



North Wyke Farm Platform

GreenFeed System Methane and Carbon Dioxide Data



User Guide



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The North Wyke Farm Platform: GreenFeed System Methane and Carbon Dioxide Data

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Description: The North Wyke Farm Platform (NWFP) was established in 2010 to study and improve grassland livestock production at the farm-scale. The NWFP uses a combination of environmental sensors, routine field and lab-based measurements, and detailed management records to monitor livestock and crop production, emissions to water, emissions to air, soil health, and biodiversity. The rich NWFP datasets help researchers to evaluate the effectiveness of different grassland (and arable) farming systems, which in turn, contributes to the development of sustainable, resilient and net zero land management strategies. This document serves as a user guide to the methane (CH₄) and carbon dioxide (CO₂) emission data, sampled from housed cattle and sheep using GreenFeed systems. This document is associated with other dedicated user guides that detail the collection, and quality control processing of all the datasets produced on the NWFP.

Site: North Wyke, Okehampton, Devon, UK. Geographic location: 50.76944, -3.90138; 50°46'10" N, 3°54'05" W.

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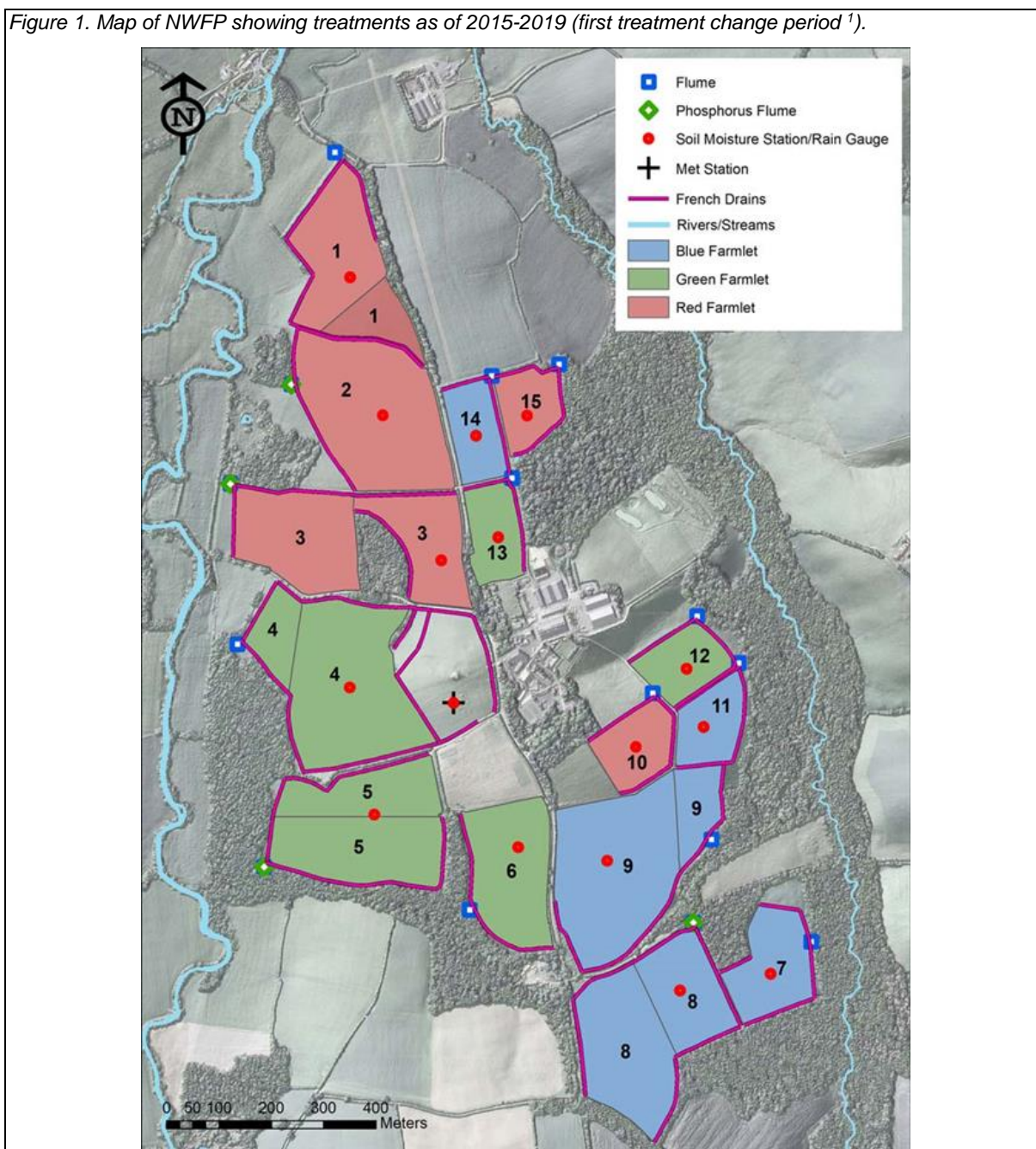
1 Introduction

This document provides a guide to the methane (CH₄) and carbon dioxide (CO₂) emission data from the cattle and sheep on the NWFP (Figure 1), sampled using GreenFeed systems (C-lock Inc., Rapid City, SD, USA).

Information on the site characteristics, design and development of the NWFP, and the quality control (QC) system for the data can be found in the following User Guide documents available on the NWFP website:

- NWFP_UG_Design_Develop.pdf
- NWFP_UG_QC.pdf

Figure 1. Map of NWFP showing treatments as of 2015-2019 (first treatment change period ¹).



¹ Green farmlet = permanent pasture, Blue farmlet = high sugar grass/clover; Red farmlet = high sugar grass, and later converted to arable in autumn 2019 (start of second system change period). In November 2017, phosphorus was measured at catchment or flume 3 in addition to flumes 2, 5, & 8. From autumn 2023 onwards phosphorus will be measured on all catchments. Numbers represent catchment number. Note some catchments consist of multiple fields.

2 The GreenFeed System

The automated GreenFeed (GF) system (C-lock Inc., Rapid City, SD, USA) measures gas fluxes from individual animals when they voluntarily visit the equipment with the reward of a small quantity of pelleted feed as an incentive (Figure 2). Whilst feeding from the equipment, the air exhaled from the mouth and nostrils of the animal is aspirated, filtered, and then analysed in real-time by a non-dispersive infrared sensor, while the flow rate of the aspirated air is determined by a flowmeter.

Figure 2. GreenFeed system.



2.1 Deployment

There are seven GF systems in total on the NWFP, three of those used by cattle and four used by sheep during their respective housing period every year. The cattle GF units have been deployed since 2016 and are situated in each of the three dedicated farmlet cattle buildings [see [NWFP_UG_Design_Develop.pdf](#), [NWFP_UG_Livestock_Data.pdf](#)]. Following their weaning in the autumn, calves are allocated to one of the NWFP farmlet systems and are housed in the appropriate farmlet building where they can access their associated GF system (Figure 3). In the case of the Green and Blue farmlet cattle and, up until 2019, the Red farmlet cattle, this is typically from October to April when they are turned out to grass on their appropriate farmlet system. In 2019, the Red farmlet was converted to arable cropping and the cattle that would have been associated with that farmlet are from here on permanently housed in their associated building from weaning to slaughter. This represents a fourth system (Brown) for evaluation of indoor intensive finishing and cattle typically access the GF system from October to the following July.

Figure 3. Locations of the GreenFeed systems in the cattle buildings.



⊕ GreenFeed systems locations

From 2019, sheep are no longer associated with the Red farmlet. The Green and Blue farmlet sheep are housed annually in the Orr Small Ruminant Facility (SRF) building from approximately the end of December until lambing time in the following mid-March-April whereafter they are turned out to grass on their allocated farmlet. Since 2022, the ewes have access to GF units, two for each farmlet, until lambing starts. If required, the four easily transported GF units can also be used for sheep housed in the biocontrol units in the SRF during feed intake trials (Figure 4).

Figure 4. Potential locations of the GreenFeed systems in the Orr Small Ruminant Facility.



- ⊕ GreenFeed systems potential locations
- ▭ Green farmlet pens
- ▭ Blue farmlet pens
- ▭ Biocontrol units

2.2 Equipment Set-up

The start of a feeding period (FP) is triggered by an animal inserting its head into the GF, at which point the animal is identified by its radio frequency identification ear tag (RFID), the first quantity of pellets is dispensed, and measurement of CH₄ and CO₂ from expiration and eructation begins. Once the animal has left the GF, both pellet dispensing and gas measurement stop. The GF systems are programmed to allow up to five FPs per animal per day, with a minimum interval of 4:40 h between each period.

2.2.1 Cattle GreenFeed

At each FP, an average quantity of 30 g of pelleted feed is dispensed from a hopper up to a maximum of five times, with an interval of 35 s between each. Thus, the cattle can receive approximately 150 g of pellets at each visit and approximately 750 g of pellets per day (Figure 5).

2.2.2 Sheep GreenFeed

At each FP, the animals receive up to 40.2 g per FP and a total of up to 210 g of pellets per day (Figure 6).

Figure 5. Cattle GreenFeed System.

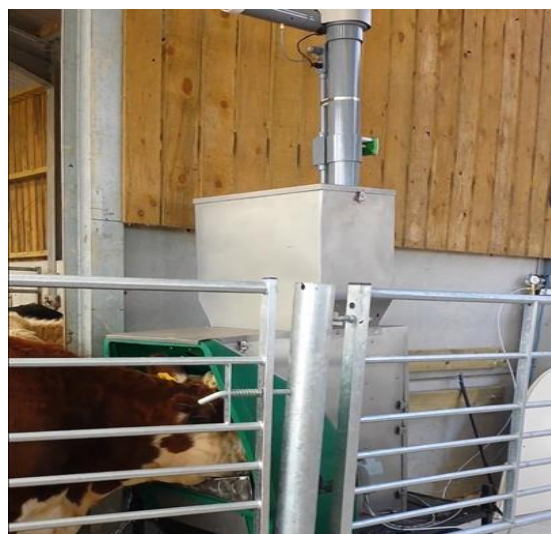


Figure 6. Sheep GreenFeed System.



2.2.3 Calibration

Standard gas calibrations using a mixture of CH₄ (508 ppm), and CO₂ (4982 ppm) and zero-grade nitrogen (N₂) are performed automatically every day at 04:00 h. Once per month, a CO₂ recovery test is performed. Air filters are checked, changed, and cleaned on a weekly basis. Details on the calculation procedure for CH₄ and CO₂ emission are described by [Martin et al., \(2020\)](#).

3 Data Portal

The NWFP Data Portal (<https://nwfp.rothamsted.ac.uk/>) allows accessibility to the core NWFP datasets to not only Rothamsted Research but also the wider research community. The data are open access and free to download but users are required to register their interest.

For information on the latest version of the 15-minute water datasets and the changes since the last version, please refer to the User Guide entitled 'NWFP_UG_QC.pdf' available on the NWFP website:

<http://resources.rothamsted.ac.uk/farm-platform-national-capability/data-portal-guides-and-information>.

In addition, the website offers a wealth of online, and regularly updated information to complement the data.

4 Descriptions of Downloaded Data

A typical example of the data available to download from the data portal is shown in [Figure 7](#).

Figure 7. Example of GreenFeed systems data available from the data portal.

Official tag	Unit ID	Start Time	End Time	CO ₂ (g/d)	CH ₄ (g/d)
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 04:28	22/12/2016 04:33	4542	183
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 08:41	22/12/2016 08:44	5009	90
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 13:59	22/12/2016 14:03	4828	137
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 18:15	22/12/2016 18:19	4330	118
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 23:57	23/12/2016 00:00	4991	153
UK 362735 101544	Cattle Greenfeed Unit 98	22/12/2016 23:58	23/12/2016 00:04	5355	211
UK 362735 101544	Cattle Greenfeed Unit 98	23/12/2016 06:13	23/12/2016 06:17	4153	156
UK 362735 101544	Cattle Greenfeed Unit 98	23/12/2016 10:24	23/12/2016 10:28	5286	163

An explanation of the column headings is as follows:

- **Official Tag:** unique identification number for the animal.
- **Unit ID:** unique identification number of the GF unit.
 - Cattle Greenfeed Unit 96 = GREEN Farmlet.
 - Cattle Greenfeed Unit 97 = RED/BROWN Farmlet.
 - Cattle Greenfeed Unit 98 = BLUE Farmlet.
 - Sheep Greenfeed Unit 239 = BLUE Farmlet.
 - Sheep Greenfeed Unit 240 = BLUE Farmlet.
 - Sheep Greenfeed Unit 241 = GREEN Farmlet.
 - Sheep Greenfeed Unit 242 = GREEN Farmlet.
- **Start Time:** date and time when the visit to the GF started.
- **End Time:** date and time when the visit to the GF finished.
- **CO₂ (g/d):** carbon dioxide (CO₂) emission in grams corresponding to the FP. When there are multiple measurements for an animal due to several visits on the same day, calculation of the average between the visits gives the daily average gas emission in grams per day (g/d).
- **CH₄ (g/d):** Methane (CH₄) emission in grams corresponding to that FP. When there are multiple measurements for an animal due to several visits on the same day, calculation of the average between the visits gives the daily average gas emission in grams per day (g/d).

5 Citing the Data

If you choose to use any of datasets provided by the NWFP in a publication, please cite:

- Orr, R. J., Murray, P. J., Eyles, C. J., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Goulding, K. W. T., Griffith, B. A., Gurr, S. J., Harris, P., Hawkins, J. M. B., Misselbrook, T. H., Rawlings, C., Shepherd, A., Sint, H., Takahashi, T., Tozer, K. N., Whitmore, A. P., Wu, L. and Lee, M. R. F. (2016). *The North Wyke Farm Platform: effect of temperate grassland farming systems on soil moisture contents, runoff and associated water quality dynamics*. *European Journal of Soil Science*, 67, 4, 374-385. ([doi:10.1111/ejss.12350](https://doi.org/10.1111/ejss.12350)).

In addition, if using data from the baseline period please cite:

- Takahashi, T., Harris, P., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Hawkins, J. M. B., Misselbrook, T. H., McAuliffe, G. A., McFadzean, J. N., Murray, P. J., Orr, R. J., Rivero, M. J., Wu, L. and Lee, M. R. F. (2018). *Roles of instrumented farm-scale trials in trade-off assessments of pasture-based ruminant production systems*. *Animal*, 12, 8, 1766-1776. ([doi:10.1017/S1751731118000502](https://doi.org/10.1017/S1751731118000502)).
- Orr, R. J., Griffith, B. A., Rivero, M. J. and Lee, M. R. F. (2019). *Livestock Performance for Sheep and Cattle Grazing Lowland Permanent Pasture: Benchmarking Potential of Forage-Based Systems*. 9, 2, 101-118. ([doi:10.3390/agronomy9020101](https://doi.org/10.3390/agronomy9020101)).

For the datasets used, please cite the latest version of the relevant User Guide PDF document(s), listed in the table below, that describe the establishment and development of the NWFP, and the various datasets produced in detail. The link to these can be downloaded from the NWFP website. Note that the User Guide entitled 'NWFP_UG_Design_Develop.pdf' should be cited irrespective of the dataset used.

Data used	Main title of User Guide PDF document
All datasets	NWFP_UG_Design_Develop.pdf
15-minute time-series datasets (water, soil moisture, meteorology)	NWFP_UG_Hydrology&WaterQuality_Data.pdf NWFP_UG_SMS_Data.pdf NWFP_UG_MET_Data.pdf
Greenhouse gases	NWFP_UG_EC_GHG_Data.pdf NWFP_UG_GreenFeed_Data.pdf
Field surveys	NWFP_UG_FieldSurvey_Data.pdf
Livestock	NWFP_UG_Livestock_Data.pdf
Field events	NWFP_UG_FieldEvents_Data.pdf

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“The North Wyke Farm Platform is a UK National Capability supported by the Biotechnology and Biological Sciences Research Council (BBS/E/RH/23NB0008).”

“We acknowledge the interests of the Ecological Continuity Trust (ECT), whose national network of LTEs includes the experiment on which this research was conducted.”