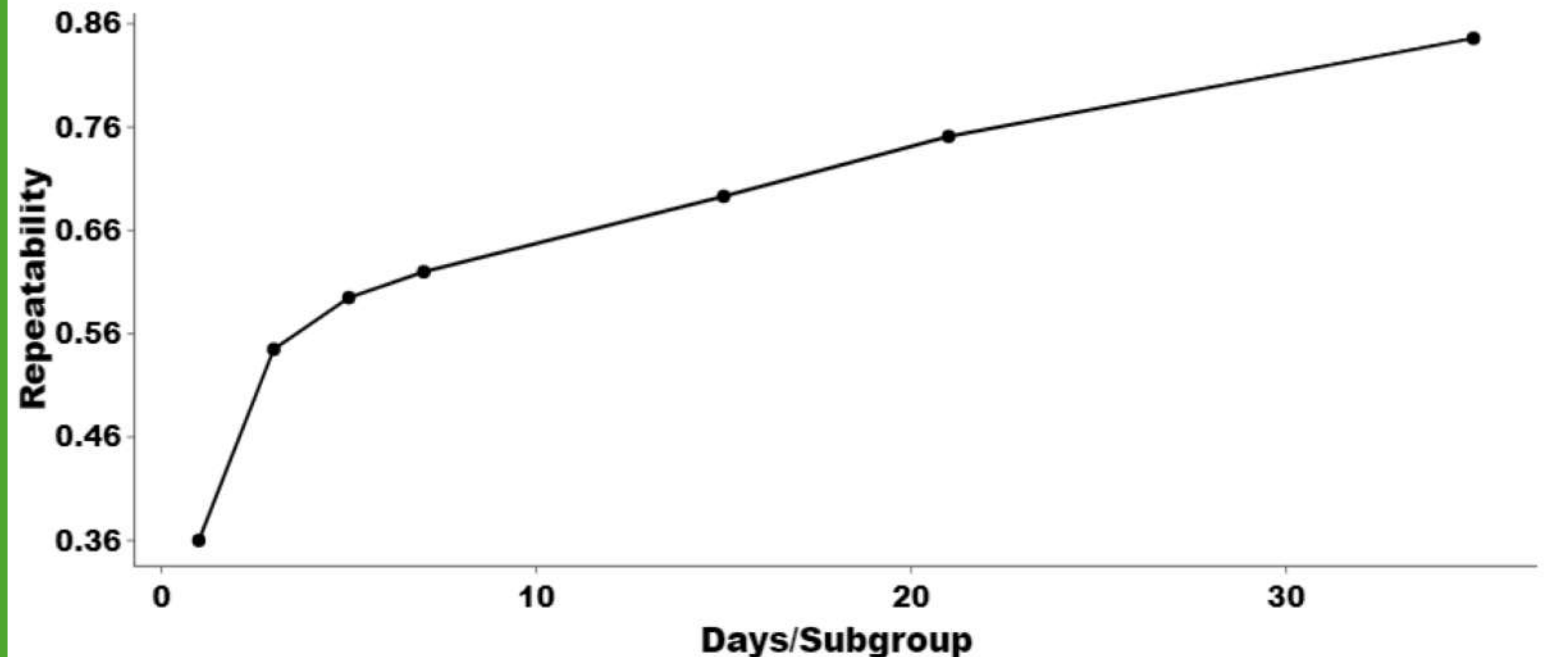
2024-04-29

✓ Select Done

Selected valid days: 105 Validated divider(s): 1, 3, 5, 7, 15, 21, 35

Automatically calculated based on the user-defined data

Repeatability over measurement period



02 Descriptive Statistics Reports

1. WHOLE PERIOD ANALYSIS

▶ Run All (Whole period)

Per Animal Per Factor1 Per Factor2 Per Factor1 X Factor2

▶ Calculate (Animal)

Download (Animal)

2. DAILY ANALYSIS

▶ Run All (Daily)

Entire dataset Per Animal Per Factor1 Per Factor2 Per Factor1 X Factor2

▶ Calculate (Entire)

Download (Entire)

3. HOURLY ANALYSIS

▶ Run All (Hourly)

Entire dataset Per Animal Per Factor1 Per Factor2 Per Factor1 X Factor2

▶ Calculate (Entire)

Download (Entire)

4. DAILY & HOURLY ANALYSIS

▶ Run All (Daily&Hourly)

Entire dataset Per Animal Per Factor1 Per Factor2 Per Factor1 X Factor2

▶ Calculate (Entire)

Download (Entire)

5. REPEATABILITY PERIOD BASED ANALYSIS

▶ Run All (Period)

Entire dataset Per Animal Per Factor1 Per Factor2 Per Factor1 X Factor2

▶ Calculate (Entire)

Download (Entire)

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This includes descriptive statistics:

- Stay duration
- Number of visits
- Number of animals
- Average of daily gas emission & standard deviation
- All results of CH₄ after diurnal adjustment

↙ Herd, Treatment, and Animal levels descriptive statistics results **across multiple time scales**

03 What is the next step?

Method: GreenDA – A user-friendly tool for processing and exploring large-scale GreenFeed® data

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Accepted on June 23rd

animal
open space



GreenDA_version4 Private

Watch 0 Fork 0 Star 0

main 1 Branch 0 Tags

Go to file Add file Code

INRAE-UMRH-Dinamic	Update version number to v4.40 in documentation	1efb93a · last week	32 Commits
1_Example_dataset	Create README.md		last month
2_Rscript_version	Add files via upload		last week
3_Standalone_version.md	Update version number to v4.40 in documentation		last week
README.md	Update README.md		last month

README

GreenDA: A User-Friendly Tool for GreenFeed Data Analysis

GreenDA is designed to simplify the analysis of diverse datasets generated by the C-Lock GreenFeed® system.

As you may know, the GreenFeed® system generates data every single time an animal visits the unit, resulting in massive datasets depending on the trial duration. However, not everyone is familiar with data analysis tools. Furthermore, researchers new to GreenFeed data often find it challenging to figure out where and how to begin their analysis.

About

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- 0 watching
- 0 forks

Releases

No releases published
[Create a new release](#)

Packages

No packages published
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Contributors 1

INRAE-UMRH-Dinamic

Languages

- ✓ **Open our application to public via GitHub**
L Example dataset + R version + Standalone version
- ✓ **Update based on users feedback**

THANK YOU FOR YOUR ATTENTION

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Le projet Méthane 2030 est financé :

- Par l'Etat dans le cadre de France 2030 et par l'Union européenne – Next Generation EU dans le cadre du plan France Relance – Union européenne,
- Par APIS-GENE,
- Par le PNDAR.

FINANCEURS

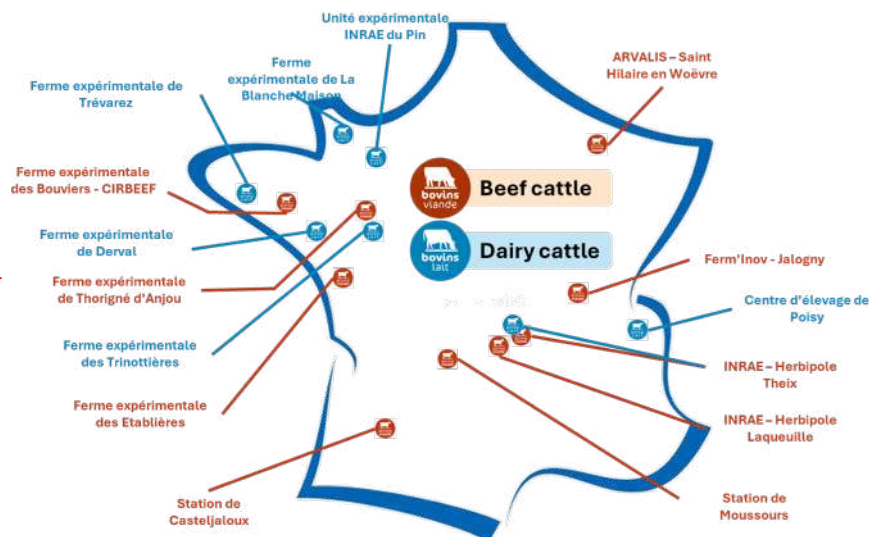
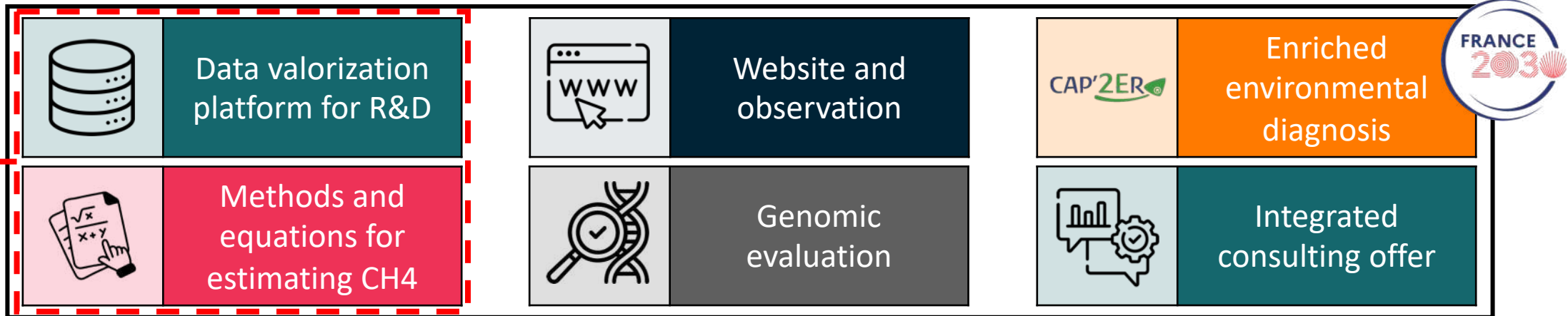


01

Chapter 1. INTRODUCTION

Methane 2030 Project

Developing multi-level solutions to accelerate the reduction 30% of enteric CH₄ emissions in cattle farms



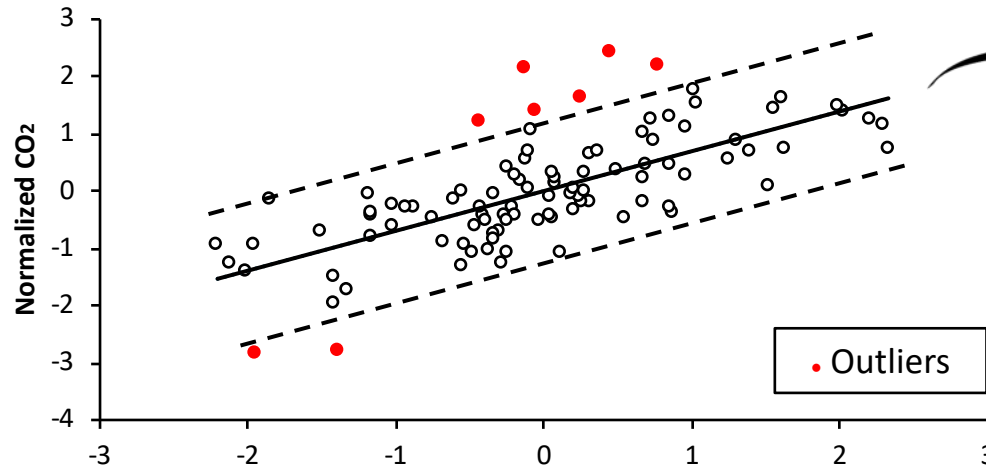
Conduct experiments in 15 sites in France

- Performance (e.g. growth, milk)
- CH₄ emission (e.g. GreenFeed, sniffer)
- Spectroscopy data (Milk, Feces)
- ...

02 Data Cleaning – Variable level

Correlation based method – CO₂ & CH₄

Arbre (2016)

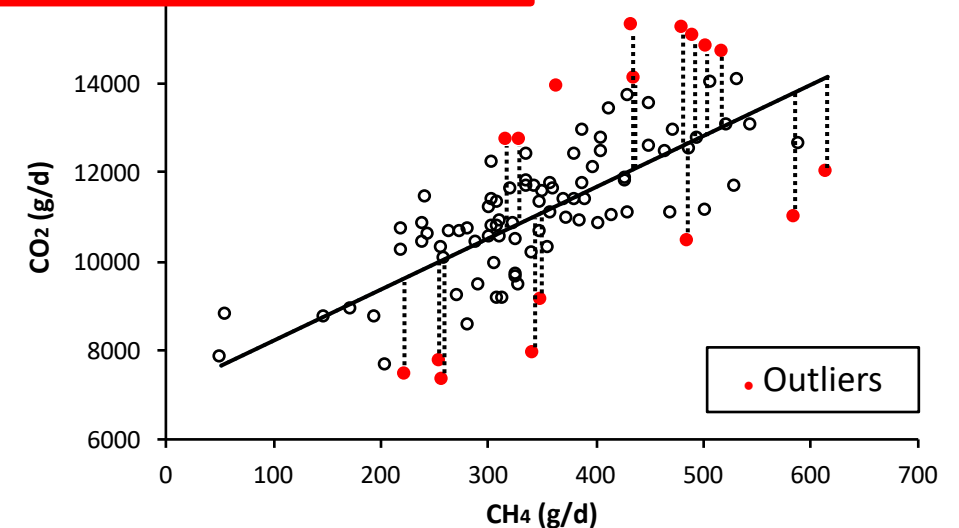
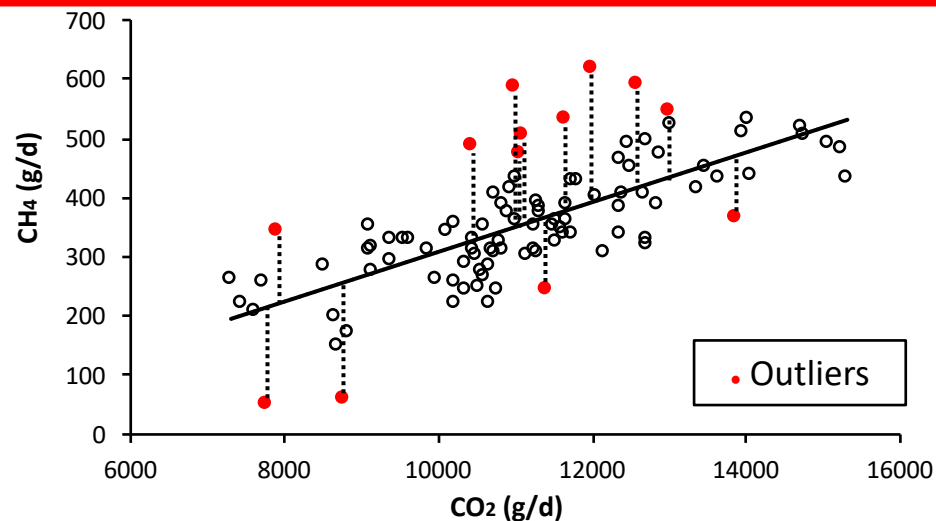


Correlation-based distance
using normalized CO₂ and CH₄ values

Residuals based on
the CO₂ and CH₄ correlation model

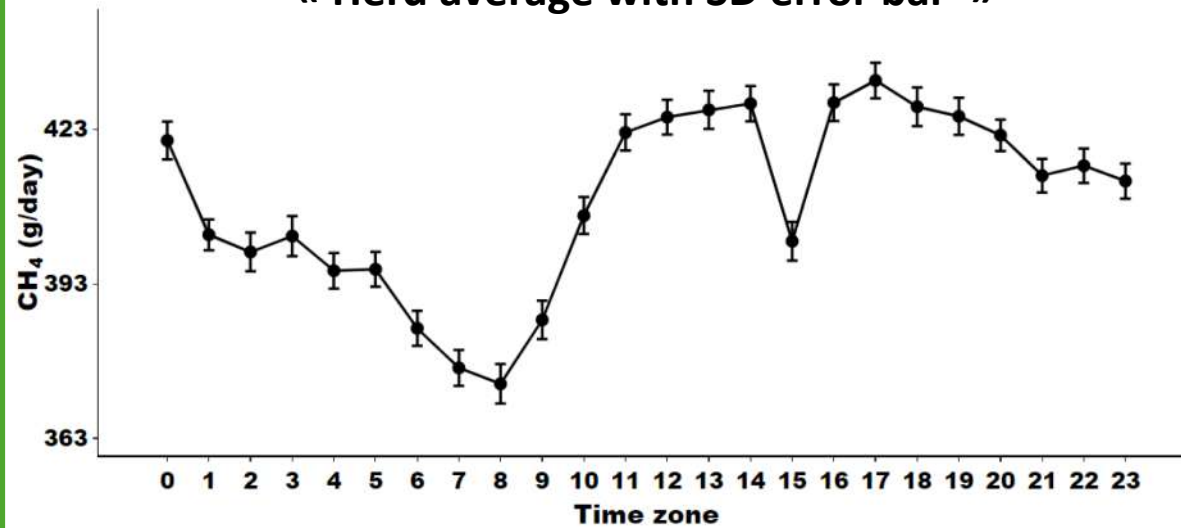
➔ **Limitation: CH₄ and CO₂ do not always significantly correlated**

Coppa (2021)

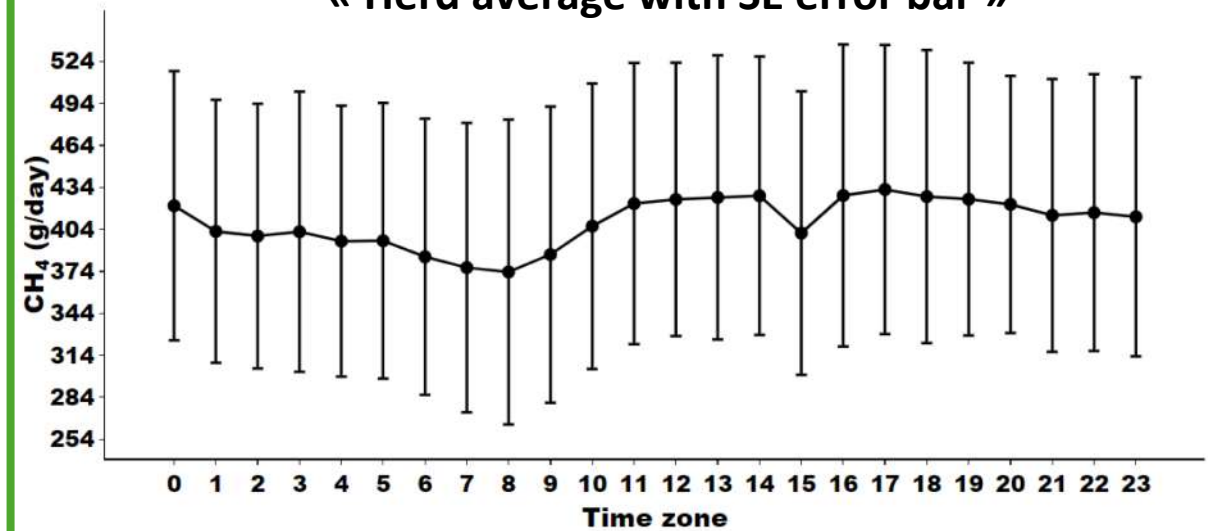


02 Hourly CH₄ emission kinetics

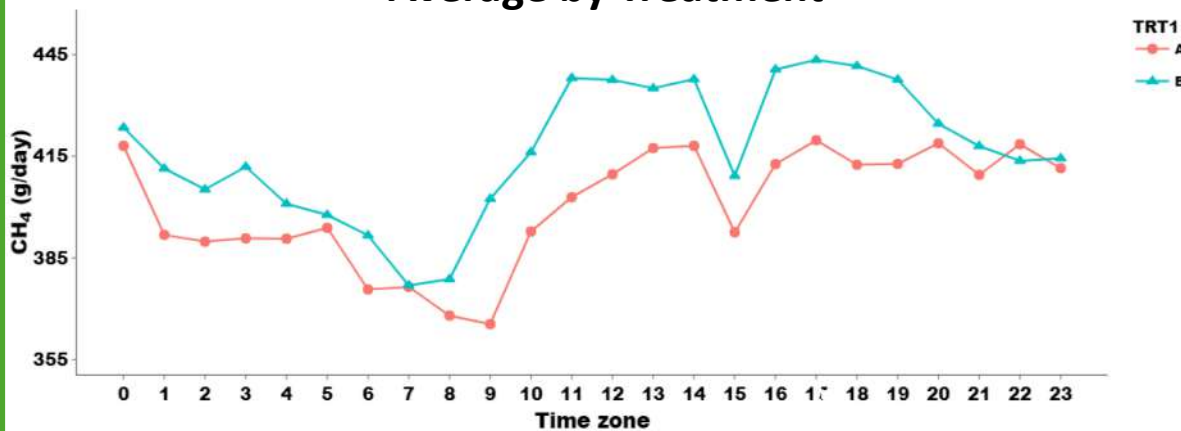
« Herd average with SD error bar »



« Herd average with SE error bar »



« Average by Treatment »



« Average by Animal »

