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D2.1 – Report of common guidelines for methodologies and templates for data collection

Closing the gap between fork and farm for circular nutrient flows

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Report of common guidelines for methodologies and templates for data collection

Contents

Report of common guidelines for methodologies and templates for data collection 4
1 Executive Summary 6
2 Introduction 6
2.1 Task objectives 7
2.2 Data Management Plan and Innovation Platform 8
2.2.1 General requirements 9
2.2.2 Metadata standards 9
2.2.3 Innovation Platform as the primary repository 9
3 Data collected in P2GreeN 10
3.1 Data from WP2 11
3.1.1 Monitoring of agro-ecological impacts 12
3.1.2 Impact assessments 12
3.2 Data from WPs 3-5 13
4 Common guidelines for methodology 14
4.1 Data collection and storage criteria 15
4.2 Using uniform templates across pilot regions 15
4.3 Metadata collaboration and standardization 15
4.4 Uploading to the Innovation Platform 15
5 Templates for data collection 16
5.1 Common metadata template 16
5.1.1 Description 16
5.1.2 Usage 17
5.2 Templates for collecting data from field trials 19

5.2.1 Description of the template 19
5.2.2 Data collection criteria: Information gathering table 19
5.2.3 Template structure and function 20
5.3 Templates for collecting data for LCAs 22
5.3.1 Use of LCA data collection templates 23
5.4 Templates for economic and stakeholder data 25
5.4.1 Economic data template 25
5.4.2 Stakeholder data template 27
6 Conclusions and Outlook 28
7 References 28
8 Annex 29

Index of Figures

Figure 1: Work packages (WPs) and key data to be collected. WP6 (dissemination and communication) will act as an overarching WP and thus not shown in the figure. 8
Figure 2: Data Collection and Management Workflow in P2GreeN. 16
Figure 3: Metadata template in development. 18
Figure 4: Figure depicting criteria used for data collection (excerpt). 20
Figure 5: Dropdown list outlining field trial data gathering templates. 21
Figure 6: Illustration of field trial data collection sheet for field trial (excerpts). 22
Figure 7: Dedicated data for each pilot region categorized in the common LCA data collection template 23
Figure 8: Example of the structured Data Collection Framework for LCAs. Collection sheets for input and energy use data. 25
Figure 9: Example with the dropdown list of economic parameters for urine drying in Sweden (top) and the input fields in the corresponding worksheet (bottom). 26
Figure 10: Template for stakeholder data collection, showing examples from the Spanish pilot region. 27

Index of Tables

Table 1: Description of data categories included in the data collection template 24

1 Executive Summary

The 'Report of Common Guidelines for Methods and Data Templates' outlines a comprehensive strategy to standardize data collection practices within the P2GreeN project. This executive summary encapsulates the document's essence:

- The primary aim of this report is to establish consistent and robust guidelines for data collection across the project. It emphasizes the importance of reliable and scientifically rigorous data to support the project's goals and ensure replicability. The guidelines encompass methodologies, data representation standards, quality control protocols, and validation measures, designed to evolve in tandem with technological advancements and ethical considerations.
- Task 2.1 focuses on establishing standardized data collection methodologies and criteria, supporting various project components, especially the Data Management Plan (DMP) and the P2GreeN Innovation Platform. Despite regional differences, the task aims to harmonize data collection practices to evaluate impacts related to agroecology, environment, society, and economics, aligning with the project's overarching objectives.
- The Data Management Plan outlines three pivotal pillars: data lifecycle management in WP2, the network hub in Task 5.1, and the Innovation Platform within WP7. These pillars underscore the strategic significance of effective data management in realizing the project's circular model objectives.
- Key aspects of the Data Management Plan involve establishing metadata standards, recording templates, and data collection formats to ensure consistency and accessibility. The Innovation Platform serves as the primary data repository, facilitating data access, metadata sharing, and adherence to FAIR principles (Findability, Accessibility, Interoperability, and Reusability).
- Collaboration between the Data Management Team and WP2 co-leads drives the development and implementation of robust guidelines and frameworks. These frameworks ensure that project outputs are easily accessible, compatible, and reusable, fostering seamless collaboration, data sharing, and utilization across all project contributions.
- Ultimately, the report aims to ensure the widespread adoption of innovative urban-rural nutrient flow solutions and governance blueprints proposed by the P2GreeN project, underpinning the project's commitment to sustainability and the 3R principle (Reduce, Reuse, and Recover).

2 Introduction

To achieve our project goals and gather trustworthy data, we're sharing the 'Report of Common Guidelines for Methods and Data Templates.' This report is a crucial step to standardize our data collection practices using strong methods. It's a collaborative effort to establish a framework that unifies how we collect data across our project. This consistency ensures our work is reliable, scientifically strong, and stays relevant as we

seek knowledge. The guidelines herein encompass a set of critical aspects, including but not limited to: (i) Methodologies for Data Collection, which outline systematic approaches and procedures for the acquisition, curation, and storage of data to maintain its fidelity and reliability throughout the research lifecycle; (ii) Templates and Standards for Data Representation, providing standardized formats and structures for documenting and presenting data, facilitating clarity, and enabling reproducibility of analyses and findings; (iii) Quality Control and Validation Protocols, to incorporate measures that ensure data accuracy, consistency, and compliance with ethical and legal standards, thereby enhancing the credibility and trustworthiness of research outcomes. These guidelines are not static; rather, they are designed to evolve in tandem with advancements in technology, methodologies, and emerging ethical considerations. Embracing a collaborative approach and soliciting feedback from the scientific community are integral to the continual refinement and enhancement of these guidelines. In the upcoming sections, we'll explore these guidelines and templates in more detail. We'll explain why they're important, how they work, and how to use them effectively.

2.1 Task objectives

The objective of this task is to establish a consistent methodology and set of criteria for data acquisition across the entire project. This uniform approach is essential to ensure that the data collected is scientifically rigorous, relevant, and capable of being replicated. In Task 2.1, the primary objective is to establish standardized guidelines for methodologies and criteria for data collection within the P2GreeN project. These guidelines and criteria will serve as a foundational framework for the pilot regions, aiding them in the setup, demonstration, and monitoring of agroecological, environmental socio-economic impacts throughout WP2 (Monitoring and assessing the benefits). These data collection guidelines also include data needed for WPs 3-5 (see **Figure 1**). One important goal is to identify the data types (quantitative, qualitative) and develop suitable frameworks for each type of data collected. An integral part of the data collection guidelines is to support the Data Management Plan, and act as an aid for structuring the data that will be gathered in the Innovation Platform as part of WP7 (Chapter 2.2).

This task is critical to assure a meaningful comparison and support dialogue between the different partner regions, despite the inherent variations in scale, technologies, geography, and climate. Task 2.1 will specifically generate comprehensive data collection criteria and templates designed to harmonize data collection practices across all pilot regions. This harmonization includes employing similar methods, units, and formats throughout the project's duration. The acquired data will play a vital role in evaluating various aspects, including agroecological, environmental, social, and economic impacts, as well as trade-offs associated with circular N & P systems showcased in WP1.

Furthermore, these data sets will play a role in achieving the shared goals of WPs 3, 4, and 5. The primary aim of these work packages is to support the Innovation Platform and adhere to the guidelines outlined in the Data Management Plan (DMP) specified within

WP7 instructions (**Figure 1**). To facilitate this harmonization and standardization effort, close collaboration with partners from WPs 1 and 3-5 was initiated at the project's outset. Multiple feedback loops and consultations were conducted to determine the most suitable methodologies and data collection requirements, ensuring coordinated data collection practices across the project's various components.

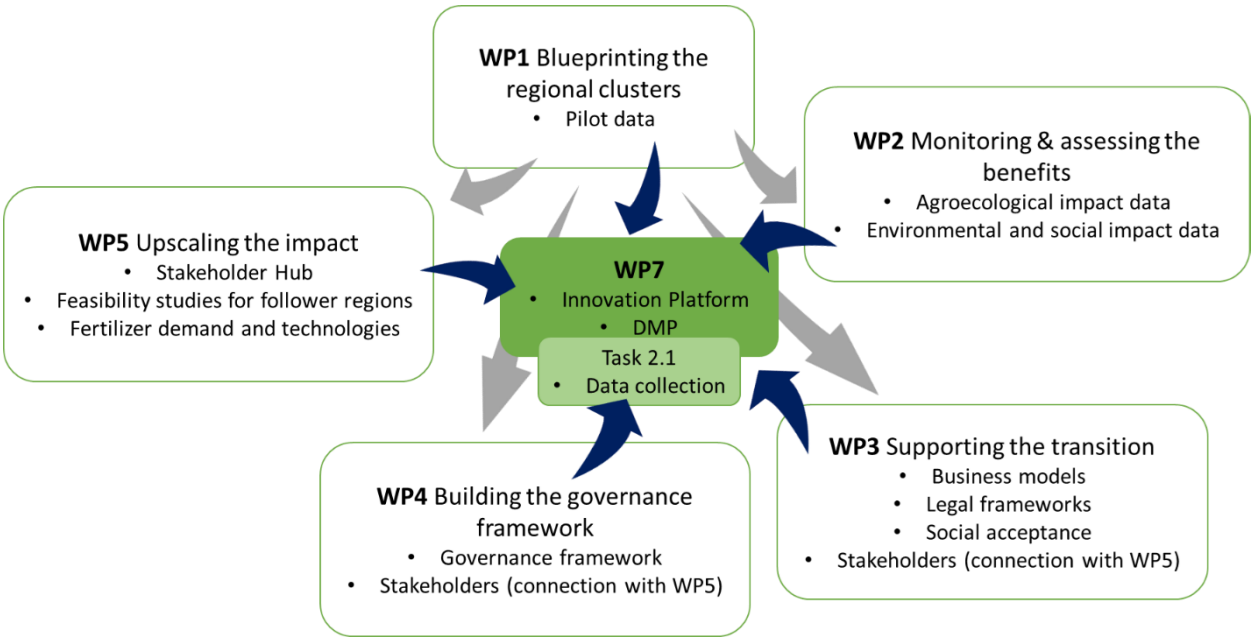


Figure 1: Work packages (WPs) and key data to be collected. WP6 (dissemination and communication) will act as an overarching WP and thus not shown in the figure.

2.2 Data Management Plan and Innovation Platform

The P2GreeN project is strongly committed to transitioning from a traditional linear resource and nutrient system to a circular model, guided by the principles of Reduce, Reuse, and Recover (the 3R principle). Central to driving this transformation is the recognition that the collection, organization, and preservation of data stand as crucial elements within our strategic framework. The effective management of data is indispensable in realizing the overarching objectives of P2GreeN.

To ensure the successful attainment of these objectives, we have established three fundamental pillars within the Data Management Plan (DMP) that specifically focus on data handling. These pillars are pivotal in supporting the project's goals. The first pillar involves WP2, where its task 2.1 is devoted to data lifecycle management. The second pillar centers around the network hub (task 5.1), while the third revolves around the Innovation Platform (WP7).

These pillars, delineated within the DMP, are integral components that underscore our commitment to effective data management practices. They form the backbone of our

strategy, facilitating the consolidation and utilization of data to drive the shift towards a circular model in line with the P2GreeN project's aspirations. Furthermore, the Innovation Platform, situated within WP7, serves as a cornerstone, fostering collaboration and innovation in our collective journey towards sustainability and the 3R principle.

2.2.1 General requirements

WP 2, specifically Task 2.1, has been created to oversee the comprehensive management of data collected throughout the entire duration of the P2GreeN project's lifecycle. The cornerstone of our data management efforts is the Data Management Plan (DMP), which serves as a comprehensive framework and supporting documents for all three data management pillars. Moreover, we recognize the importance of preserving P2GreeN's legacy and objectives. To achieve this, we will establish a robust connection between the DMP and the Innovation Platform. This integration will be supervised by the Data Management Team, consisting of the project coordinator, AGR, and the co-coordinator, IGZ.

2.2.2 Metadata standards

As reported in deliverable D7.3 (Beblek, 2023), survey results indicate that while some consortium members are familiar with metadata standards, the majority are not. The metadata standards define the structure and attributes for organizing and describing data and resources within the project. To facilitate sound scientific data acquisition, the Data Management Team, in collaboration with WP 2 co-leads, has developed a common standard for metadata recording. This metadata standard is implemented by a template for capturing all relevant metadata belonging to a specific data file (described in detail in Chapter 5.1). Furthermore, it entails the design of four different data collection templates (see Chapter 5), ensuring their mandatory use when uploading the respective data on the Innovation Platform as specified in deliverable D7.3 (Beblek, 2023). WP 2, in partnership with the Data Management Team, will continue to work on common metadata terms and their implementation for diverse datasets. Depending on possible changes in data collection requirements during the project, and in-line with the planned revisions of the DMP (M34 and M46), the templates for metadata and data collection files will be updated during the project. This is necessary, because the templates are also intended to ensure data accessibility and findability on the P2GreeN Innovation Platform.

2.2.3 Innovation Platform as the primary repository

The P2GreeN innovation platform will serve as the project's primary data and material repository during the project period and for five years post-project. It consists of a project-internal area for storing and sharing data within the project, and a public repository for sharing P2GreeN’s methods and results with external stakeholders. The public repository will align with trusted data repositories and provide open access to datasets, searchable digital identifiers, and metadata descriptions for each dataset. The co-coordinator, IGZ, will host and maintain the innovation platform, upholding scientific standards.

Data access and metadata sharing

The Data Management Team will create, oversee, and uphold data access regulations in partnership with WP 2. Metadata will be freely accessible under CC0 1.0 licensing, with a suggestion for users to acknowledge the sources. For each data file, the Innovation Platform will store obligatory readme files, which are based on the metadata template created by task 2.1 (see chapter 5.1). These files will provide specific information about data files, facilitating correct interpretation and internal usage. Data access and finding of metadata and data will be facilitated with categorization of the data. The data categories will describe the type and theme of the data to ensure easier filtering and use.

Data collection and processing standards

Data collection and processing in WP 2 will adhere to W3C recommendations, particularly the W3C PROV Data Model (W3C, 2013). The DMP referred to W3C recommendations as a guide. However, the PROV data model, while primarily suited for web development, was also considered. Although we adhere to W3C recommendations for gathering general metadata, our project has evolved its own metadata standard (implemented by the metadata template) to encompass project-specific aspects alongside this adherence so that quality assurance and regular data updates will be overseen by the Data Management Team with support from WP 2 co-leads.

Ensuring FAIR principles

Finally, all project outputs, not just data, will conform to the P2GreeN FAIR framework developed collaboratively by the Data Management Team and WP 2 co-leads. This framework, jointly formulated by the Data Management Team and WP 2 co-leads, sets the standard for ensuring Findability, Accessibility, Interoperability, and Reusability across all project deliverables. By integrating robust guidelines, this framework ensures that project resources are easily located, accessible, compatible, and reusable, fostering seamless collaboration, data sharing, and utilization across all facets of the project's outcomes and contributions. So, to ensure the widespread adoption of P2GreeN's innovative urban-rural nutrient flow solutions and governance blueprints.

3 Data collected in P2GreeN

Within WP2 of the project, standardized data collection sheets have been devised to ensure a consistent approach across all pilot regions while accommodating local variations and research needs. These sheets offer a structured framework for data collection during field trials and impact assessments, promoting comparability while allowing customization. The focus lies on monitoring agro-ecological impacts, necessitating meticulous data collection and analysis covering crucial parameters like nutrients, pathogens, pollutants, leachate, and greenhouse gas emissions. Collaboration with specialized laboratories ensures the thorough examination of data, ensuring the safety and sustainability of using bio-based fertilizers from human sanitary waste in

agriculture. Additionally, for life cycle assessments (LCAs) examining environmental and social impacts, accurate data collection on inputs, outputs, and impact categories is fundamental, contributing to a comprehensive evaluation process.

Collaborating with WPs 3, 4, and 5, WP2 has developed data collection methodologies for uniformity across various project objectives. While WP2 focuses on quantitative data, WPs 3-5 encompass qualitative survey and interview data. Data tagging with metadata categories and WP numbers enhances its usability within and beyond the project scope. WP3 delves into regional business models, legal frameworks, and social acceptance, collecting economic performance data and qualitative insights. Meanwhile, WP4 examines governance frameworks and stakeholder engagement, categorizing governance data separately and merging stakeholder data into specific templates. WP5 concentrates on stakeholder data collection, operating the project's Network hub, and conducts feasibility studies and knowledge exchange. Synergies in economic data collection across multiple WPs have led to the development of a common template to streamline the process and ensure consistency.

3.1 Data from WP2

In the context of WP2, the development of standardized data collection sheets represents a fundamental aspect of our data management approach. These sheets are designed to ensure a consistent approach to data collection across all pilot regions while remaining adaptable to local requirements and specificities (see details in Annexes). The key principle behind this approach is to strike a balance between uniformity and flexibility.

The data collection sheets serve as a foundational framework, outlining essential variables and parameters that need to be captured during field trials and impact assessments. They provide a common structure that all pilot regions can follow, thereby promoting comparability and harmonization of data collection practices. This uniformity is essential for generating scientifically rigorous and replicable data that can be aggregated and analyzed collectively.

However, recognizing that each pilot region may have unique value chains, technologies, agricultural practices, environmental conditions, and research objectives, the data collection sheets are intentionally designed to be adjustable. Local needs, preferences, and specific research questions can be accommodated by allowing for the inclusion of additional variables or customized fields. This flexibility ensures that the data collected remains contextually relevant and aligned with the goals of each pilot region.

In summary, the data collection sheets for WP2 strike a balance between standardization and adaptability. They provide a structured foundation for data collection across all pilot regions while allowing for necessary adjustments to meet local requirements. This approach ensures that the data collected is not only scientifically robust but also tailored to the diverse needs of our project's stakeholders and partners.

3.1.1 Monitoring of agro-ecological impacts

Monitoring agroecological impacts arising from the utilization of human sanitary waste to produce safe bio-based fertilizers in agriculture necessitates a comprehensive approach to data collection and analysis. To ensure the sustainability and safety of this practice, it is essential to assess various critical parameters. These parameters encompass macronutrients, micronutrients, pathogens, pharmaceuticals, pollutants, leachate, and greenhouse gas emissions.

At the beginning of Task 2.1, a detailed data collection plan was developed by WP2. As shown in Annex 1, this plan outlines the parameters to be monitored and specifies the frequency of data collection, ensuring alignment with the project's specific objectives. Collaboration with certified laboratories specializing in soil, water, crop, and fertilizer sample analysis is crucial. These laboratories should adhere to stringent testing protocols to maintain the accuracy and reliability of data. Sample collection involves gathering specimens from different points within the agricultural system, including soil, water sources, crops, and bio-based fertilizers produced from human sanitary waste. This process should encompass various time intervals to account for seasonal variations. The next step involves analysing soil and fertilizer samples for macronutrients (such as nitrogen, phosphorus, and potassium) and micronutrients (including iron, manganese, zinc). This analysis helps determine nutrient concentrations and their availability for plant uptake. Pathogen assessment is another critical aspect. Microbial analyses will be conducted to detect and quantify pathogens in soil, water, and fertilizers, ensuring the safety of bio-based fertilizers concerning potential human health risks and crop contamination. Pharmaceutical and pollutant testing is imperative to screen for the presence of pharmaceutical residues and pollutants in fertilizers, soil, and water samples. This is essential to prevent the introduction of harmful substances into the agroecosystem.

Leachate analysis involves the collection of samples from fields or test plots to evaluate nutrient and contaminant runoff. Analysing the composition of leachate helps understand its potential impact on water quality and nearby ecosystems. Assessment of greenhouse gas values using existing literature, particularly nitrous oxide (N_2O), associated with fertilizer application is a crucial step. Quantifying emissions resulting from soil and fertilizer interactions helps assess their contribution to climate change.

3.1.2 Impact assessments

Life cycle assessment (LCAs) is used to assess both the environmental and social impacts of bio-fertilisers originating from sanitary waste production chains. Economic impacts will be assessed through a cost-benefit analysis. The assessments consist of the calculation of both positive and negative impacts throughout the products' life cycle, from raw material acquisition to the processing and end-use of the products as fertilizers. The data collection for both environmental and social LCAs is crucial for the accuracy of the

assessments. Without case-specific details on e.g., production processes, the assessment would need to rely on averages from literature and databases, which would lower the creditability of the study.

To be able to describe and collect the data needed and make the inventory analysis in LCAs, several aspects need to be defined. Firstly, the system boundaries for the assessments need to be identified. The system boundaries define the process steps that are included in the assessment, and thus, they also define the scope of data collection. After definition of the boundaries, it is possible to make the inventory for the inputs and outputs of the system. The inventory analysis includes collecting data on all relevant inputs and outputs flows, resource use during processing and emissions.

In addition to the system boundaries, the selected impact categories can also affect the data collection, especially regarding the collected characteristics of material flows. For example, impact categories such as eutrophication and acidification need detailed information of elements such as nitrogen and phosphorous, while these are not necessarily usable in analysing the impact category of greenhouse gas emissions.

The impact assessments consist of analysis of environmental impacts (e-LCA), social impacts (s-LCA) as well as a cost-benefit analysis of the use of these products in agriculture. Data needed in the environmental LCAs consists of mass, nutrient and carbon flows within the value chain, energy consumption (including its source) during each process step, as well as transportation (including transported distances) and equipment used. In addition, data on the emissions from the processes, including during storage and fertilizer use phases are crucial information. However, it has been acknowledged that all needed information may not be available and possible to be analysed from the pilot regions. Thus, missing data can be supplemented with literature data and information available in databases. The s-LCA data collection is complementary to the e-LCA data collection and is executed with the same data collection methodology. It will be supplemented with additional information on the origin of different input materials as well as their market value. The cost-benefit analysis focuses on the monetary costs and revenues. The cost data will be collected with other projects economic data in a separate data collection template (section 3.3).

The LCA data collection will be executed on yearly basis. Thus, it should be noted that the collected data can be calculated averages of several time points, or e.g., several runs with the processing equipment to produce the biofertilizer product.

3.2 Data from WPs 3-5

To facilitate the common and uniform data collection, WP2 together with co-leads of WPs 3, 4 and 5 developed data collection sheets and methods also for other objectives of the project. While WP2 is focused on quantitative data, for which data collection templates can be more easily developed, WPs 3-5 contain also qualitative survey and interview data, which cannot be collected in similar sheets as quantitative data. As common

templates are not possible or feasible to prepare for qualitative data, it becomes most important to be able to search and tag data to enable its usability within the project and beyond. To achieve this, each data file will be categorized with meta data category and WP number.

WP3 focuses on regional business models, legal frameworks and social acceptance in the context of production of bio-based fertilizers from sanitary waste. WP3 will collect data regarding e.g. economic performance of the pilots as well as qualitative data from surveys and interviews. This WP has linkages to the data collection in WP2, more specifically, task 2.2. regarding the economic and social data. Co-leads of WPs 2 and 3 together will make sure that all necessary data related to social and economic aspects will be collected within the templates (LCA template described above, and economic data template described in chapter 5.4.1) or is otherwise available as separate data files. WP4 studies the governance frameworks and their taxonomy as well as stakeholder engagement. Collected governance data will be categorized as a separate data category, while stakeholder data gathered in this WP will be merged into a specific stakeholder template developed by WP5 along with similar data from other WPs.

WP5 is a key WP in the stakeholder data collection and is responsible for the project's Network hub. WP5 also focuses on feasibility studies and knowledge exchange between the follower regions. During discussions with WP co-leads, it became apparent that there are synergies in data collection between WPs. The Network hub (task 5.1.) will be one crucial source of data applicable in WP3 and WP4, for which a separate data template was generated by task 5.1. As this template also covers the stakeholder information required in WP4, it will be used as a common stakeholder data template for P2GreeN (see chapter 5.4.2). In addition, economic data will be collected jointly as part of WPs 2, 3 and 5. Thus, a common template for the collection of economic data (see chapter 5.4.1) has been developed.

4 Common guidelines for methodology

The project's core revolves around efficient data management practices encompassing diverse aspects. We start by establishing stringent criteria for data collection and storage, ensuring the reliability and integrity of our datasets. Additionally, uniform templates across pilot regions enable better comparability of data, aided by ongoing refinements to accommodate evolving project needs. Moreover, our focus extends to metadata collaboration and standardization, aiming for a common set of metadata standards to enhance data interpretation and consistency. Finally, our comprehensive data management efforts culminate in the systematic uploading of data and metadata to our Innovation Platform, ensuring accurate organization, compliance, and reliability throughout the project's duration (**Figure 2**). In the sections below we provide detailed descriptions of the diverse aspects.

4.1 Data collection and storage criteria

A fundamental aspect of our task, together with the Innovation Platform (D7.2), involves establishing precise criteria for data collection and storage. To ensure the integrity and reliability of our datasets, we defined clear and comprehensive guidelines for how data should be collected and stored. These guidelines encompass factors such as data formats, storage security measures, and quality assurance. Additionally, we determined the timing and frequency of data collection to align with the project's specific objectives (refer to Annex 1 for detailed specifications).

4.2 Using uniform templates across pilot regions

To facilitate better comparability of data across our various pilot regions, we implemented the use of standardized data collection templates. These templates were designed to incorporate all necessary variables and metadata fields. Work package co-leads in each pilot region are actively involved in ensuring that data is collected according to these templates, thereby promoting uniformity and consistency. Regular updates and refinements to the templates will be carried out as needed to accommodate the evolving requirements of our project.

4.3 Metadata collaboration and standardization

Effective data management also involves metadata, which provides critical context and information about our datasets. WP2 has engaged in collaborative discussions with project partners to identify the essential metadata elements required for each dataset. Through these discussions, we defined a common set of metadata standards that will facilitate interoperability (see Ensuring Fair principles under section 2.2.3). Subsequently, we have established a template for recording metadata alongside collected data, to ensure that our data remains well-documented and easily interpretable. Following the establishment of the metadata recording template alongside the collected data, we will regularly update and refine these templates to adapt to the evolving needs of our project.

4.4 Uploading to the Innovation Platform

The culmination of our data management efforts involves uploading collected data and associated metadata to our Innovation Platform. We will develop a systematic procedure to ensure that data is organized, labeled accurately, and complies with our established standards. To safeguard data integrity, we will implement version control mechanisms, allowing us to track changes and updates systematically. This process ensures that our datasets are not only accessible but also maintain their quality and reliability throughout the project's lifecycle. However, we still need to clarify how this can be implemented on the platform, ensuring that the process aligns with the platform's technical requirements and functionalities. This may involve consulting with our platform developers and IT specialists to determine the most effective and seamless integration of our data management procedures within the platform's framework. By addressing this aspect, we

can ensure that our data management protocols are not only robust but also seamlessly integrated into the platform, optimizing the accessibility and usability of the uploaded data for all project stakeholders.

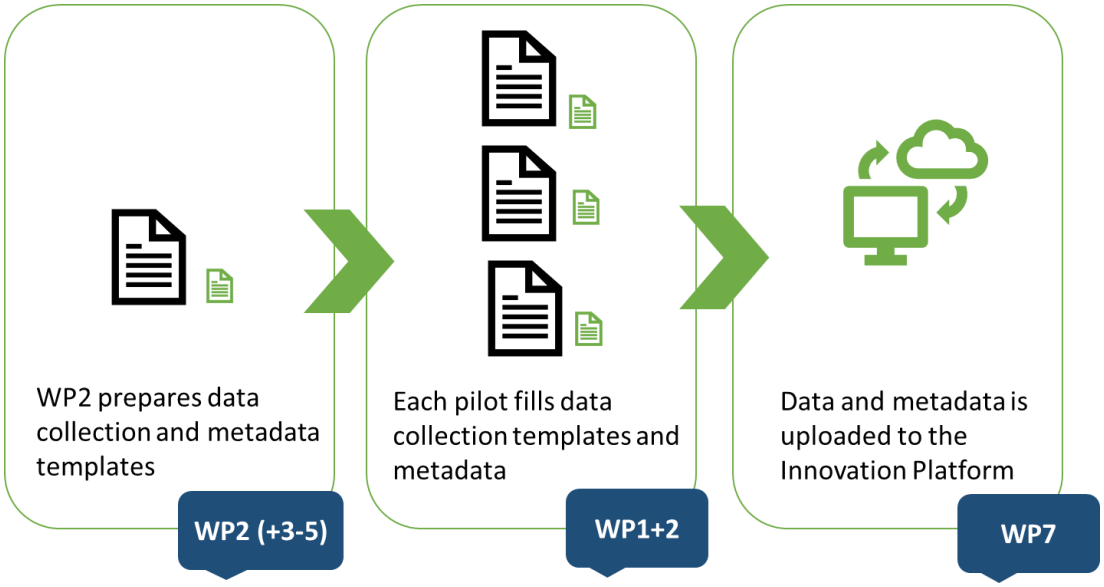


Figure 2: Data Collection and Management Workflow in P2GreeN.

5 Templates for data collection

The utilization of templates for data collection and data storage is vital within our project due to its distinct characteristics, encompassing multiple pilot regions and a transdisciplinary partnership involving experts from various fields. These templates are indispensable in the context of our project's unique features, characterized by its geographic spread across multiple pilot regions and the collaborative engagement of researchers from diverse disciplines.

5.1 Common metadata template

5.1.1 Description

The metadata Excel file template functions as a structured framework to document vital details about datasets, featuring a dropdown list of diverse metadata categories and fields for essential dataset information collected within the project. It allows to record specific metadata elements for each dataset, such as work package, task, responsible organization, data format, data type, data category, and tags. It contains a dropdown list sheet, which includes a range of classification options, covering various aspects from background information to data classification.

The worksheet within the template as shown in **Figure 3**, provides input fields for recording general metadata (such as work package, task, authors, data file name, file

type, creation date, etc.) and background information related to the data (like geographical location, site operator, soil type, studied crops, objectives, questions, hypotheses). Additionally, it incorporates sections for data classification details, which enable us to specify data type (quantitative/qualitative), the data category (see below), and assign one or more (optional) tags for further data classification and identification. Currently, 13 different data categories are considered:

- Reports and publications
- Agro-environmental data
- Blueprints
- Guidelines and Recommendations
- Impact assessment
- Technological data
- Financial/economic data
- Stakeholder data
- Regulatory and Governance data
- Information material
- Planning data
- Feasibility studies
- Geographic data

To further characterize the data, a variable number of tags can be assigned to each dataset. Approximately 50 different tags were identified during a survey in the consortium in M11. Together with an overview of the data collection in the project, which was created for the DMP and the innovation platform in M4, WP2 created an initial list of tags and shared it with the consortium. The tags will be further updated during the development of the Innovation Platform based on the feedback from the consortium.

5.1.2 Usage

Like the subsequent templates presented, utilizing this specific template involves:

- In the worksheet, select from the dropdown lists provided for categorizing essential details such as Work package, Task, Organization, Data format, Data type, and Data category.
- Fill in the necessary details in the 'General Information' section, including Work Package, Task, Responsible Organization, Authors, Confidentiality of Data, Description, Data File Name, File Type, Number of Data Points, Creation Date, Date Modified, and Version.
- Provide 'Background Information' for contextual understanding (if applicable), including Geographical Location, Site Operator, Soil Type, Studied Crops, Included Treatments, Objectives, Questions, and Hypotheses.

- Define the 'Data Type' (Quantitative, Qualitative, or Mixed) and 'Data Category' to classify the type and category of the collected data.
- Use 'Tags' (Tag 1 to Tag 5) as identifiers for additional classification and further categorization of the data.

It is also currently being explored whether the information entered when uploading data to the innovation platform can be used to create a metadata file (README) containing the same information as the metadata template. The advantage here could be that users are guided by the platform, simplifying the metadata capture process and reducing errors.

Required information	Explanation and exapmles	Input field
General information: Header with general metadata of the corresponding data file		
Work package	WP from which the data was collected	Select from list
Task	Task to which the data belongs	
Responsible organisation	The organisation that collected the data	
Authors(s)	The person(s) who entered the data	
Confidentiality of data	Indicate here if the data is sensitive (only for project-internal use) or not (publication possible)	
Description	Brief description of the data (free text)	
Data file name	This needs to refer exactly to the filename containing the data, (e.g. "Data_P2GreeN-WP2-Sweden_20230801.xlsx")	
File type	Specify the file format (e.g. "Microsoft Excel", "Text", "PDF")	Select from list
Number of data points	This field needs to be filled with the number of individual data entries (rows)	
Creation date	The date when the file was first created	
Date modified	The date when the last modification occured	
Version	A whole number, starting from 1 and updated for each modification step (e.g. if the original file version 1 was updated twice the most recent file version is 3)	
Background information: Metadata that is needed for understanding the collected data		
Geographical location	Where the data was collected, as detailed as possible (e.g. 'German pilot region, field trial')	
Site operator	Only relevant for data from treatment plants and field trials	
Soil type	Only relevant for data from field trials	
Studied crops	Only relevant for data from field trials	
Included treatments	Only relevant for data from field trials (e.g. Unfertilised control, Recycling fertiliser, Mineral fertiliser control, Organic fertiliser control)	1. 2. 3. 4.
Objectives	The main objective that is behind the data collection	
Questions	List questions that the data should help to answer (e.g. economic, social and environmental impacts, etc.)	1. 2. 3.
Hypotheses	Are there already hypotheses about possible findings?	1. 2. 3.
Data classification: Details of the data, each data file has to be assigned to exactly one data category and at least one tag has to be added (multiple tags possible)		
Data type	Indicate if the data is quantitative or qualitative or a combination of both ('Mixed')	Select from list
Data category	The main category to which the data belongs	Select from list
Tag	Mandatory tag for further classifying the data (use 'Other' if there is no suitable tag in the list)	
Tag	Optional tag	
Tag	Optional tag	
Tag	Optional tag	
Tag	Optional tag	

Figure 3: Metadata template in development.

5.2 Templates for collecting data from field trials

5.2.1 Description of the template

This Excel template serves as a vital tool for monitoring the agroecological and environmental impacts resulting from the use of recycled fertilizers in field trials in the three pilot regions. It provides a structured framework tailored to the specific needs of each pilot region involved in the project. The template is designed to collect data on various parameters for assessing the impacts of recycled fertilizer usage on soil, plants, air, and water quality. Utilizing this template ensures a standardized and systematic approach to data collection, enabling accurate and consistent recording of measured parameters. It streamlines the collection process by providing a predefined structure as well as dropdown menus with filling options, reducing the likelihood of errors, and facilitating data interpretation. Moreover, this template promotes uniformity across different pilot regions, allowing for comparative analysis while accommodating the unique requirements of each specific location.

5.2.2 Data collection criteria: Information gathering table

Before the establishment of the template for collecting agro-environmental data from P2GreeN's pilot regions (see 5.2.3), a collaborative effort was undertaken with project members and stakeholders in each pilot region within Work Package 2 (WP2) to develop a comprehensive table for data collection criteria (**Figure 4**). This collaborative process aimed to incorporate agroecological and environmental data specific to individual pilot regions, with the intention of guiding data collection during the field trials. The table was designed to capture and outline the methods and parameters of interest that are intrinsic to the agricultural practices, environmental conditions, and research objectives within each region, thereby laying the groundwork for generating the data collection template. The development of the table involved a meticulous consideration of the agroecological and environmental factors pertinent to each pilot region, ensuring that the data collection criteria were tailored to the unique characteristics and requirements of the respective locations. This approach facilitated the identification of four overarching main categories for data collection in the field trials, each of which plays a crucial role in elucidating the agro-environmental dynamics within the pilot regions.

- The first category, "Material flows," focused on capturing the N & P mass balance from sanitary waste inputs to fertilizer application on the field, thereby shedding light on the nutrient dynamics and resource utilization within the agricultural systems.
- The second category, "Plant nutrition" encompassed the assessment of nutrient contents in fertilizers, crops, and soil, as well as the evaluation of harvest product quality parameters, aiming to gauge the efficacy of fertilizer utilization and its impact on crop productivity.

- The third category, "Contaminants," delved into the detection and analysis of pathogens, pharmaceutical residues, other organic pollutants, and heavy metals, recognizing the significance of monitoring and mitigating potential contaminants that may affect agricultural and environmental sustainability.
- Lastly, the "General/other parameters" category encompassed a diverse range of factors including climate, soil characteristics, sanitary waste management, crop attributes, and emissions, acknowledging the multifaceted nature of agro-environmental interactions.

Sample matrix	Measured parameter	Measurement frequency (suggestions)			Methods used		
		Germany	Sweden	Spain	Germany	Sweden	Spain
Sanitary waste	Input: volume/mass of urine, dry toilet contents and wastewater	Per batch	Per batch	monthly (raw wastewater entering the WWTP / day) monthly (wastewater treated after secondary treatment - activated sludge / day)	Urine: measurement scale on storage tanks; Faeces: weighing of transport containers + subsamples for dry mass		water flow meter
	Total N and P content of input materials	Per batch, if applicable	-	on-demand (Nitrates, Nitrites, Total nitrogen, Ammonium, Total phosphorus, Chlorides, Sulfates)	Total N: combustion + TCD; total P: aqua regia extraction + ICP-OES		sample analysis spectrophotometry tbd (PNT-FQ-015 PNT-FQ-013 PNT-FQ-016 PNT-FQ-030)
Recycling fertilisers	Output: volumes/mass of urea fertiliser, faecal compost and reclaimed water	Per batch, prior to fertiliser application	Per batch	daily (reclaimed water produced)	Aurin: bottles with defined volume; compost: similar to input		water flow meter
	Total N and P content in fertiliser products, K analysis (NPK balance)	Per batch, prior to fertiliser application	Per batch	daily (NH4, NO3 and K+) punctual analysis (on demand) (PO4)	Total N: combustion + TCD; total P and K: aqua regia extraction + ICP-OES		NH4, NO3 and K+ in reclaimed water measured with water sensors PO4 in reclaimed water measured with detection test strips

Figure 4: Figure depicting criteria used for data collection (excerpt).

5.2.3 Template structure and function

Based on information provided in the table for criteria selection (as described in section 5.2.2), we created a data collection excel file template with three sheets. The first sheet serves as a guideline, offering instructions on how to use and navigate through the template efficiently. The second sheet contains a dropdown list encompassing various collection methods for measuring agroecological and environmental parameters such as macronutrients, micronutrients, pathogens, pharmaceuticals, heavy metals, fertilizer and water quality parameters, soil characteristics, crop quality parameters, and emissions like N and P leaching and N_2O emissions in soil, water, air, and crops (**Figure 5**).

The third sheet serves as the primary data collection tool designed to capture information for each component within the four main categories outlined in section 5.2.2. Each data point (i.e. measured value) is accompanied by a comprehensive set of descriptive information, systematically organized into designated columns to facilitate thorough

interpretation of the data points in each row. This information encompasses a range of essential information, including specific data criteria selected from dropdown lists (e.g., sample matrix, parameter type, fertilizer treatment, studied crop), as well as manual input of additional details such as date, time, responsible institution, collectors' information, additional comments, and field observations (**Figure 6**). Furthermore, the corresponding units and measurement errors are meticulously recorded in separate columns next to the measured values.

Measured parameters	**1**	**2**	**3**
N_Nitrogen	Total N: combustion + TCD	Photometric determination (FIA)	tbd
P_Phosphorus	Total P: aqua regia extraction + ICP-OES	Total N: combustion + TCD; total P and K: aqua regia extraction + ICP-OES	CaCl2 extraction and photmetric determinatio
K_Potassium	Aqua regia extraction + ICP-OES	Water sensors (K+)	Total K: aqua regia extraction + ICP-OES
S_Sulfur	Aqua regia extraction + ICP-OES	Certified laboratory	SOP (standard operating procedure) / External; Instrument = Sample of 0,5 l in polyethylene bottle
Ca_Calcium	Ca: titration	Certified laboratory	SOP (standard operating procedure) / External; Sample of 0,5 l in polyethylene bottle; Instrument = Lysimeter
Mg_Magnesium	Aqua regia extraction + ICP-OES	Certified laboratory	SOP (standard operating procedure) / External; Sample of 0,5 l in polyethylene bottle; Instrument = Lysimeter
NH_4_Amonium	Water sensors	Photometric detection via FIA	SOP-FQ-016 - Internal Method based on: SM 4500-NH3 F; Instrument = Sample of 0,5 l in polyethylene bottle & Lysimeter
NO_3_Nitrate	Water sensors	Photometric determination via FIA (for nitrate	SOP-FQ-013 - Internal Method based on: SM 4500-NO3 - B; Instrument = Sample of 0,5 l in polyethylene bottle & Lysimeter
PO_4_Phosphates	Water extraction + ICP-OES	Photometric detection via FIA	Detection test strips

Figure 5: Dropdown list outlining field trial data gathering templates.

The selection of data criteria from dropdown lists ensures standardized categorization of the measured values, thereby enabling consistent classification and analysis. Furthermore, the inclusion of manual input fields for supplementary information, such as date, time, and responsible institution, serves to contextualize the data and establish a comprehensive record of the data collection process. Additionally, the incorporation of collectors' information, additional comments, and field observations offers valuable insights into the circumstances surrounding the data collection, contributing to a more nuanced understanding of the measured values. By recording the units and measurement errors in separate columns, it is possible to combine different parameters on the same sheet while having only one column for all measured values. This facilitates later

processing of the data with script-based software (e.g. R or MATLAB), with the possibility to apply filters based on the different input fields in each row.

Field trials data collection template:WP2

Location	Date of collection	Time of collection	Date of analysis	Time of analysis	Laboratory	Responsible organisation	Sample matrix	*Sanitary waste type (pretreatment)*
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater
Spain	14/06/2023			2:30:00 PM			Sanitary_waste	Municipal wastewater

Parameter type	Measured parameter	Method & Intruments	Sample reference number/code	Value	Unit	No. of replicates (if applicable)	Measurement error [±] (if applicable)	Type of error (if applicable)
Macronutrients	N_Nitrogen	SOP (standard operating procedure) / External; Instrument = Sample of 0,5 l in polyethylene bottle		55,7	mg/l		4,5	Standard deviation
Macronutrients	P_Phosphorus	SOP (standard operating procedure) / External; Instrument = Sample of 0,5 l in polyethylene bottle		3,56	mg/l		0,28	
Macronutrients	NO_3_Nitrate	SOP-FQ-013 - Internal Method based on: SM 4500-NO3 - B; Instrument = Sample of 0,5 l in polyethylene bottle & Lysimeter		1,79	mg/l		0,15	
Macronutrients	NH_4_Amonium	SOP-FQ-016 - Internal Method based on: SM 4500-NH3 F; Instrument = Sample of 0,5 l in polyethylene bottle & Lysimeter		61,8	mg/l		9,3	
Macronutrients	K_Potassium	SOP (standard operating procedure) / External; Instrument = Sample of 0,5 l in polyethylene bottle & Lysimeter		30,7	mg/l		6	
Water_quality_parameters	EC_Electrical_Conductivity_at_25°C	Water sensors		2880	µS/cm		95	
Water_quality_parameters	Turbidity	SOP-FQ-003 – Internal Method based on: UNE-EN ISO 7027-1		5,5	U.N.F		0,43	
N_leaching	N_Nitrogen	SOP (standard operating procedure) / External; Instrument = Sample of 0,5 l in polyethylene bottle			mg/l		126	

Figure 6: Illustration of field trial data collection sheet for field trial (excerpts).

5.3 Templates for collecting data for LCAs

This LCA-template is specifically geared towards capturing multifaceted insights, including environmental, social and cost-benefit impacts. By incorporating such a holistic approach, this specialized LCA template equips us with the precise tools needed to conduct a thorough assessment, enabling us to make informed decisions and promote sustainable practices across diverse domains. Within this template, we detail various parameters related to resource consumption, emissions, and waste generation at different stages of fertilizer product's and process's life cycle (**Figure 7**).

One common data collection template is aimed to be used by all three pilots to ensure the accuracy and replicability of the approach. However, each pilot region will receive their own template to decrease the risk for confusion and overwriting of input made by others. Each file will then contain one pilot-specific sheet to shortly describe the pilot region characteristics and the value chain to be studied. This information will be provided by WP2 (more specifically, task 2.3). The data collection itself will be done with uniform

style and content and it will be mainly carried out by representatives of each pilot (i.e., WP1).

Location	Inputs	Outputs	Processing phases
Select from list	*Select from list*	*Select from list*	*Select from list*
Germany	GER: dry toilet waste	GER: compost (Goldeimer)	GER: aerated interim storage (Goldeimer)
Sweden	GER: urine	GER: drainage from thermophilic composting	GER: thermophilic composting (Goldeimer)
Spain	GER: straw (Goldeimer)	GER: drainage from composting (Goldeimer)	GER: composting (Goldeimer)
	GER: biochar (Goldeimer)	GER: drainage from aerated interim storage	GER: screening (Goldeimer)
	GER: claey-loamy soil (Goldeimer)	GER: inorganic fraction from screening	GER: fertilizer use of compost
	GER: organic fraction from screening (Goldeimer)	GER: organic fraction drainage screening	GER: storage of compost
	GER: distilled water from yellow water (Vuna)	GER: Aurin fertilizer (Vuna)	GER: nitrification (Vuna)
	GER: activated carbon (Vuna)	GER: distilled water from yellow water (Vuna)	GER: distillation (Vuna)
			GER: purification (Vuna)
	SWE: urine	SWE: urine fertilizer	GER: fertilizer use of Aurin
	SWE: chemical stabilizer	SWE: evaporated water	GER: storage of Aurin
	SWE: binding material		
		SPA: Irrigation water	SWE: drying
	SPA: treated wastewater		SWE: granulation
	SPA: well water		SWE: fertilizer use
	SPA: artificial fertilizer		SWE: storage of fertilizer
	Water (tap water)		SPA: tertiary treatment
	Packaging		SPA: reclaimed water pumping to mixing unit
			SPA: local water pumping to mixing unit
			SPA: mixing unit
			SPA: smart fertigation tool
			SPA: storage of fertilizer

Figure 7: Dedicated data for each pilot region categorized in the common LCA data collection template.

Because all pilots apply different value chains, but the data collection is aimed to be uniform, the template contains drop-down lists. The lists are provided so that the users can select the correct data category related and dedicated to their own pilot region. All data categories (inputs, outputs and process phases) needed from each pilot region have been identified and are combined in **Figure 7**. The lists have been reviewed by the representatives of each pilot.

5.3.1 Use of LCA data collection templates

The data collection template consists of sheets for 1) guidelines, 2) the goal and scope of the impact assessment, and 3) data sheets for data inputs. In addition, there is one sheet for the information visible in the drop-down lists (**Figure 7**). However, this sheet should only be used if, for example, additional process stages or inputs/outputs need to be added, which were not foreseen during the preparation of the template.

The first sheet of the template shortly describes the content, and describes, how the template should be filled. It also includes contact information of WP2 task 2.3. personnel, who oversee the data collection and will help, if there are issues with the templates. A nomenclature for the analytical data needs is also included. The second sheet is dedicated information for each pilot region and contains description of the value chain and system boundaries applied in the assessment. This sheet also contains simple schematics of the process chain.

The data collection itself is divided into seven different stages of the bio-fertilizer production value chain: i) inputs, ii) outputs, iii) energy use, iv) transportation, v) storage,

vi) fertilization, vii) gaseous emissions (see examples in **Figure 8**). The description of each stage and data inputs needed is summarised in **Table 1**. The template specifies the units in which the data should be added to enable its easier further use. Thus, there will be some differences between units used between pilot regions, e.g., in the Spanish case fertigation process will be likely based on volumes, while Swedish and German case use mass of materials as the basis for data inputs.

Table 1: Description of data categories included in the data collection template.

Process stage/data category	**Examples of data needs**	**Examples of units**
Inputs	Raw materials, water, chemicals, and other additives used during processing	t/y, %, g/kg
Outputs	Fertilizer and fertigation products, residues, and reject streams	t/y, m3/y, %, g/kg
Energy use	Heat, electricity and fuel consumption and types during different stages of processing chain	kWh/t, L/t
Transportation	Transportation distances and types used to transport different inputs and outputs	km, t, L/t
Storage	Storage times, types, and amounts used to store different inputs and outputs	weeks, t/y
Fertilization	Fertilizer/fertigation application, soil and crop types, and description of leachate in soils	t/ha, kg/t/ha, m^3/ha, mg/L
Gaseous emissions	Gaseous emissions generated at different stages of processing chain	kg/ha/y, kg/t/y, % of N processed, % of N applied

In addition, for each data point, the date of data inputs is to be added. This is done to keep on track with the updated information. The aim is, that the data is collected during the project duration.

The data to be collected in the LCA template is to reflect the overall performance of the process. This is why, the aim is that the data inputs consist of averages of multiple tests runs rather than individual analysis results. For example, with transportation of bio-fertilizer, an average distance to the receiving fields can be used. For clarity, there is a column to specify the time range from which the applied averages are calculated. In addition, one column is dedicated to specifying whether the input data is based on

measurements or estimations. Estimations might be needed to produce realistic picture of, e.g., transportation distances.

			Mass		Characteristics										
	Specification	Date of information added	Mass tons per year	Source country of origin	Density L/kg	TS (total solids) %	VS (volatile solids) %TS	N-tot g/kg FM	NH4-N g/kg FM	P-tot g/kg FM	C-tot g/kg FM	COD mg/L	Is the data based on measurements or estimations	from which the average characteristics are calculated
Process outputs	Select from list													
	Select from list													
	Select from list													
	Select from list													
	Select from list													
	Select from list													
	Select from list													

			Heat			Electricity			Fuel			
	Specification	Date of information added	Heat use kWh/t trea	Type of energy renewable/non-renewable/mix	Source of heat country of origin	Electricity use kWh/t treated	Type of energy renewable/non-renewable/mix	Source of electicity country of origin	Fuel use l/t treated material	Type of fuel used diesel/gasoline	Is the data based on measurements or estimations
Process phase	Select from list										
	Select from list										
	Select from list										
	Select from list										
	Select from list										
	Select from list										
	Select from list										
	Select from list										

Figure 8: Example of the structured Data Collection Framework for LCAs. Collection sheets for input and energy use data.

5.4 Templates for economic and stakeholder data

Several meetings were conducted with co-leads and members from WP3, WP4 and WP5 to discuss their data collection processes and needs. The outcomes of these discussions were that most of the data gathered in these WPs is qualitative data and will not need data collection templates. The exception to this is the data regarding economics of the value chains within the pilot regions and the stakeholder data, which represent crosscutting topics between various WPs. Thus, we have developed templates for these two topics. The other data from WP3-WP5 will be managed by tagging using the common metadata template.

5.4.1 Economic data template

The economic data template serves as a structured tool for recording and comparing economic data across the different pilot regions within the project. As shown in **Figure 9**, this template contains a sheet, with a dropdown list for each pilot region that includes various parameters related to expenditures (costs), income, and further specifications for each of the four P2GreeN technologies (VUNA process, fecal composting, urine drying, and water reclamation for fertigation). This includes, for example, capital expenditures (investment costs), operational expenditures (e.g. energy consumption, heat consumption, personal costs, transport costs), availability of raw materials, sizing of the technology, and product storage costs. To avoid overlaps/redundant data collection in different templates, the economic data template has a clear focus on cost data. Other economically relevant parameters such as nutrient recovery rates, material input and

output flows, nutrient concentrations, as well as energy and heat consumption in [kWh] are collected within the above described LCA template.

The main data collection sheet in the economic data template allows to select a specific pilot region and then choose relevant parameters or metrics associated with that region in the dropdown list. For instance, in the case of Sweden, users can select various cost aspects (e.g. CAPEX, OPEX) related to S360's urine drying process and then add the actual cost data in the field "Value". In addition to the technology, parameter and unit selected from the dropdown list, further information about data collection is to be filled into the collection sheet. This comprises the location and date of collection, and the data source (organization). How often the economic data is gathered in the pilot regions is still under discussion. However, it has been suggested to collect the data on a yearly basis to trace cost dynamics and technological developments. In the end, the economic data gathered in the pilot regions will be used for business model development in WP3 and for replicating/upscaling the value chains/technologies in P2GreeN's follower regions (WP5).

Overall, the economic data template provides a structured framework for capturing and comparing diverse metrics and project-specific details across the three pilot regions, aiding in comprehensive data analysis and evaluation within the P2GreeN project.

	Technology	Parameter	Units
Sweden	Urine drying	Storage of urine	€/m3(storage)
	Urine drying	CAPEX	€/reactor
	Urine drying	OPEX reactor	€/m3(fresh urine)/yr
	Urine drying	OELEX reactor	€/reactor
	Urine drying	OPEX transport	€/m3(fresh urine)/km
	Urine drying	OPEX transport commercialization	€/kg(dried urine)/km
	Urine drying	Space for reactor (rental/purchase costs)	€/reactor/yr
	Urine drying	Human resources requirement	FTE
	Urine drying	Planned technological lifetime	yr
	Urine drying	Net present value (NPV)	€/reactor
	Urine drying	Maximum input available (optimal case)	m3(fresh urine)/yr
	Urine drying	Sizing	m3(urine)/d/reactor
	Urine drying	Chemical stabilizer	€/kg(dried urine)
	Urine drying	Binding material	€/kg(dried urine)
	Urine drying	Fertilizer selling price	€/kg(dried urine)
	Urine drying	Storage of dried urine	€/kg(dried urine)
	Urine drying	OPEX commercialization	€/kg(dried urine)
	Urine drying	Maximum product storage time	yr

1	Location	Date	Data source (organisation)	Technology	Parameter	Value	Units
2				Urine drying	OPEX reactor		Select from list
3							
4							
5							
6							

Figure 9: Example with the dropdown list of economic parameters for urine drying in Sweden (top) and the input fields in the corresponding worksheet (bottom).

5.4.2 Stakeholder data template

Stakeholder data will be collected in different WPs, particular in task 4.2 on stakeholder engagement and task 5.1, which aims at creating a Stakeholder Network Hub on the Innovation Platform. Both tasks started to collect stakeholder data from the beginning of the project and used separate excel files for this. In task 2.1, we consulted with the co-leaders of WP3, WP4 and WP5 regarding their stakeholder data collection needs. As a result, it was suggested to develop a common stakeholder data collection template based on the existing excel files from WP4 and WP5. WP2 then assessed how the two files could be combined and concluded that the stakeholder data collected in task 4.2 could be easily integrated into the more comprehensive stakeholder data template from task 5.1, which is managed as a 'living document' where all project partners can add relevant stakeholders that they identify.

Organisation/Insitution	Thematic Focus	Stakeholder Type	Link/info	Comments	Connection established P2GreeN	Priority for P2GreeN (High, medium, low)
Junta de Andalucia	Governance	Government and public administration	https://www.juntadeandalucia.es/	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	medium
Consejería de Agricultura, Ganadería, Pesca y Desarrollos Sostenible - Junta de Andalucia	Sustainability/Circularity	Government and public administration	https://www.juntadeandalucia.es/organismos/agriculturapescaaguaydesarrollorural.html	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	high
Territorial Delegation of Agriculture, Fisheries, Water and Rural Development in Malaga	Food and agriculture	Government and public administration	https://www.juntadeandalucia.es/organismos/agriculturapescaaguaydesarrollorural/consejeria/delegaciones/malaga.html	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	high
Dirección General Infraestructura y Explotación del Agua - Junta de Andalucía	Architecture/Planning	Government and public administration	https://www.juntadeandalucia.es/organismos/agriculturapescaaguaydesarrollorural/consejeria/sga/dgia.html	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	high
AGAPA (Andalusian Agrarian and Fisheries Management Agency) - Department of Agriculture, Water and Rural Development, Regional Government (Junta de Andalucía)	Food and agriculture	Government and public administration	https://www.juntadeandalucia.es/agenciaagrariaypesquera/portal/	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	high
TRADE (Business Agency for Transformation and Economic Development) - Junta de Andalucía	Sustainability/Circularity	Government and public administration	https://www.juntadeandalucia.es/organismos/trade.html	Invitation to participate in 1st Cross-Fertilisation Workshop (T1.4)	yes	high
Servicio de Promoción Rural en Junta de Andalucía	Food and agriculture	Government and public administration	https://www.juntadeandalucia.es/organismos/agriculturapescaaguaydesarrollorural/areas/desarrollo-rural.html		no	medium
Municipality of Algarrobo	Governance	Government and public administration	https://www.algarrobo.es/	Regular contact for project updates	yes	high
Municipality of Vélez Málaga				Invitation to participate in		

README | Nat, EU, Int Networks | EUProjects,Clusters,Initiatives | Germany Stakeholders | Spain Stakeholders | Sweden Stakeholders | Italy Stakeholders

Figure 10: Template for stakeholder data collection, showing examples from the Spanish pilot region.

An updated version of the stakeholder data template (**Figure 10**) was created by task 5.1, considering the feedback from task 2.1 on data collection criteria. The template includes an instruction on how to use the file (README sheet) and separate worksheets for national/EU/international networks, EU stakeholders (projects, clusters and initiatives), and local/national stakeholders from each pilot and follower region. Stakeholders are categorized according to type and thematic focus based on a pre-

defined list that was developed in a co-creation process with the P2GreeN consortium. Separate columns include contact information (website links), comments (e.g. on how well the connection is established and by whom), an indication if a contact to the stakeholder is established, and the relevance of the stakeholder for P2GreeN. To comply with GDPR requirements, only general and publicly available information on stakeholders will be collected in the template.

6 Conclusions and Outlook

In conclusion, the 'Report of Common Guidelines for Methods and Data Templates' represents a pivotal step in ensuring the integrity, reliability, and collaborative nature of data collection within the P2GreeN project. By establishing standardized methodologies, criteria, and frameworks for data acquisition, management, and sharing, this document sets a strong foundation for achieving the project's goals. The outlined guidelines emphasize the evolution of practices alongside technological advancements and ethical considerations, demonstrating adaptability and responsiveness to changes. Task 2.1's commitment to harmonizing data collection practices across diverse regions, despite inherent variations, underscores the project's dedication to comprehensive evaluation and comparison of impacts across agroecology, environment, society, and economics. The strategic pillars defined within the Data Management Plan highlight the critical role of effective data management in realizing the project's vision of transitioning to a circular model. The focus on metadata standards, templates, and the Innovation Platform as a central repository reflects a commitment to accessibility, interoperability, and reusability of project data, facilitating seamless collaboration and knowledge sharing. Collaboration between the Data Management Team and WP2 co-leads remains integral in refining and implementing robust guidelines and frameworks. This collaborative effort ensures that project outputs are not only easily accessible but also compatible and reusable, fostering widespread adoption of innovative solutions proposed by the P2GreeN project. Overall, this report lays the groundwork for reliable and scientifically sound data practices, essential for achieving the project's objectives and contributing to sustainable urban-rural nutrient flow solutions. The commitment to shared standards and continuous improvement underscores the project's dedication to advancing knowledge and promoting impactful outcomes within the scientific community.

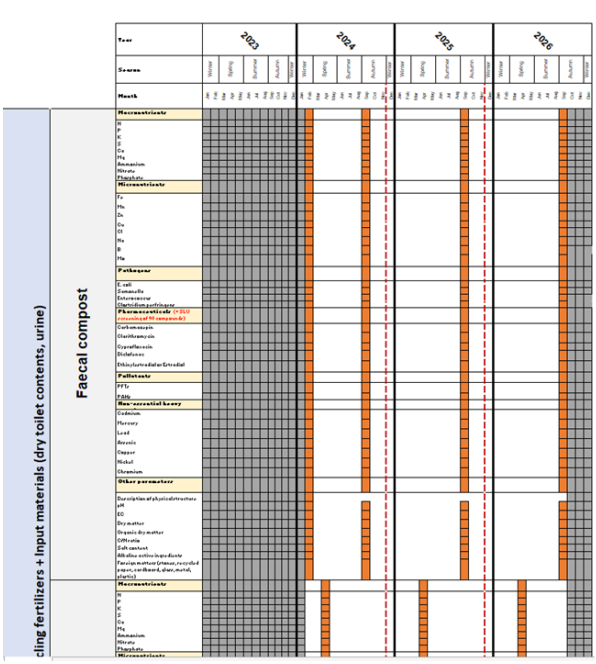
7 References

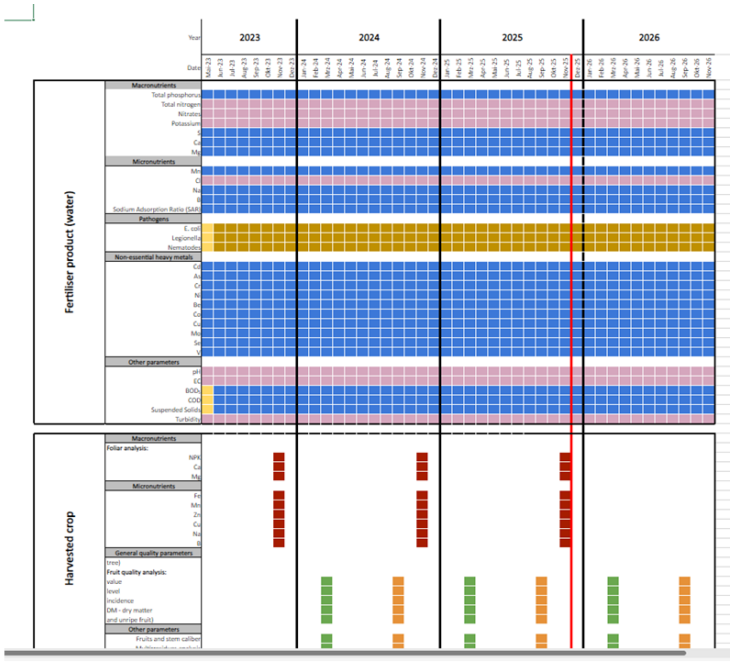
Beblek, A., D7.3 Initial data management plan P2GreeN, 2023

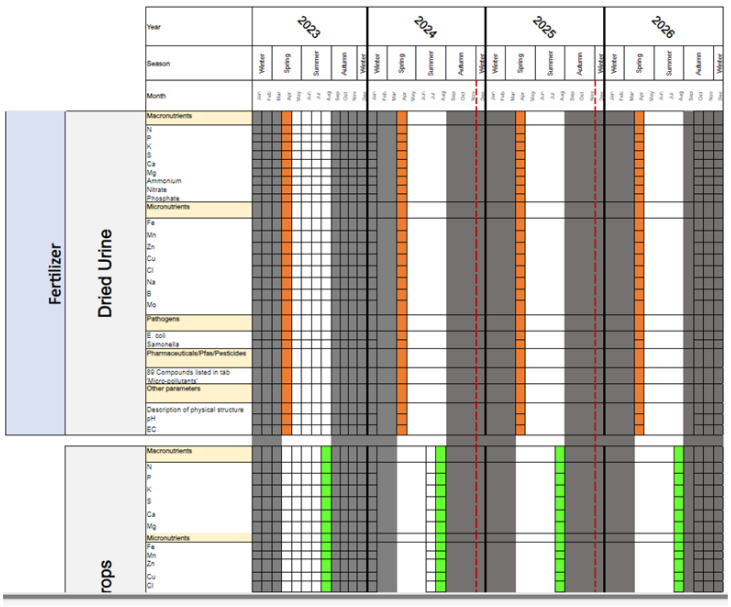
W3C, The PROV Data Model, 2013: https://www.w3.org/TR/prov-dm/

8 Annex

Annex 1: Sampling plans for the agroecological field trials in three pilot regions.







Annex 2: Overview of agroecological analyses performed in WP2.

Monitoring agroecological impact

	Swedish pilot - 360Sanitation (Urine dehydration)	**German pilot - Goldeimer** (Multi-step feacal composting)	**German pilot - VunaNexus** (Vuna process of urine nitrification)	**Spanish pilot - BIOAZUL** (Wastewater reclamation)
Fertiliser product	Urine-based fertiliser	Faecal compost	Aurin fertiliser	Reclaimed water
Macronutrients				
NPK	x	x	x	x
S	x	x	x	x
Ca	x	x	x	x
Mg	x	x	x	x
Micronutrients				
Fe		x	x	
Mn		x	x	x
Zn		x	x	
Cu		x	x	
Cl	x	x	x	x
Na	x	x	x	x
B		x	x	x
Mo		x	x	
SAR (Sodium Adsroption Ratio)				x
Pathogens				
Salmonella	x	x	x	
E. coli	x	x	x	x
Enterococcus		x		
Bacteriophages MS2 and PhiX (somatic coliphages)		?		
Parasites Ascaris lumbricoides				
Cryptosporidium				
Clostridium perfringens and spores		?		
Non-essential heavy metals (SLU)				

Contact

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