ResidueGas DELIVERABLE NO. 1.2

Database on amount and chemical characteristics of crop residues and net N inputs

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1. Summary

This dataset presents the chemical characteristics of plant biomass and crop residues from agrosystems in European areas (carbon and nitrogen contents and biochemical composition). These data have been collected from the scientific literature. The specific data and their origins are presented. The mean values from these data are also provided by major production type (main crops, forage and pasture crops, green manure and cover crops, vegetable crops and energy crops), species and litter type. These data were collected as part of the framework of the European project ResidueGas, which aims to improve the estimation of greenhouse gas emissions associated with crop residues.

2. Introduction

Greenhouse gas emissions from the recycling of crop residues and their management are calculated from the amount of nitrogen recycled, which is the product of the biomass recycled and the nitrogen content of these biomasses. Default data are available in the international IPCC method for calculating these emissions, but these data are based on agronomic situations that are sometimes quite far from those of the countries or regions concerned. It is therefore important to have data adapted to the local context. In the framework of the ResidueGas project, one of the objectives of the WP1 was to identify and collect these data for the main crops of European agrosystems and make them available to scientists, but also to stakeholders (e.g. in charge of emission inventories). The other objective was to collect not only data on the nitrogen content of the biomass, but also to gather rarer data on the biochemical composition of these residues, explaining their biodegradability, and possibly on physical characteristics. Extensive review of the European scientific literature dealing with crop residue production and management was done.

3. Materials and methods

3.1 Data collection

The literature survey was conducted on studies carried out in the European area using the following keywords: “crop residue” OR “biomass” OR “areal dry matter” OR “straw” OR “root” OR “root dry matter” OR “main crops” OR “forage crops” OR “meadow” OR “cover crop” OR “catch crop” OR “green manure” OR “legume”, AND “N content” OR/AND “C content” OR/AND “biochemical composition”. Several data retrieval directions were pursued and included in English and without limit of publication year and a query of several search engines: Web of Science, Researchgate, and Google Scholar; in addition, we systematically explored the reference list of the relevant articles, which allowed us to identify additional articles/reviews with which the initial keywords had not been associated; we also contacted the authors to obtain the raw data for their published works.

During this collection phase, we collected all available elementary data (e.g., biomass, % N, % C, and lignin content), even partial, and we calculated values where possible, based on the information given in the articles. For example, dry biomass per hectare and corresponding N quantity allow the N concentration of the residues to be calculated; the residue N concentration and C:N ratio made it possible to calculate the C concentration. However, many articles were not retained because they presented aggregated data and/or modelled plant growth adjustments without presenting sufficient information on the initial data.

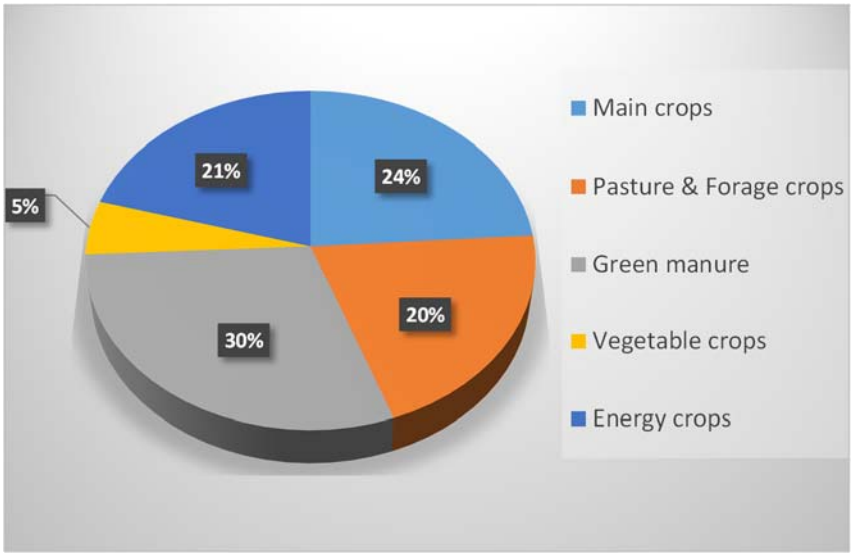

Figure 1: Final distribution of data collected by crop types

3.2 Dataset organization

We classified the data into five crop categories corresponding to the main agricultural production types: main crops, forage and pasture crops, green manure and cover crops (typical soil incorporated in an immature state rather than harvested), vegetable crops, and energy crops. We retained input variables presenting enough occurrences to justify their presence in the dataset. For example, we chose the biochemical composition determined by proximate analysis according to the Van Soest method and did not keep the data on lignin obtained by the Klason method because they were very scarce. We also did not retain the data on sugar concentrations (glucose, sucrose, fructose, etc.), which were rarely available in the literature, and we did not retain data on lipids, resins and starch contents.

4. Results and discussion

4.1 Data description

The dataset contains data collected in 177 documents, including 158 scientific articles, 3 books, 4 PhD theses, 2 Master theses, 7 reports and 3 conference presentations. This literature was published between January 1985 and January 2021. Their distribution of the publications over the years, except 2021, which is in progress, is presented in Fig. 1. The 158 scientific articles used were published in 44 journals. These studies were carried out in 17 European countries. The journals Plant and Soil, Soil Biology and Biochemistry, Nutrient Cycling in Agroecosystems, Agriculture, Ecosystems and Environment, and European Journal of Agronomy accounted for 56% of the data. The dataset includes approximately 2300 individual data records. It is structured into five categories according to the crop type: main crops (24% of occurrences), pasture and forage crops (21% of occurrences), green manure and cover crops (30% of occurrences), vegetable crops (5% of occurrences), and energy crops (21% of occurrences). (Figure 1). While field crops are well represented, this is not the case for vegetable crops for which data are still scarce. On the other hand, many references are available for new crops, such as energy crops. The list of species, Latin names and botanical families of the five crop types identified in the dataset are presented. This effort allowed us to generate, for each category of crop type, a raw data file and a mean data file. The raw data provide a diversity of values for each plant species for a given variable. The mean data files allowed us to compare species and reveal missing information. Examples of mean data are provided here in figures 2, 2 and 4. The dataset includes a file that describes the list of terms and abbreviations used and a file with references: author name, year published, journal name and access link.

The information available in the “Raw_data” files is:

Species: common name, Latin name, cultivar, and family;

Agricultural conditions of growth: plant part, harvest stage, sowing date, harvest date, N fertilization (kg.ha-1 yr-1), country (region or town), and origin (field, glasshouse, lysimeter);

Dry matter: ton ha-1 and percentage of fresh matter (% FM);

Chemical composition: neutral detergent soluble (NDS), hemicellulose + cellulose, hemicellulose, cellulose, lignin, LCI (lignin cellulose index = lignin/[hemicellulose + cellulose + lignin]), water soluble C (WSC), total C, total N, and C:N ratio (carbon:nitrogen ratio = total C/total N);

Soil properties: texture characteristics, bulk density, layer, pH, total N, organic C, and soil classification according to authors; and

References: authors (year published), journal, issue (volume), pages or report number, and access link.

We performed the mean and standard error calculations whenever possible, specifying the number of observations. When the amount of data collected was too law or the range of the values was too large, we did not calculate means, leaving this action to the users.
The information available in each “Mean_data” file is:

Species: common name, Latin name, and family;

Agricultural conditions of growth: plant part and harvest stage;

Dry matter: ton ha^{-1} and % FM;

Chemical composition: NDS, hemicellulose + cellulose, hemicellulose, cellulose, lignin, LCI, WSC, total C, total N, C:N ratio.

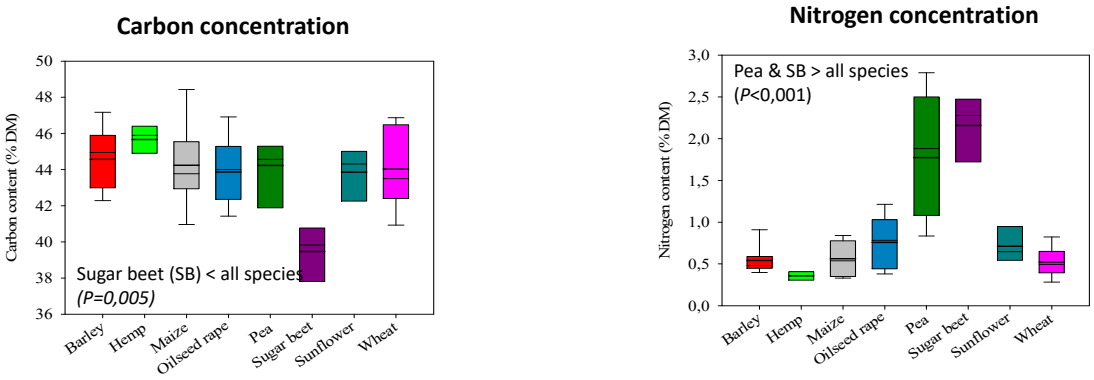

Fig. 2: Carbon and Nitrogen concentrations (% Dry Matter) of aboveground residues for the main crops category available in the « Raw_data » file. Data represented: points (data dispersion), error bars (10^{th}-90^{th} percentile), box (25^{th}-75^{th} percentile), mean (thick line) and median (thin line).

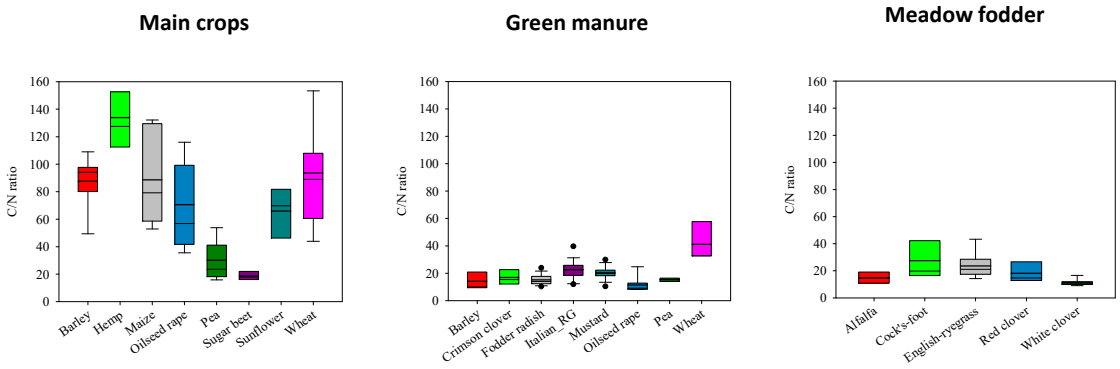

Fig. 3: Comparison of C:N ratio of aboveground residues for crop species of the main crops, green manure and meadow fodder categories available in the « Raw_data » file. Data represented: points (data dispersion), error bars (10^{th}-90^{th} percentile), box (25^{th}-75^{th} percentile), mean (thick line) and median (thin line).

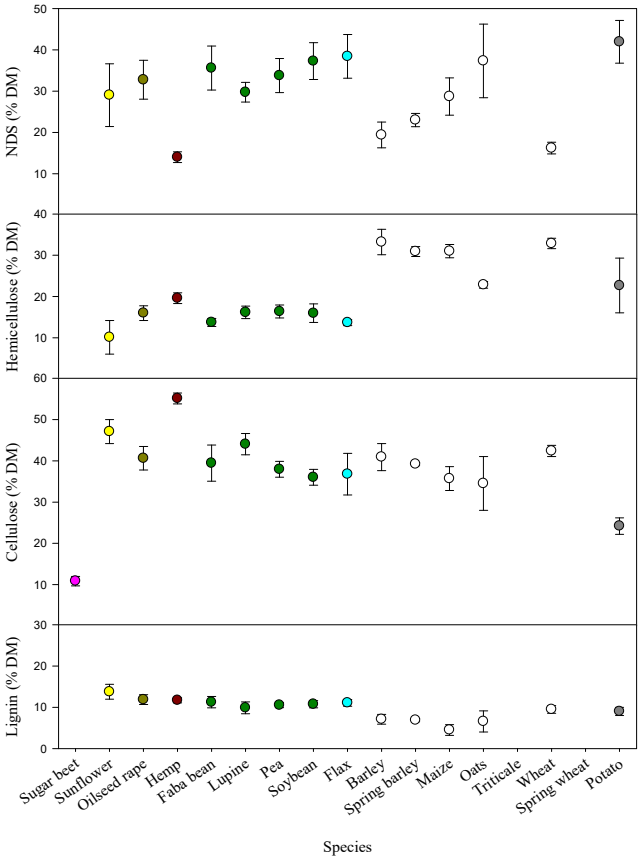

Fig.4 : Biochemical composition (mean and standard error) of aboveground residues for the main crops category, available in the « Mean_data » file. *NDS : Neutral Detergent Soluble ; %DM : percent of Dry Matter. The color legend correspondance (family species) is : pink = amaranthaceae, yellow = asteraceae, dark green = brassicaceae, brown = cannabaceae, green = fabaceae, blue = linaceae, white = poaceae, grey = solanaceae.*

4.2 Dataset repository and data paper

The dataset is freely available on the data repository of INRAE (data INRAE https://data.inrae.fr/). *Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement. (2018). Data INRAE. INRAE.* It has a persistent ID: *https://doi.org/10.14758*/9T8G-WJ20A

Data INRAE is a data repository offering new services for the purpose of managing, sharing and searching for data. Data INRAE offers services to INRAE research teams and their partners to facilitate the management and release of scientific data (related or not to scientific publications), particularly in the context of European projects.

The data repository is used to identify and describe data, deposit related files, establish access conditions to data (open here), search for data and download related files. It is intended to update this dataset once a year using new literature published.

The data set is presented in a data paper currently submitted to the journal “Data in Brief” (Elsevier) which is a peer reviewed, open access journal. https://www.journals.elsevier.com/data-in-brief.

Fig. 5: Access to the dataset on the INRAE Data Portal

5. Conclusion

The objectives of WP1 were met in terms of collecting, organising and making available data on the nature and quality of plant residues from European agrosystems. At the end of this work, a database consisting of excel files that can be consulted and downloaded was compiled and made available online on a data repository. These data are presented in a data paper. In addition, these data were used to provide information on the nature of the residues in the selection of articles from the literature used in the meta-analysis (WP2); and to update the data used in the emission inventories (WP5) and compare them with the IPCC default data and the local data used in England and France. This work also allowed a better understanding of the categories of plant residues (according to species, maturity, type of organ considered), a concept used in several of the works of the ResidueGas project.

6. References

All references used to build the datasets are provided online in a specific file.