North Wyke Farm Platform

Field Survey Data

User Guide

Version 1.0

The North Wyke Farm Platform: Field Survey 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 sub-catchment high-resolution (within-field) and low-resolution (field-level) surveys collected on the NWFP. Most surveys are site-wide across all the NWFP fields, while some are specific to a given triplet or small group of NWFP catchments. Low resolution surveys are site wide and are carried out quarterly and routinely as a management tool. This document is associated with other dedicated user guides that detail the design, establishment and development of the NWFP, field events, and the quality control process of datasets.

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

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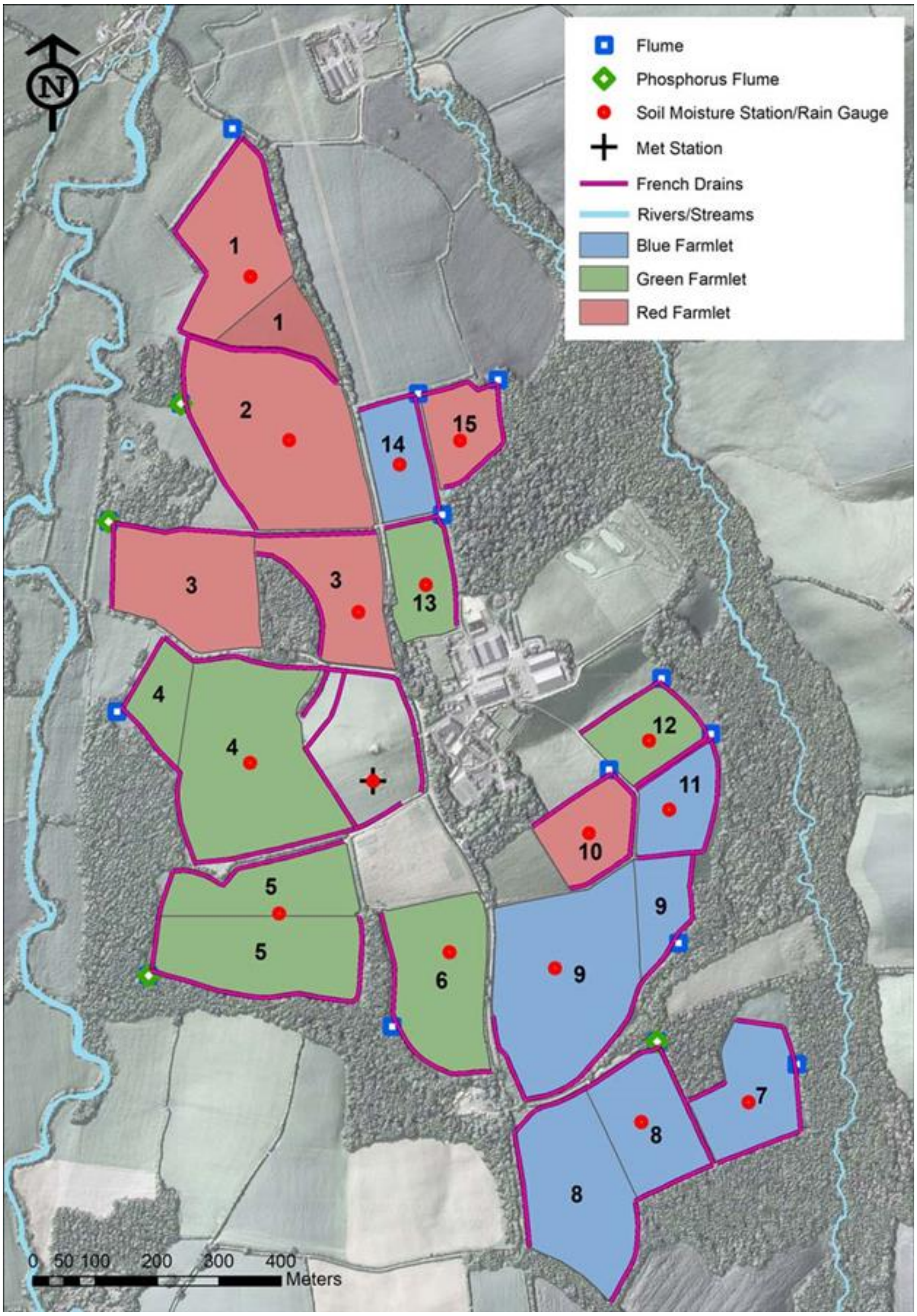
1 Introduction

This document provides a guide to the Field Survey data produced on the NWFP (Figure 1). 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 User Guide entitled NWFP_UG_Design_Develop.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 LiDAR, Soil classes and Other contextual spatial datasets

For the NWFP site, LiDAR data [Ferraccioli et al., 2014] provides both a digital surface model (DSM) and a digital terrain model (DTM) (see representations given in Figure 2). The soil is predominantly of two similar series, Hallsworth and Halstow, that comprise of a slightly stony clay loam topsoil (approximately 36% clay) overlying a mottled stoney clay (approximately 60% clay), derived from carboniferous culm measures [Harrod T.R and Hogan D.V, 2008]. The subsoils data are depicted in Figure 3, together with the 15 NWFP catchments and 21 field boundaries. All such contextual spatial datasets or layers (shapefiles) are available to Data Portal users via an HTTPS download.

Figure 2. Elevation for NWFP site.

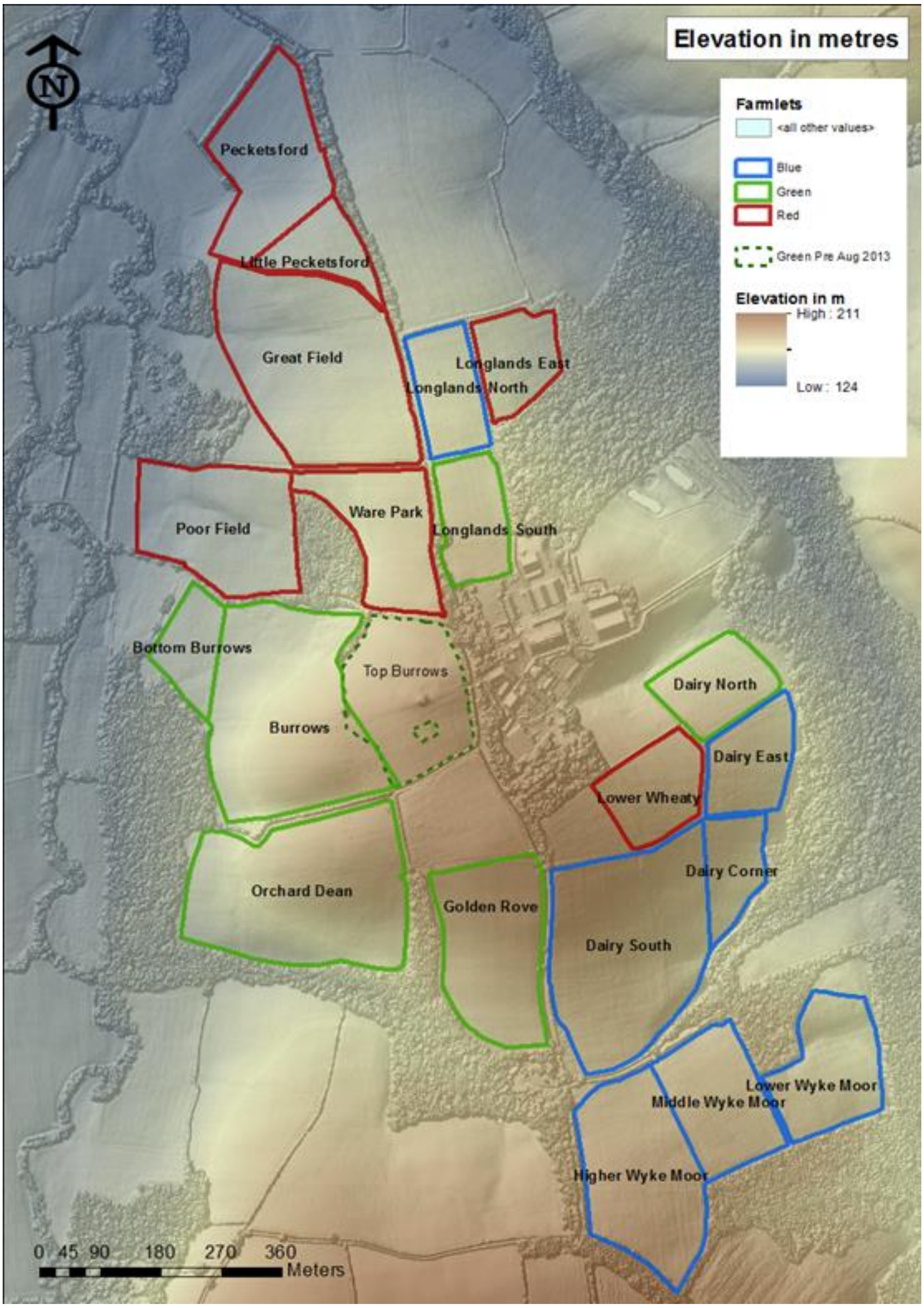
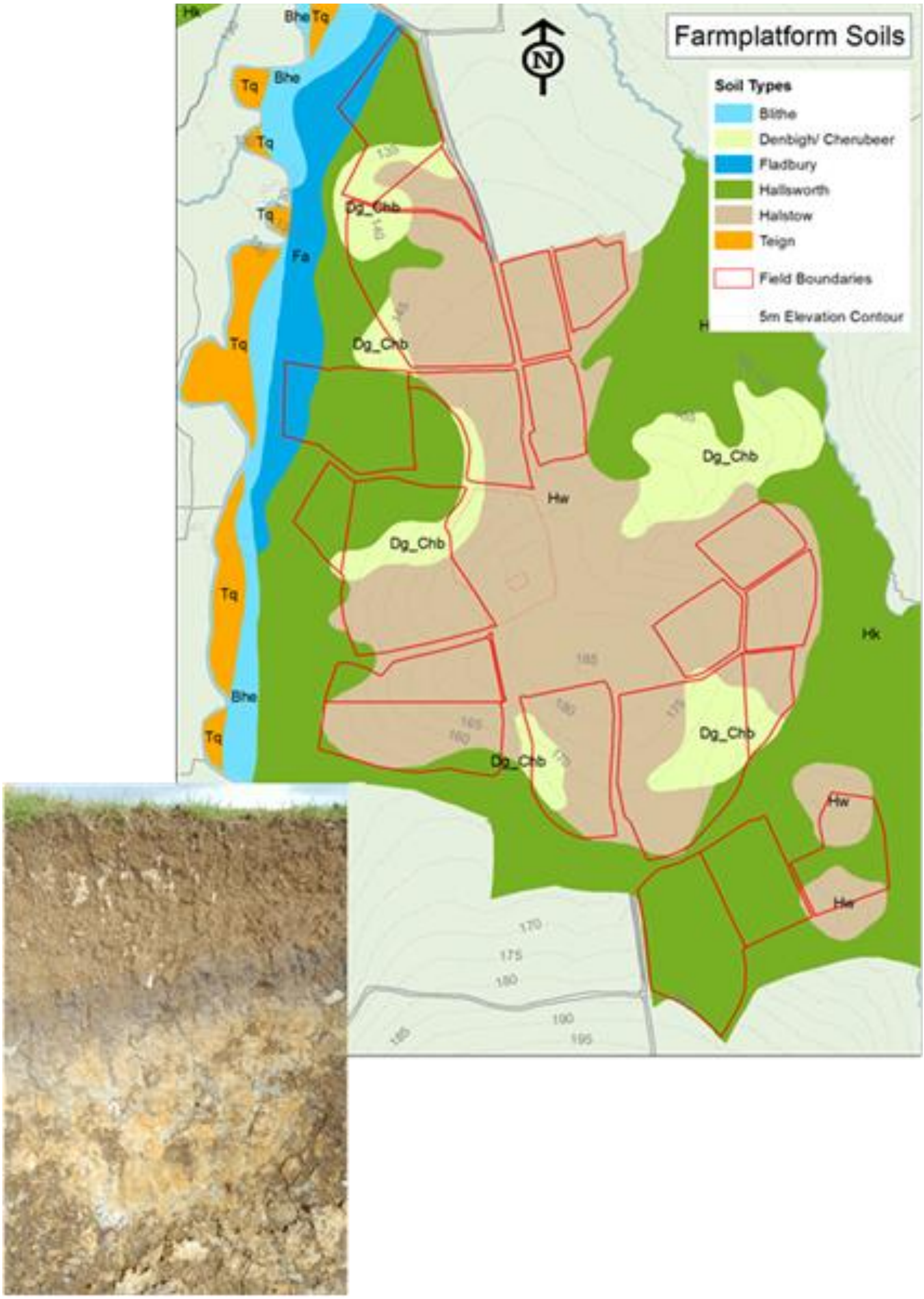


Figure 3. Map of the soils of the NWFP.

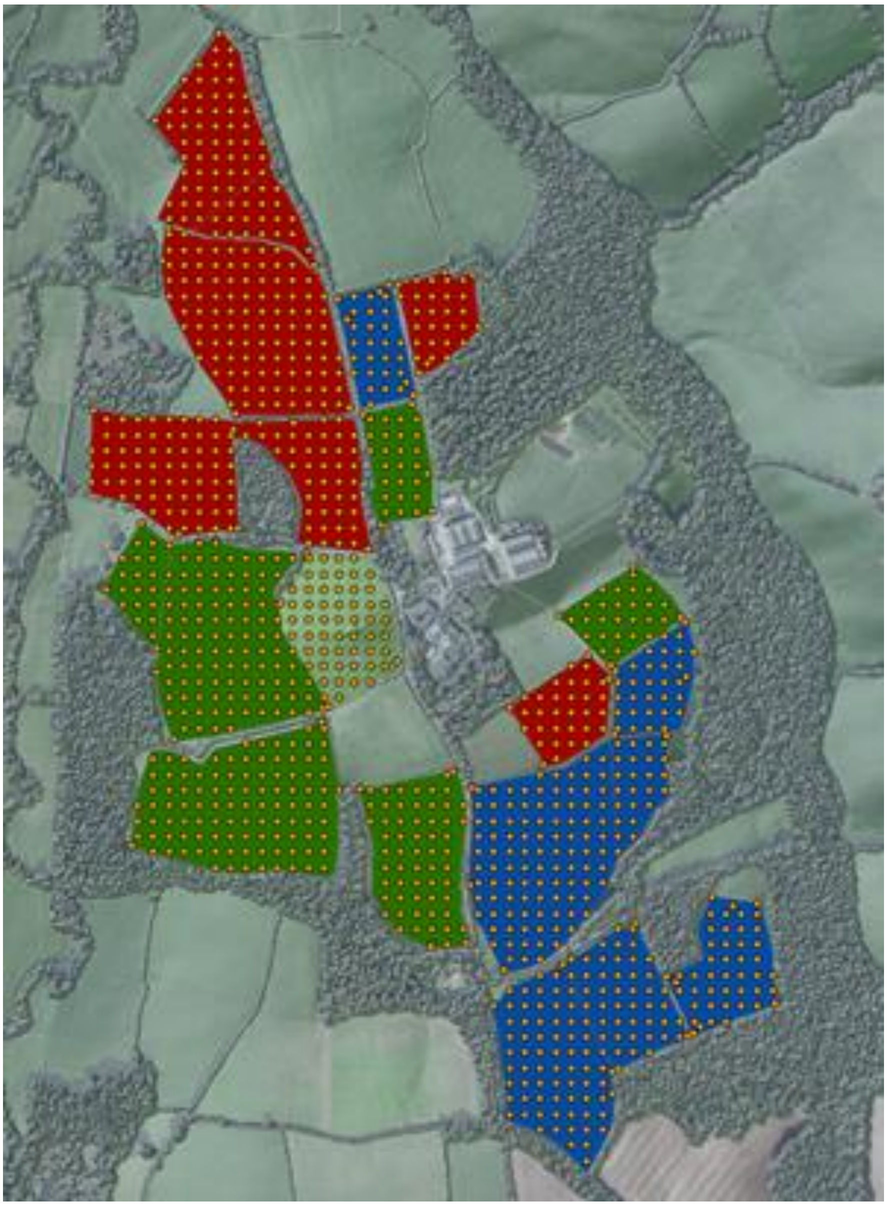


3 Survey Sample Locations: High-Resolution

Several 'high-resolution' field surveys have taken place since 2011 on the NWFP, ranging from soil chemistry and soil physics to soil fauna to botanical composition. The surveys have been predominantly carried out on pre-established grid locations, or occasionally on 'off-grid' sampling locations (especially when a good assessment of small-scale spatial variation is required). In both cases, real time kinematics global positioning system (RTK GPS) equipment was used locate and record the sampling locations. For the grid, a 25 m resolution is used that covers the entire NWFP site. This enables sampling surveys to be performed consistently on any 25, 50, 75 or 100 m interval (Figure 4)[2].

Survey data are stored alongside their sampling points and coordinates in the NWFP database and released through the Data Portal.

Figure 4. The 25m sampling grid of the NWFP (plus additional sampling along edges).



[2] *Note that the 50 m grid is not fully regular in that it is shifted by 25 m along a vertical line between catchments 6 and 9 (see Figure 1). This affects several surveys.*

4 Survey Data Releases

Registered Data Portal users can download the survey data in the form of a csv file, which will contain the survey results for each sampling point, the OSGB36 grid-coordinates[3] for that point and a sampling ID (but only if the sampling point coincides with an existing 25 m grid-location). The data contain the Experiment ID, which can be used to identify a specific survey (e.g. the Experiment ID of the 2012 Soil nutrients survey is FP003). The data download file will contain the whole dataset of the selected surveys during the selected time-interval, including data that fall outside that time-interval. Note that even if one sample point falls within the time-interval selected for the data-download, the WHOLE dataset will be returned. Also provided in the data download is the UTC-timestamp, as the time and date of sampling are essential. For example, a field could have been treated with fertilizer a few days before soil samples were taken. As the fertilizer application would affect the results of the soil sample, it is vital to record the sample date. Livestock movement is also an important consideration in this respect too [see, NWFP_FieldEvents_Data.pdf; NWFP_Livestock_Data.pdf]; as are times when fields or catchments were ploughed and reseeded – moving from baseline to subsequent treatment changes. Additionally, each listed survey parameter will have a traffic light flagging system for quality control (QC), together with the date of this QC. Currently the traffic light quality flag assignment consists of the following 6 levels: Not Set; Good; Acceptable; Suspicious; Highly Suspicious; and Reject.

For field survey data **released on the 29th February 2016** and **17th July 2018,** and soils invertebrate survey data **released on the 30th September 2016**, the baseline surveys are summarised in Appendix A. All survey parameters have been flagged as “Acceptable”.

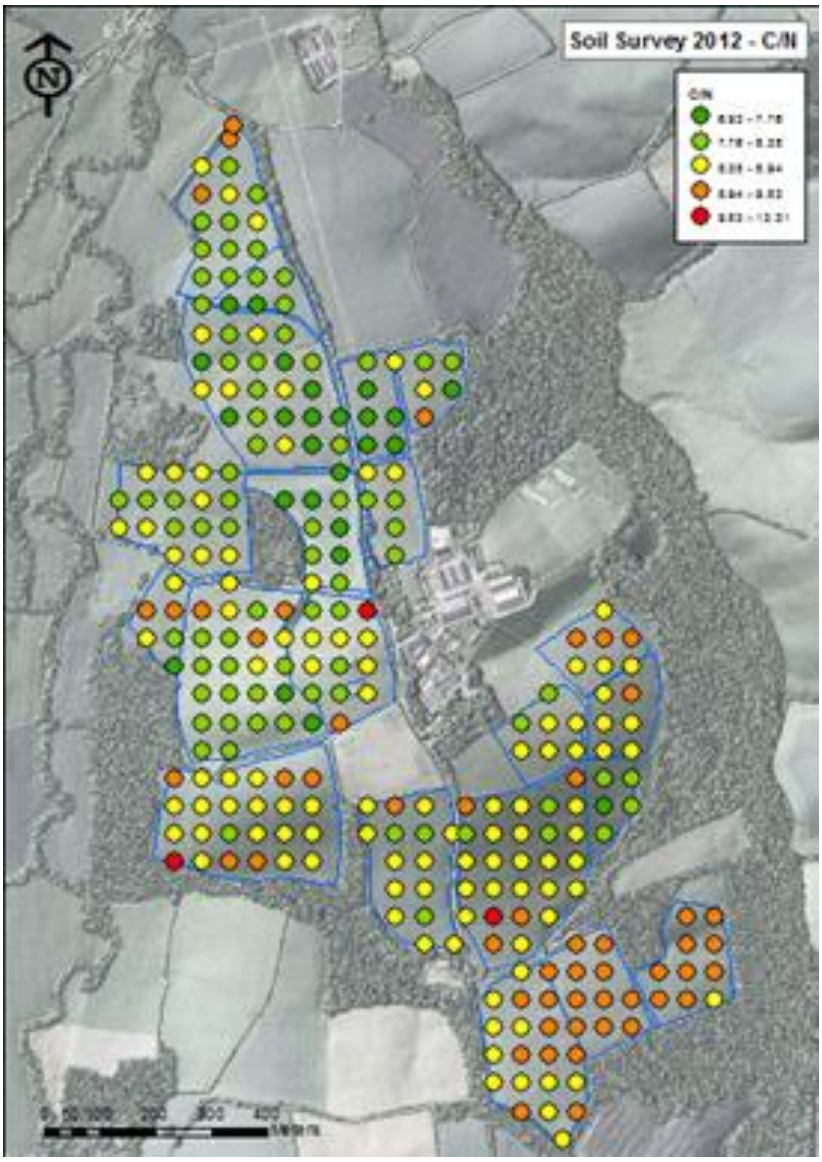
[3] *Details on the coordinate systems that are used are available on request. It is also useful to link to https://www.ordnancesurvey.co.uk/business-and-government/help-and-support/navigation-technology/os-net/surveying.html.*

5 Soils Nutrients: Site-wide Surveys (2012 and 2016)

The first NWFP soil survey was carried out during the summer of 2012 on the 50 m sampling grid [e.g. Noacco 2012; Harris et al. 2014]. This is viewed as the main baseline survey for rudimentary soil chemistry and physics and sampled for the parameters listed in Appendix B. The sampling period for these data ran from 01st June 2012 to 31st July 2012. All 15 catchments were sampled. Figure 5 displays an example map of these data.

A secondary more comprehensive soil survey was carried out between 01st July to 21st July 2016 during the first treatment change period. All the NWFP fields were surveyed (21 fields in total). Most were sampled on the 50 m sampling grid, but some were sampled on the 25 m grid (Longlands North, Longlands South, Longlands East, Dairy North, Dairy South, Dairy East and Lower Wheaty). The samples were analysed for the parameters listed in Appendix C.

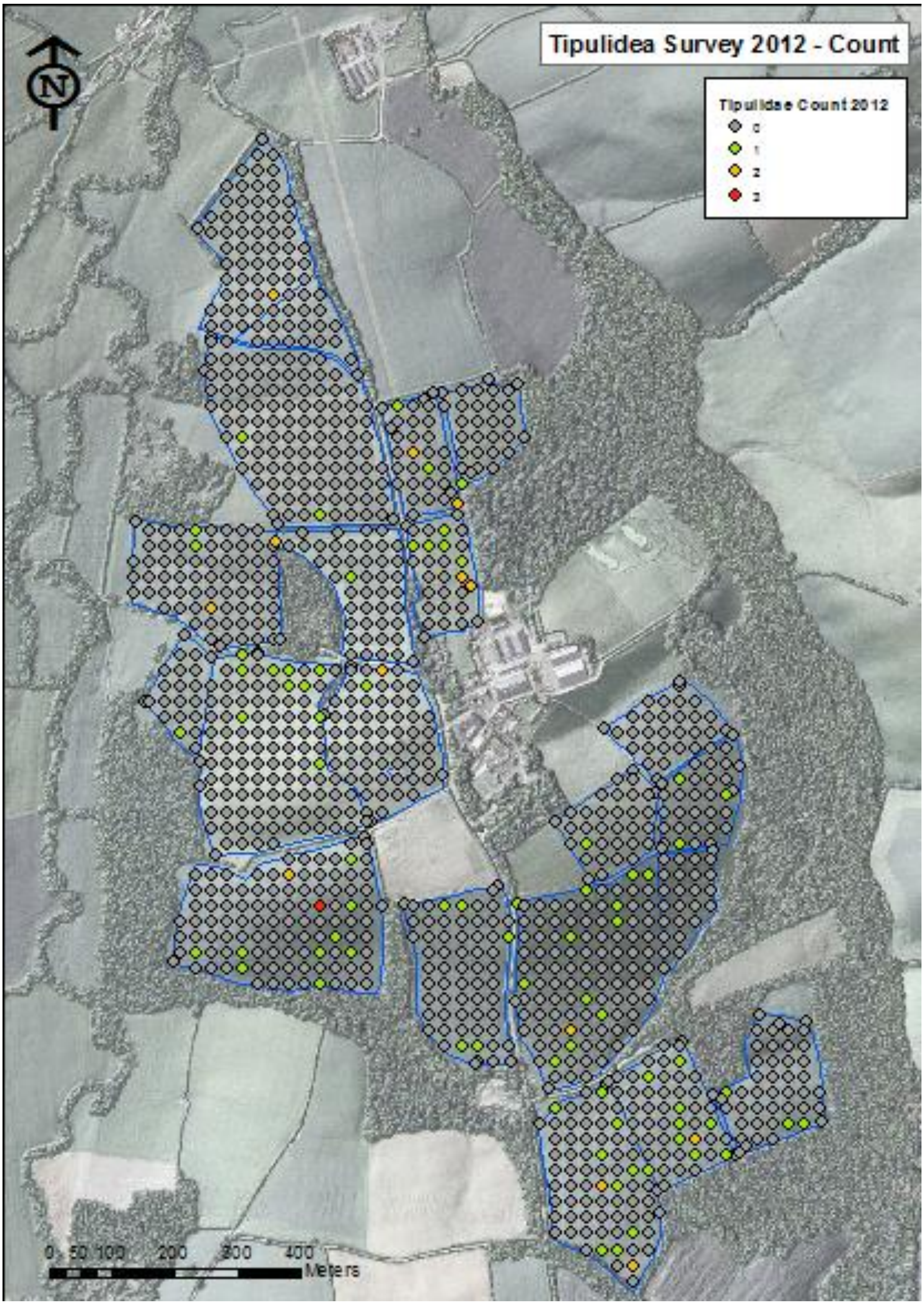
Figure 5. Example map for the 2012 soils survey – the Total C to Total N ratio.



6 Soils Invertebrates: Site-wide Surveys (2011 to 2013)

Soil fauna (insect taxa) surveys were conducted over a three-year period starting 15th November 2011 and ending on 08th April 2013 (see Appendix A). This resulted in two site-wide surveys covering all 15 catchments on the 25 m grid. One survey was aligned to 2012, the other 2013. Both surveys can be classed as baseline. Details of this fuller sampling campaign can be found in Ahmed (2013), Benefer et. al. (2016) and Wei et. al. (2016). An example map of these data for 2012 is given in Figure 6.

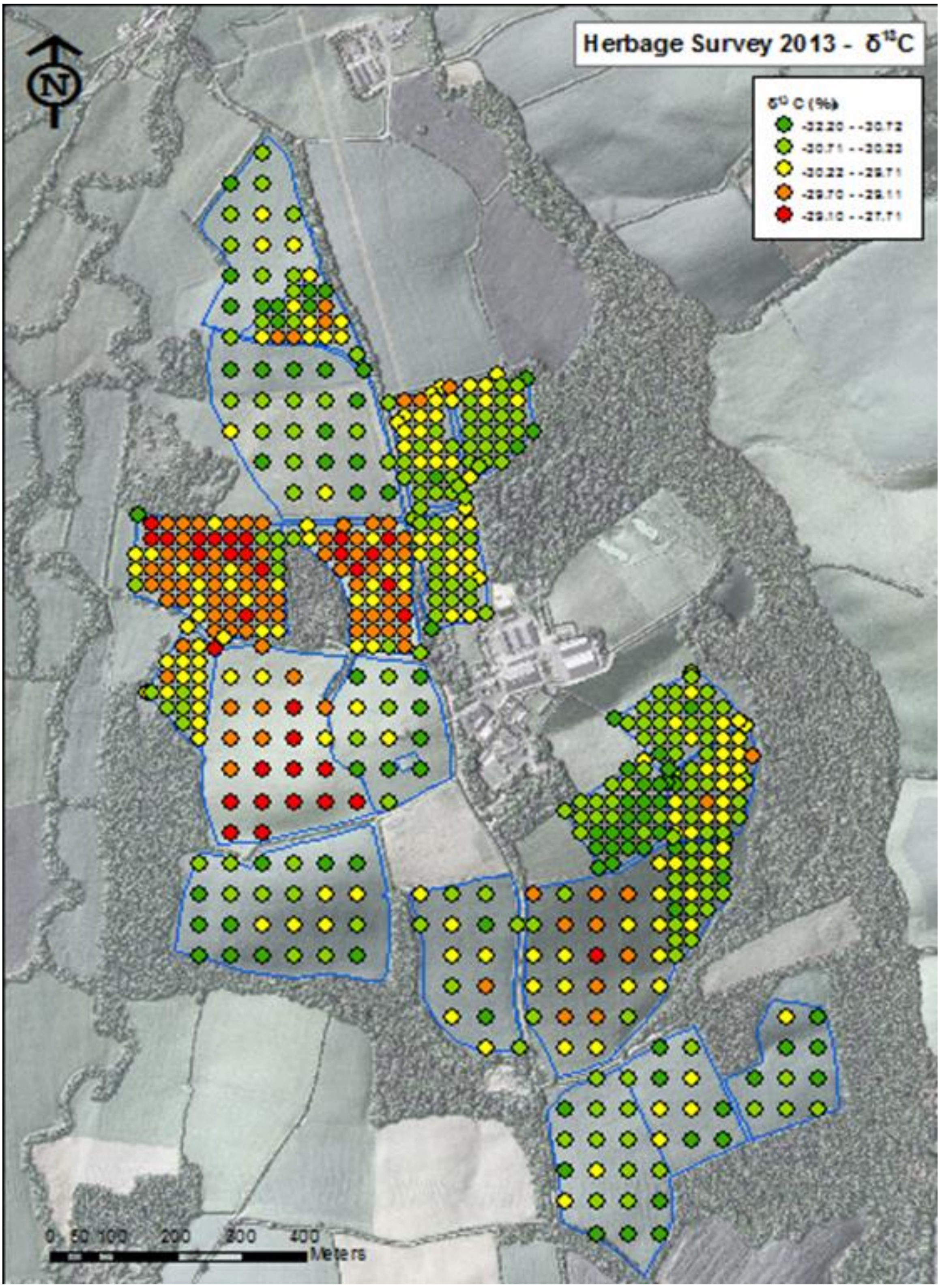
Figure 6. Example map for the 2012 soils invertebrates survey.



7 Herbage Nutrients and Sward Height: Site-wide Survey (2013)

A combined plant nutrients and sward height (herbage) survey was carried out during the summer of 2013 on a mixture of the 25 and 50 m sampling grids [e.g. Kear 2013]. Sampled parameters are listed in Appendix D. These data's sampling period ran from 12th June 2013 to 02nd July 2013. All 15 catchments were sampled. An example map of these data is given in Figure 7.

Figure 7. Example map for the 2013 plant nutrient survey - δ13C.



8 Botanical Composition: Site-wide Surveys (2013 to 2021)

Botanical assessments of the NWFP fields were undertaken during the summer of 2013 on a mixture of the 25 and 50 m sampling grids [Tozer 2013]. A quadrat consisting of a 50 x 50 cm metal frame was used to assess the botanical composition. The frame was placed on the ground with the SW corner directly on the sampling point; using a compass to align the edge in a Northerly direction. The botanical composition was assessed in these 0.25 m^2 quadrats at each of 293 sampling locations and species were scored according to the Domin Scale. The National Vegetation Classification: Users' Handbook [Rodwell 2006] describes the Domin Scale in the following manner:

"For every species recorded in the sample, an estimate should be made of its quantitative contribution to the vegetation. Cover is a measure of the vertical projection on to the ground of the extent of the living parts of a species."

Cover is defined according to the following categories given in Appendix E. Domin scale data can be converted to a linear scale using a suitable conversion factor [Tozer 2013].

Rodwell's handbook explains that:

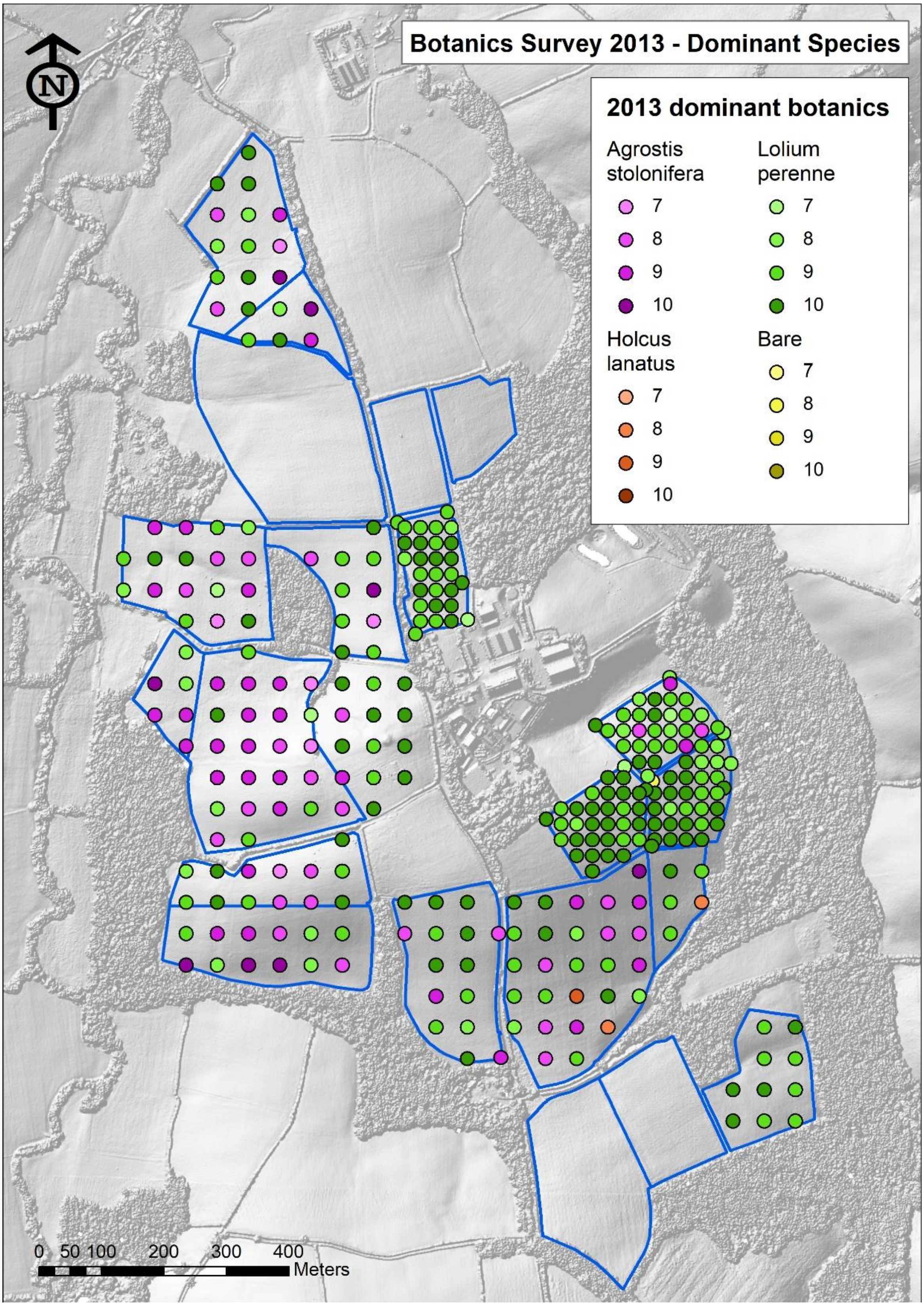
"Even when vegetation does not appear to be considerably layered, the sum of all the Domin values for a species can be greater than 100% cover because of structural overlap of the plants."

The species observed were: Agrostis stolonifera, Alopecurus geniculatus, Dactylis glomerata, Holcus lanatus, Lolium perenne, Phleum pratense, Poa annua, Poa trivialis, Cardamine pratensis, Cerastium fontanum, Cirsium arvense, Juncus effuses, Ranunculus repens, Rumex crispus, Rumex obtusifolius, Veronica serpyllifolia, Taraxacum officinale, Trifolium repens. In addition, areas of 'Bare' and 'Dung' were recorded. This dataset's sampling period ran from 22/07/2013 to 07/08/2013. The study is considered site-wide and baseline, but only 11 of 15 catchments were sampled due to re-seeding in some catchments. Figure 8 displays an example map of this data.

In 2016, a second survey was carried out using the same methodology as that for the 2013 survey except that the SW corner of the quadrat frame was placed exactly 1 m due north of the sampling grid points to avoid freshly trampled areas resulting from a different type of field survey that had used the same grid points.

In 2018 and 2021, third and fourth surveys were carried out using the same methodology as that for the 2013 and 2016 survey i.e. the SW corner of the quadrat frame was placed exactly 1 m due north of the sampling grid points to avoid trampled areas from a different types of field survey that had used the same grid points.

Figure 8. Dominant botanical species for the 2013 survey.



9 Limited Surveys (2013 to 2019)

9.1 Soil nutrients and pH

A combined soil nutrients and pH survey was carried out during the summer of 2013 on the 25 m sampling grid [Baldet 2013]. The soil nutrient parameters that were sampled are listed in Appendix F. These data were sampled in one day on 01st June 2013. Only 3 catchments were sampled (Longlands East, South and North) and provided 89 sampling locations in total.

9.2 Soil pH over time

A spatio-temporal soil pH survey was carried out during the summer of 2013 on the 25 and 50 m sampling grids to inform a precision application of prilled lime. The pH data were collected at sites in Longlands South (catchment 13), Longlands North (catchment 14), Longlands East (catchment 15) and Higher Wyke Moor (one field of catchment 8). Ten different sampling times were used, thus providing a spatio-temporal dataset for pH. The first days sampling was conducted on the 08th August 2013 and the last on the 14th October 2013.

9.3 Soil physics

A soil physics survey was carried out in 2019. Soil hydro-physical properties are essential in understanding key processes of the hydrological cycle and in turn can ensure an efficient management of water resources. Saturated soil hydraulic conductivity (KSAT) is one such variable that typically exhibits high within-field spatial variability. However, for calibrating a process-based model, such soil hydro-physical properties are commonly taken at the field level only. To address this shortfall, within-field KSAT measurements were taken from Great Field and thus these data have the potential to improve the simulation accuracy of a process-based model when the model is specified in a within-field form (i.e. a grid-to-grid form).

For this survey, KSAT was measured by the falling head technique. Twenty-seven points at 0–10 cm, 10–20 cm and 20–30 cm soil depths were measured on a 50 m sampling grid for Great Field (catchment 2) over the period March to July 2019 (where the field was still under the high sugar grass treatment). Thus, 81 KSAT measurements were taken in total. Undisturbed soil samples were taken using a 250 ml volume steel cylinder with 8 cm inner diameter and 5 cm length (cores were taken in the middle of each soil layer). The KSAT measurement was performed using a KSAT® device [METER Group AG, Munich, Germany].

Each soil core was covered by a saturation plate with a filter paper at the cut side, then placed into a water pan, keeping the cut side at the bottom. The water pan was filled with approximately 2 cm degassed tap water and tilted so that any trapped air bubbles could escape. The water level was then raised almost to the core height thus simulating an elevated water table. To ensure saturation, the core was kept in this state for 2 weeks., The pan was then filled with at least 12 cm water so that the core was flooded. The saturated porous plate on top of the sampling ring was sealed by turning the apparatus upside down under water and removing the saturation plate as well as the filter paper. After equilibration, the core was fitted with a collar and an appropriate upper and lower screen (all included with the device) to prevent particles from escaping. This ensured all water passed through the substrate instead of passing outside of the core. The core was then fitted into the device and re-saturated from the base to replace any water lost during preparation. Using the device, KSAT was measured three consecutive times in the constant head measurement mode. Both KSAT (cm d^{-1}) and time (minutes) to saturation (duration) measurements are given at three soil depths.

10 Silage Cuts (2011 onwards)

Grass is cut for silage approximately twice a year when not required for grazing and samples are taken at time of harvest to calculate dry matter (DM) yield. Prior to 2020, in-field grass samples were taken from cuts made by a plot harvester (Haldrup GmbH, Ilshofen, Germany) of exactly 1.5 m wide and 10 m in length, with a predefined GPS sample location at its centre point. For example, Figure 9 maps the field locations of the cuts for 2011-2013 and Figure 10 provides an example output of this data.

Figure 9. Location of silage fields for 2011-2013.

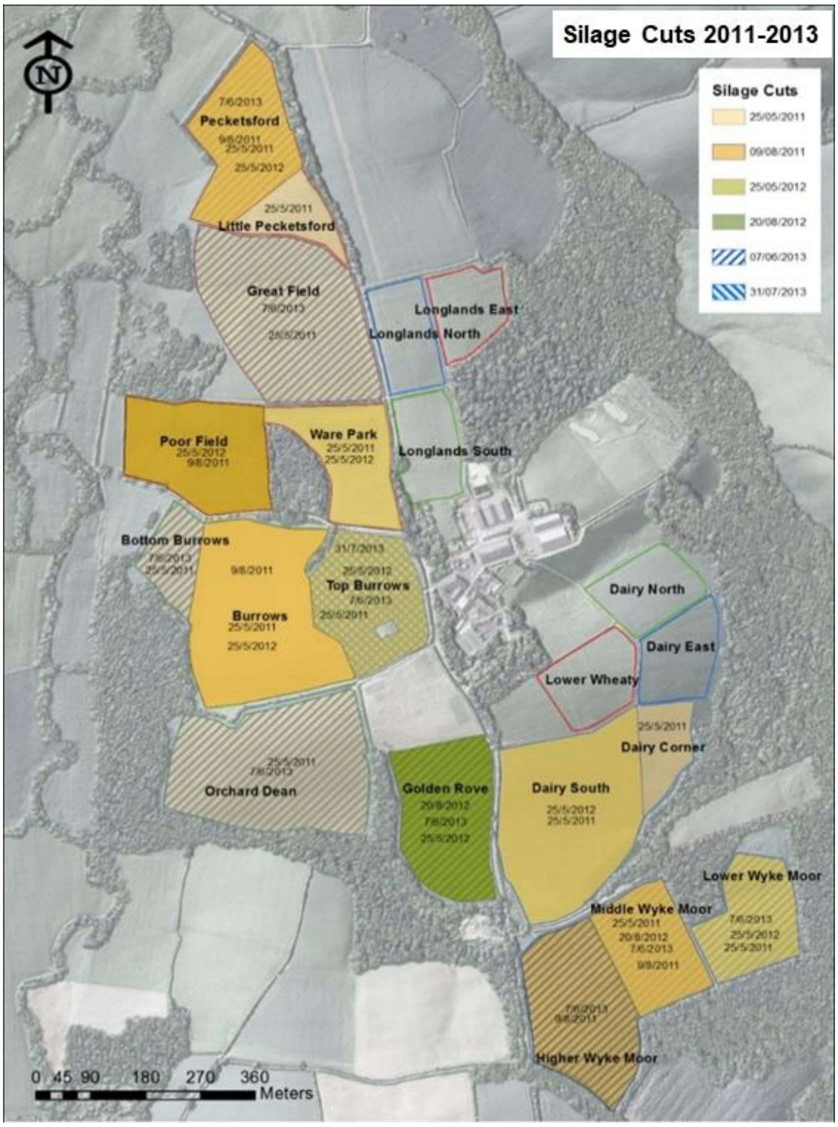


Figure 10. Example output from data portal for silage cuts.

Experiment_Id	SP_ID	sample_ distance (m)	Field	Flume	Sample_date	Sample_time	comments	Start_Sample _Date	GPS_Sample _Nr	Easting	Northing	Silage Dry Matter Yield (kg/ha)	Silage Dry Matter Yield Quality	Silage Dry Matter Yield Quality Last Modified
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	1	265701.23	99027.88	6220.02	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	2	265621.36	99162.64	8335.66	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	3	265637.33	99038.39	7116.73	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	4	265595.77	99118.06	7003.35	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	5	265615.02	99241.73	8485.22	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	6	265637.09	98733.25	6037.3	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	7	265721.10	98793.43	7351.36	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	8	265672.90	98935.10	7192.93	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	9	265596.13	98952.16	7291.08	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	10	265616.02	98873.17	6595.04	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	11	265651.76	98817.32	6441.03	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	12	265776.81	98702.39	8375.28	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	13	265791.05	98485.19	6513.4	Not set	09/04/2015
NW558_SC1	NA	NA	NA	NA	25/05/2011	12:00:00		NA	14	265799.51	98624.97	7425.67	Not set	09/04/2015

Since 2020, samples are collected from every trailer that transports the grass to the silage clamp. Each trailer load is weighed on a weigh bridge and the trailer weight, trailer number and field name recorded. Representative samples (4 handfuls; c.400g total) are collected from the heap as the grass is tipped into the silage clamp.

Where silage is made into round bales, samples are taken just prior to wrapping. Five bales from each field are sampled, each sample comprised of 4 representative handfuls (c. 400g per sample) and the weight of the trailer loaded with bales from the field is recorded.

Fresh samples are oven dried, and the DM calculated on Kg ha^{-1} basis.

11 Quarterly Low-Resolution Surveys (2018 onwards)

A quarterly low-resolution collection of soil and herbage samples is made from each of the 21 fields (NB. 20 fields post-autumn 2019; See NWFP_UG_Design_Develop.pdf) of the NWFP and which are analysed for macro and micronutrient contents. These low-resolution surveys started in April 2018 and have largely replaced the high-resolution surveys.

Samples are taken as either a composite or bulked sample representing the whole field or, during one of the four sampling events, as individual point samples within a field. The individual point samples are recorded using GPS and used to create an archive of samples which are available for future analysis to obtain field-level variances.

Results from these surveys aid management decisions, build a long-term record of nutrient values, and create an archive of samples which are available for future analysis.

The low-resolution surveys and are completed about every three months. The exact timings for the surveys are influenced by annual ground and weather conditions, but the approximate periods are as follows:

- **2018-2020**

Until 2020, the March/April survey collected both bulked samples at a field scale for immediate analysis and retained individual samples from each point to be stored in the NWFP archive for potential future analysis. Samples from the three other sampling occasions were bulked at a field scale for immediate analysis only.

1. March/April – Prior to any fertiliser applications. Bulked sampling and individual survey (10 sampling locations per field for both bulked and individual samples). Individual samples were archived up until 2020.
2. June/July – Bulked sampling survey (20 sampling locations per field).
3. August/September - Bulked sampling survey (20 sampling locations per field).
4. December/January – Bulked sampling survey (20 sampling locations per field).

- **2021 - onwards**

The archiving of individual samples was moved from the March/April survey to the September/October sampling from 2021 onwards. This change was to align sampling with the harvesting of crops following the transition of the Red farmlet from pasture to arable cropping (Figure 1).

1. March/April – Prior to any fertiliser applications. Bulked sampling survey (20 sampling locations per field). Bulked samples archived.
2. June/July – Bulked sampling survey (20 sampling locations per field).
3. August/September - Bulked and individual archived survey to align with arable crop harvest (10 sampling locations per field for both bulked and individual samples). Individual samples are archived from 2021 onwards.
4. December/January – Bulked sampling survey (20 sampling locations per field).

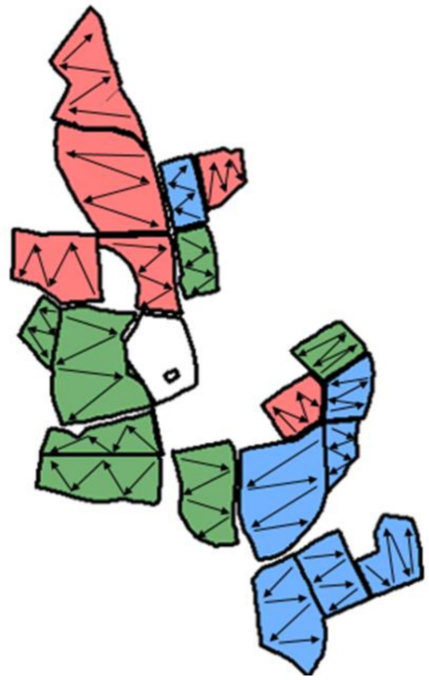
11.1 Sample collection

All soil and herbage samples taken, whether as bulked field samples or as individual point samples, are identified with a unique number and GPS location in the case of the latter.

At the three bulked sample timings, soil and herbage samples are collected simultaneously at twenty locations within each of the 21 fields (20 fields post-autumn 2019; see NWFP_UG_Design_Develop.pdf. to give one soil and one herbage composite sample from each field.

A 'W' transect walking pattern is followed across each field to give good spatial coverage, avoiding areas near gateways, water troughs, hedgerows, or areas where supplementary livestock feeding may have occurred, or livestock congregate (Figure 11).

Figure 11. The 'W' walking pattern implemented in each of the NWFP fields.



11.2 Soil sampling

Samples are collected using a 10 cm deep soil pot corer (Figure 12).

Figure 12. 10 cm deep soil pot corer.

11.2.1 Bulked soil samples

For the three composite sample timings, two 10 cm deep soil cores are collected at each of the twenty sampling points, and bulked. The total soil collected from each field weighs at least 600 g fresh weight.

Since 2021, for the March/April sampling, two extra 10 cm soil cores are taken at each sample location bulked as a separate sample which is then air dried and archived. Thus, on this sampling occasion, each field produces two composite soil samples, one for immediate analysis and one for archiving for future analysis.

11.2.2 Individual point soil samples

For the timings where individual samples from each sampling point are retained (March/April sampling up until 2020; August-September sampling 2021 onwards), samples are collected at 10 points per field along a 'W' transect. At each point, the precise GPS location is recorded and ten 10 cm deep cores are taken and bulked.

On the arable based system, to remove time pressure at harvesting which may coincide with this sampling occasion, the ten individual sample points are pre-marked out using labelled markers, and their precise GPS location recorded in each of the six Red farmlet fields. The points are evenly distributed around the field along a 'W' transect to get representative samples. At the same time, the ten 10 cm core soil samples are collected from each point.

The details of the soil parameters measured, and methods of sample analysis are given in Appendix G. In the Data Portal, values exceeding the limits of detection for the analytical methods are denoted by -99999.

11.3 Herbage sampling

Snip samples are cut using hand-held scissors from the top two thirds of the plants available to represent the portion of the plant consumed by a grazing animal.

11.3.1 Bulked herbage samples

For the three composite sample timings, several snips are taken at each sampling point within a field and bulked together. The number of snips is dependent on the quantity of herbage available at time of sampling, but the aim is to collect a total fresh weight of at least 200 g from each field.

Since 2021, for the March/April sampling, extra snips are taken at each of the twenty sampling points in each field and bulked as a separate sample of at least 400 g total fresh weight / field. Thus, on this sampling occasion each field produces two bags of bulked herbage, one for immediate analysis, and one to archive for future analysis once dried.

11.3.2 Individual point herbage samples

For the timings where individual samples from each sampling point are retained (March/April sampling up until 2020; August-September sampling 2021 onwards), samples are collected at ten points per field along a 'W' transect (Figure 11).

For the pasture based systems, at each point the precise GPS location is recorded and several snips are taken to obtain a fresh weight of at least 200 g.

As close as possible to harvest time, and preferably the same day, grain and straw samples are taken from each of the pre-labelled ten points (see section 11.2.2). A Sampo 2010 Plot Combine (Sampo Rosenlew, Pori, Finland) is used to cut a ~1 m strip through each point after having first removed the marker. From this strip, the grain is collected (~ 200 g) from the spout of the machine and the straw is collected (~ 400 g) from the closest point behind it. The grain and straw samples are separately bagged. The details of the parameters measured in herbage, grain and straw are given in Appendix H, Appendix I, and Appendix J respectively.

11.4 Sample analysis

11.4.1 Soil analysis

Details of soil sample analysis are given in Appendix G. Full details of analytical methods are given in Appendix K.

11.4.2 Herbage analysis

Details of herbage sample analysis are given in Appendix H. Full details of analytical methods are given in Appendix L.

12 Sample Archiving

All samples for archiving are stored in bags, boxes or tins, depending on the type, which are labelled with their unique identification number, field name and sampling point. Samples from the same field are then stored in a plastic box (one for each of the sample types) that is labelled with the year, type of sample, and the range of unique sample identification numbers it contains.

12.1 Soil samples

Samples are weighed for fresh weight, air dried, and their dry weight recorded. The samples are sieved to 2 mm and then stored in a labelled brown paper bag before being put into a cardboard box which is also labelled.

12.2 Herbage samples

Samples are weighed for their fresh weight, oven dried at 60 ºC for ~48 hours until completely dry and their dry weight recorded. The dried samples are coarsely ground (Retsch SM 300 mill, 0.5mm sieve) before being put into labelled plastic bags.

12.3 Grain and straw samples

Samples are oven dried at 60 ºC for 48 hours, coarsely ground (Retsch SM 300 mill, 0.5mm sieve) and placed into a labelled metal lever lid tin.

13 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.

14 References

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15 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).*

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).*

- *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).*

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_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."

16 Appendices

Appendix A. Field survey data released 29/02/2016, 17/07/2018, 19/04/2020.

Survey	Year(s)	Experiment ID	Parameters measured†
High (within-field) Resolution			
Site-wide (most fields)			
Soil nutrients	2012	FP003	Bulk Density, pH, SOM, Total N, Total C, δ^{13}C, δ^{15}N
	2016	FP059	Bulk density, pH, SOM, Total N, Total C ^{13}C, ^{15}N, AL, As, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Ti, Zn, Olsen extractable P, water extractable PO_4 , water extractable total phosphorus
Soil invertebrates (soil fauna)	2012 2013	FP002	Anthomyiidae, Bibionidae, Cantharidae, Carabidae (adult & larvae), Chironomidae, Chrysomelidae, Dolichopodidae (A&B), Elateridae, Muscidae, Noctuidae, Psychodidae, Scatopsidae, Sciaridae, Stratiomyidae, Tipulidae, Unknown Coleoptera
Herbage (plant nutrients)	2013	FP010	Total N, Total C, δ^{13}C, δ^{15}N, Average Sward Height
Botanics (floristics)	2013 2016 2018	FP013 FP061 FP098	Cover of plant species
Limited (few fields)			
Soil nutrients	2013	FP008	pH, SOM, Total N, Total C
Soil pH	2013	FP012	pH
Saturated Soil Hydraulic Conductivity	2019	FP106	KSAT
Silage Cuts (resolution dependent on grazing management)			
Silage cuts	2011 2012 2013 2014 2015 2016 2017 2018 2019 2020	NW558 NW569 NW583 NW600 NW621 NW626 NW653 NW686 NW702 NW735	Silage Dry Matter Yield
Low (field-level) Resolution			
Site-wide (all fields)			
Soil nutrients	2018 2019 2020	NW686 NW702 NW735	See Appendix G
Herbage nutrients	2018 2019 2020	NW686 NW702 NW735	See Appendix H

Appendix B. Rudimentary soil chemistry and physical parameters (2012).

Parameter	Units
Bulk Density	g dry soil/cm^3
pH	-
Soil Organic Matter (SOM)	% of Dry Matter
Total Carbon (Total C)	% of Dry Matter
Total Nitrogen (Total N)	% of Dry Matter
δ^{13}C (isotope of C)	delta vs air
δ^{15}N (isotope of N)	delta vs PDB†

†Pee Dee Belemnite

Appendix C. Soil nutrient parameters (2016).

Parameter	Units
Bulk Density	g dry soil cm^{-3}
pH	-
Soil Organic Matter (SOM)	% of Dry Matter
Total Carbon (Total C)	% of Dry Matter
Total Nitrogen (Total N)	% of Dry Matter
Olsen P, Total P & PO_4	mg Kg^{-1} Dry Matter
δ^{13}C (isotope of C)	delta vs air
δ^{15}N (isotope of N)	delta vs PDB†
Major & Trace Elements	mg Kg^{-1} Dry Matter

†Pee Dee Belemnite

Appendix D. Plant nutrient and sward height parameters (2013).

Parameter	Units
Total Carbon (Total C)	% of Dry Matter
Total Nitrogen (Total N)	% of Dry Matter
$\delta^{13}C$ (isotope of C)	-
$\delta^{15}N$ (isotope of N)	-
Average Sward Surface Height	cm

Appendix E. Domin Scale used to classify grassland vegetation.

Cover	Domin Score
91–100%	10
76–90%	9
51–75%	8
34–50%	7
26–33%	6
11–25%	5
4–10%	4
<4% (many individuals)	3
<4% (several individuals)	2
<4% (few individuals)	1

Appendix F. 2013 Soil nutrient parameters and pH.

Parameter	Units
pH	-
Soil organic matter (SOM)	% of Dry Matter
Total Carbon (Total C)	% of Dry Matter
Total Nitrogen (Total N)	% of Dry Matter

Appendix G. Parameters measured and methods of analysis for low resolution survey soil samples.

Soil Analysis	Method of Analysis	Unit	Minimum Level of Detection†
Total N	DUMAS Technique	%w / w dry soil	0.02
Total C		%w / w dry soil	0.05
Available Phosphorus	Sodium Bicarbonate Extractable (Olsen)	mg L^{-1} dry soil	2.5
Available Potassium	Ammonium Nitrate Extractable	mg L^{-1} dry soil	15
Available Magnesium	Ammonium Nitrate Extractable	mg L^{-1} dry soil	5
Available Sodium	Ammonium Nitrate Extractable	mg L^{-1} dry soil	2
Extractable Calcium	Ammonium Nitrate Extractable	mg L^{-1} dry soil	200
Extractable Manganese	DTPA Extractable	mg L^{-1} dry soil	0.5
Extractable Iron	DTPA Extractable	mg L^{-1} dry soil	0.1
Extractable Copper	EDTA Extractable	mg L^{-1} dry soil	0.3
Extractable Zinc	EDTA Extractable	mg L^{-1} dry soil	0.2
Available Boron	Hot Water Soluble	mg L^{-1} dry soil	0.1
Available Sulphate	Phosphate Buffer Extractable	mg L^{-1} dry soil	5
Available Molybdenum	Acid Ammonium Oxalate Solution (Tamm's Reagent)	mg L^{-1} dry soil	0.05
Available Cobalt	Acetic Acid Extractable (ICP OES)	mg L^{-1} dry soil	0.1
Nitrate Nitrogen	2M KCL extraction	mg Kg^{-1} dry soil	0.05
Ammonium Nitrogen		mg Kg^{-1} dry soil	0.05
Nitrite Nitrogen		mg Kg^{-1} dry soil	0.1
Total Selenium	Wet Digestion with Hydrochloric and Nitric acids	mg Kg^{-1} dry soil	0.09
Total Phosphorus	Aqua-regia Digestion	mg Kg^{-1} dry soil	50
Dry Matter	Oven Dry Matter	% w / w	0.1
Organic Matter	Loss on Ignition	%w / w dry soil	0.5
pH	Measured in water (1:2.5)	pH	0.1
Electrical Conductivity	Saturated Calcium Sulphate	uS cm^{-1} dry soil	1

†Data exceeding the limits of detection for the analytical methods are denoted by -99999 in the data portal

Appendix H. Parameters measured and methods of analysis for low resolution survey herbage samples.

Herbage Analysis	Method of analysis	Unit	Minimum Level of Detection†
Total Nitrogen	DUMAS Technique [AOAC Official Methods of Analysis (1990) Method 949.12.]	% w / w dry herbage	0.1
Total Carbon		% w / w dry herbage	0.1
Total Phosphorus	Aqua-regia Digestion‡ [The Analysis of Agricultural Materials, MAFF Reference Book RB427, ISBN 0 11 242762 6.]	% w / w dry herbage	0.001
Total Potassium		% w / w dry herbage	0.005
Total Calcium		% w / w dry herbage	0.0015
Total Magnesium		% w / w dry herbage	0.0005
Total Sulphur		% w / w dry herbage	0.0005
Total Manganese		mg Kg^{-1} dry herbage	0.00003
Total Copper		mg Kg^{-1} dry herbage	0.00002
Total Zinc		mg Kg^{-1} dry herbage	0.00006
Total Iron		mg Kg^{-1} dry herbage	0.001
Total Boron		mg Kg^{-1} dry herbage	0.00007

Appendix I. Parameters measured and methods of analysis for low resolution survey grain samples.

Grain Analysis		Unit
Total Nitrogen	DUMAS Technique [AOAC Official Methods of Analysis (1990) Method 949.12.]	% w / w dry basis
Total Carbon		% w / w dry basis
Total Phosphorus	Aqua-regia Digestion‡ [The Analysis of Agricultural Materials, MAFF Reference Book RB427, ISBN 0 11 242762 6.]	% w / w dry basis
Total Potassium		% w / w dry basis
Total Calcium		% w / w dry basis
Total Magnesium		% w / w dry basis
Total Sulphur		% w / w dry basis
Total Manganese		mg Kg^{-1} dry basis
Total Copper		mg Kg^{-1} dry basis
Total Zinc		mg Kg^{-1} dry basis
Total Iron		mg Kg^{-1} dry basis
Total Boron		mg Kg^{-1} dry basis
Total Molybdenum		mg Kg^{-1} dry basis
Total Cobalt		mg Kg^{-1} dry basis
Total Selenium		mg Kg^{-1} dry basis
Total Sodium		% w / w dry basis
Water Soluble Chloride	Water extraction [Standard Methods for the Examination of Water and Wastewater 1985 16th Edition.]	% w/w dry basis
Residual Moisture		% w / w
Moisture	Whole grain NIR	% w / w
Crude Protein		% w / w
Specific Weight		Kg hL^{-1}
Thousand Grain Weight		g
Hagberg Falling Number		s

† Data exceeding the limits of detection for the analytical methods are denoted by -99999 in the data portal.

‡ For conversion of Aqua-regia data from %w / w dry herbage to mg Kg^{-1} dry herbage, multiply by 10,000.

Appendix J. Parameters measured and methods of analysis for low resolution survey straw samples.

Straw Analysis		Unit
Total Nitrogen	DUMAS Technique	% w/w dry basis
Total Carbon		% w/w dry basis
Total Phosphorus	Aqua-regia Digestion‡ [The Analysis of Agricultural Materials, MAFF Reference Book RB427, ISBN 0 11 242762 6.]	% w/w dry basis
Total Potassium		% w/w dry basis
Total Calcium		% w/w dry basis
Total Magnesium		% w/w dry basis
Total Sodium		% w/w dry basis
Total Sulphur		% w/w dry basis
Total Manganese		mg Kg^{-1} dry basis
Total Copper		mg Kg^{-1} dry basis
Total Zinc		mg Kg^{-1} dry basis
Total Iron		mg Kg^{-1} dry basis
Total Boron		mg Kg^{-1} dry basis
Total Molybdenum		mg Kg^{-1} dry basis
Total Cobalt		mg Kg^{-1} dry basis
Total Selenium		mg Kg^{-1} dry basis
Water Soluble Chloride	Water extraction [Standard Methods for the Examination of Water and Wastewater 1985 16th Edition.]	% w/w dry basis

‡ For conversion of Aqua-regia data from %w/w dry herbage to mg Kg^{-1} dry herbage, multiply by 10,000.

Appendix K. Details of methods used for analysis of soil samples from low resolution surveys.

Soil Parameter	Methodology
pH	The pH of soil is defined as the pH, measured potentiometrically, of the suspension obtained by stirring soil with water. The ratio of soil to water is 1:2.5. Temperature is one of the factors that affects the measurement of pH, so the measurement is carried out in a temperature-controlled environment.
Available Phosphorus	The available phosphorus is extracted from the soil at 20°C by shaking with 0.5M sodium bicarbonate solution at pH 8.5 for 30 minutes. The concentration of phosphorus is then determined by flow injection analysis /colorimetry by reacting it with acid ammonium molybdate to form the phosphomolybdate ion, which, when reduced with ascorbic acid, forms a blue coloured complex. The blue colour is measured spectrophotometrically at 880nm. The instrument is calibrated using commercial phosphate standards traceable to the SI unit.
Available Potassium **Available Magnesium**	The available potassium and magnesium are extracted from the soil by shaking with 1M ammonium nitrate at 20°C for 30 minutes. After filtration, the concentration of potassium and magnesium in the extract is determined by atomic absorption spectrometry. The instrument is calibrated using commercial potassium and magnesium standards traceable to the SI unit.
Available Sodium **Extractable Calcium**	The available calcium and sodium are extracted from the soil by shaking with 1M ammonium nitrate at 20°C for 30 minutes. After filtration, the concentration of calcium in the extract is determined by Atomic Absorption Spectrophotometry.
Organic Matter	The organic matter is destroyed by dry combustion at 430ºC and the loss in weight of the sample is reported as % of the original sample as the organic matter content.
Extractable Manganese **Extractable Iron** **Extractable Copper** **Extractable Zinc**	The available zinc, manganese, iron, and copper are extracted from the soil at 20ºC with DTPA solution, ratio 1:2.
Soluble Boron	The available boron is extracted by hot water extraction. The concentration of boron in the extract is determined using ICP-OES (Inductively Coupled Plasma Optical Spectroscopy).
Extractable Sulphate	The available sulphate is extracted from the soil under controlled conditions, using a phosphate buffer extracting solution ratio 1:2. The filtered extract of the sample is analysed by Inductively Coupled Plasma Emission Spectroscopy.

Available Molybdenum	Soil is shaken overnight with acid ammonium oxalate solution and filtered. Analysis is carried out by ICP-OES.
Available Cobalt	Soil is shaken overnight with acetic acid extracting solution and filtered. Analysis is carried out by ICP-OES.
Total Selenium	The sample is digested in concentrated hydrochloric and nitric acids at elevated temperature and pressure using a temperature-controlled digestion block. The sample extract is then treated with hydrochloric acid to convert all Selenium present into Selenite (Se VI). Sodium Borohydride is continuously added to the treated sample to produce gaseous selenium hydride which is atomised using a hydrogen diffusion flame. Atomic fluorescence is the measured after excitation using a selenium boosted discharge hollow cathode lamp. The concentration of selenium present is then determined by comparison with a series of standards of known concentration.
Moisture or Dry Matter	As-received samples are homogenised, and a representative sub-sample taken in a suitable tray. The weight is accurately recorded before and after drying in an oven at 105°C +/- 5 to determine the 'Oven Dry Matter' as a % weight loss. The drying time is at least 12 hours and samples are checked to ensure they are completely dry.
Nitrate Nitrogen **Nitrite Nitrogen** **Ammonium Nitrogen**	The soil is chopped and mixed to obtain a homogenous sample. A portion is shaken with 2M KCl to extract the mineral-N fractions and a dry matter determination carried out. Once in solution the Nitrate-N, Nitrite-N and Ammonium-N can be measured colorimetrically as follows: The determination of Nitrate-N and Nitrite-N is based on the formation of a diazo compound between nitrite and sulphanilamide. This compound is then coupled with N-1 napthylethylenediamine dihydrochloride to give a red azo dye. The colour is measured at 540nm. In channel one, nitrate is reduced quantitatively to nitrite by cadmium metal in the form of an open tubular cadmium reactor (OTCR). The nitrite and reduced nitrate are therefore both measured as total oxidised nitrogen. In channel two, nitrite is measured. Nitrate-N is therefore determined by deducting the nitrite figure from the TON. In channel three, ammonium reacts with alkaline hypochlorite and phenol to form indophenol blue. Sodium nitroprusside acts as a catalyst in formation of indophenol blue which is measured at 640nm. Precipitation of calcium and magnesium hydroxides is eliminated by the addition of a combined potassium sodium tartrate/sodium citrate complexing reagent.
Electrical Conductivity	Soluble salts, other than calcium sulphate, are extracted from soil with saturated calcium sulphate solution, ratio 1:2.5. The specific conductivity of the extract at 20ºC is recorded as soil conductivity. Results are expressed as uS cm^{-1} at 20ºC.
Total Phosphorus	A representative portion of the prepared sample is digested in an open vessel with concentrated hydrochloric and nitric acid (aqua-regia) using a temperature-controlled digestion block. The formation of strong oxidising agents will destroy organic matter and break down the mineral matrix of the sample. The elements dissolved in the acid are analysed by ICP-OES / ICP-MS. Silicates present in the sample are not solubilised and are left as an insoluble residue in the digest.
Total N **Total C**	Samples are totally combusted in an oxygen enriched atmosphere in a reaction tube. Nitrogen & carbon products are carried by a constant flow of carrier gas (helium) through an oxidation catalyst, and then reduced through copper wires, where excess oxygen is removed, and nitrogen oxides are reduced to elemental nitrogen. The nitrogen and carbon products are separated through a chromatographic column. As the products are eluted from this column, they pass through a T.C.D. detector, which generates an electrical signal proportional to the amount of nitrogen and carbon present. Various products can be eliminated if required using various traps, such as magnesium perchlorate trap to eliminate hydrogen. Peak elimination reduces the risk of overlapping peaks and shortens run times.

Appendix L. Details of methods used for analysis of herbage samples from low resolution surveys.

Herbage Parameter	Methodology
Total Nitrogen **Total Carbon**	Samples are totally combusted in an oxygen enriched atmosphere in a reaction tube. Nitrogen and carbon products are carried by a constant flow of carrier gas (helium) through an oxidation catalyst, and then through reduced copper wires, where excess oxygen is removed, and nitrogen oxides are reduced to elemental nitrogen. The nitrogen and carbon products are separated through a chromatographic column. As the products are eluted from this column they pass through a T.C.D detector, which generates an electrical signal proportional to the amount of nitrogen and carbon present. Various products can be eliminated if required using various traps, such as a magnesium perchlorate trap to eliminate hydrogen. Peak elimination reduces the risk of overlapping peaks and shortens run times.
Total Phosphorus **Total Potassium** **Total Calcium** **Total Magnesium** **Total Sulphur** **Total Manganese** **Total Copper** **Total Zinc** **Total Iron** **Total Boron**	A representative portion of the prepared sample is digested in an open vessel with concentrated nitric and hydrochloric acid (reverse aqua-regia) using a temperature-controlled digestion block. The formation of strong oxidising agents will destroy organic matter and break down the mineral matrix of the sample. The elements dissolved in the acid are analysed by ICP-OES / ICP-MS which gives an estimation of the 'total' content. Silicates present in the sample are not solubilised and are left as an insoluble residue in the digest. The elements in solution are then determined either by Inductively Coupled Plasma Mass Spectrometery (ICPMS), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) or Atomic Fluorescence Spectroscopy (AFS). Elements determined by OES are phosphorus, potassium, magnesium, calcium, sulphur, sodium, manganese, zinc, boron and copper with chromium, lead, arsenic, cadmium, molybdenum, nickel and cobalt by MS and mercury and selenium by AFS.