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V1

D3.1 - Protocols for data collection and analysis of the systemic feasibility

ADVISOR NETWORK FOR OPTIMAL FERTILISERS USE

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Glossary

GP	Good Practice
BP	Best Practice
RI	Research Innovation
WP	Work Package
FIN	Fertilization Innovation Network
TRL	Technology Readiness Level
BBF	Bio-Based Fertilizer
PF	Precision Farming
SQ	Soil Quality

Introduction

This protocol document is designed to assist all partners of the Fertilisation Innovation Networks (FIN) in effectively collecting relevant information about the collected Good Practices (GPs) and Research Innovations (RIs). This document can be used alongside the 'guidelines for the identification of GPs and RIs' (D2.1). The difference in both documents lies in that the guidelines will focus on collecting the GPs and RIs while this document further discusses the collection of relevant data for these practices.

The document is divided in two parts. In part A, the protocol will assist in collecting relevant data for the quick-scan (Task 3.2). Part A is further divided into protocols for each network (Bio-Based Fertilizer, Precision Farming and Soil Quality) depending on the nature of the GP or RI. Furthermore, part B will focus on the collection of data for the detailed analysis of the remaining Best Practices (BPs).

One of the **main objectives** of the STRATUS project is to identify a minimum of 48 Best Practices (BPs) on optimal fertilizer use, adapted to the different regions of the project, as well as key success factors for their replicability across the European Union (EU), and the barriers affecting their acceptance and adoption considering economic, environmental, and social aspects. To this end, in WP2, the document 'Guidelines for the identification of Good Practices and Research Innovations' was written for the Fertilization Innovation Networks (FIN) to collect at least 104 Good Practices (GPs) and Research Innovations (RIs) which will undergo a systemic feasibility assessment in WP3, through a two-step analysis process.

The current methodology was built to connect seamlessly with the collection protocol from WP2: the identification sheets are structured as questionnaires, which should enable the FIN partners to identify GPs and RIs, and at the same time collect relevant data in a clear and understandable way, hereby integrating the local conditions of the different regions. After completion, the forms should contain enough information for the quick-scan (Task 3.2), a preliminary systemic feasibility analysis. The results from this first step must feed the FIN discussions in WP1, in order to determine the BPs that will be analysed more thoroughly in the second step (Task 3.3). The information flows between WPs 1-3 and Tasks 3.1, 3.2 and 3.3 are visualized in figure 1.

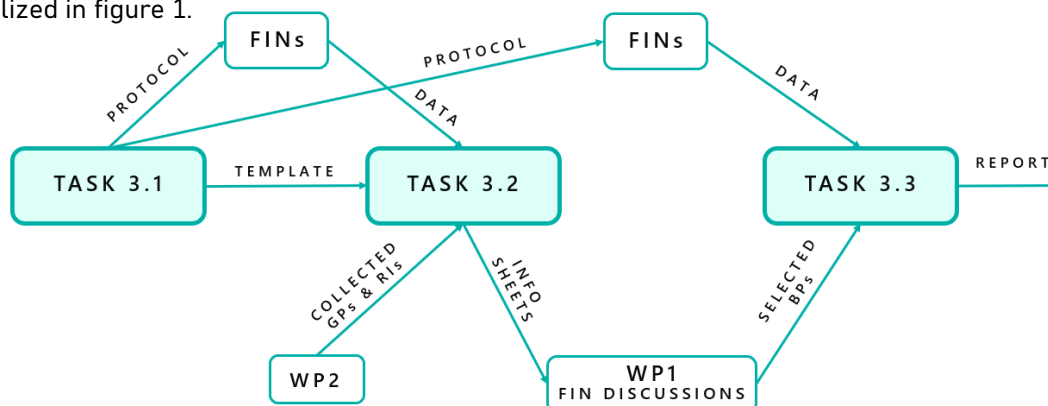


Figure 1: Information flows between work packages and the tasks within WP3.

By completing the forms, the selected GPs and RIs are evaluated on farm-economic effects, on-farm applicability, environmental effects, social implications, and regulatory aspects. For each of the three subnetworks a different template was created using Microsoft Forms. Each subnetwork deals with a distinct aspect of Integrated Fertilization Management:

- The FIN on [biobased fertilizers](#) (BBF) deals with sustainable, affordable high-quality biobased alternatives from different residue and waste streams, which may substitute mineral fertilizers partly or completely. (click on the [link](#) to go to the identification form)
- The FIN on [precision farming](#) (PF) deals with the use of technology and digitalization for an optimal fertiliser use. (click on the [link](#) to go to the identification form)
- The FIN on [soil quality](#) (SQ) deals with the use of different farming techniques, such as alternative crops, cover crops, carbon farming, or timing of input applications for more sustainable nutrient management, reducing nutrient losses while ensuring soil fertility and quality. (click on the [link](#) to go to the identification form)

Part A of this protocol was developed to guide the FIN partners through the identification forms.

In case of questions regarding the completion, please **contact**:

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PART A: Data Collection for the quick-scan

1.1 General Questions (for all 3 networks)

Each questionnaire starts with a list of general questions:

QUESTION 1 - Name of the FIN-partner submitting the information

QUESTION 2 - Contact information of the FIN partner (email and/or phone number)
 Mention at least one, preferably email.

QUESTION 3 - Region (EU member state)

QUESTION 4 - Title/Name of the practice
 How is the practice identified or how is it referred to in general?

QUESTION 5 - Describe the practice
 Please be specific and complete: what does the practice entail and how is it applied? On what scale (crop/parcel/...)? To which purpose?

QUESTION 6 - Which practice is considered as the standard in this region?
 This additional information is required to benchmark the effect of the novel practice against a practice that is well-established in a certain region.

QUESTION 7 - Is the practice a 'Research Innovation' or 'Good Practice', according to the definition outlined in the STRATUS Proposal?
 A **Research Innovation (RI)** is an Integrated Fertilization Management (IFM) grey literature review based innovative solution that has been shown promising through research but is not yet implemented by the advisors, whereas a **Good Practice (GP)** is an innovative IFM strategy, approach, and/or activity that has been 'tried and tested' with good results several times showing to be effective, efficient, sustainable, and transferable and to reliably lead to all desired results. In terms of Technology Readiness Level (TRL), one could state that every practice with a TRL lower than 7 should be categorized as RI. TRL-levels can be checked in figure 2.

DEPLOYMENT	9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT
	8	SYSTEM COMPLETE AND QUALIFIED
	7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
DEVELOPMENT	6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT
	5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT
	4	TECHNOLOGY VALIDATED IN LAB
RESEARCH	3	EXPERIMENTAL PROOF OF CONCEPT
	2	TECHNOLOGY CONCEPT FORMULATED
	1	BASIC PRINCIPLES OBSERVED

Figure 2: Technology Readiness Levels (TRLs). A TRL lower than 7 can be considered as a RI.

QUESTION 8 - Name the source of information

(In case of a written source, proceed to question 11)

Where/how did you hear about the practice? Please be specific, is it a

- farm,
For GPs only: what is the name of the farm where the practice was tested/implemented? Which kind (size, type of output...)?
- company,
In case the practice was developed by a company, please state the name, the type (small/medium-sized/big) and the activity
- project,
In case the practice was developed during a project, please state the name, type, scope, start and end date/year
- other?

QUESTION 9 - What was the on-farm issue/challenge/opportunity that led to the implementation of the practice?

(if the practice is a RI, proceed to question 11)

This question applies to GPs only, but is not limited to concrete, practical use cases. Meaning that the on-farm issue/challenge/opportunity does not necessarily need to be linked to a specific case that the respondent experienced directly or indirectly, but this may also be an issue/challenge/opportunity experienced in agriculture in general.

QUESTION 10 - Specify the time it took to implement the GP and the measures needed to monitor,

QUESTION 11 - If the source is a written source, please provide the title, type of literature, and a weblink (if available)

Examples of literature types: scientific journal (peer-reviewed), professional magazine, blog, company website...

QUESTION 12 - Upload a picture or a video of the practice in the [folder matching the subnetwork \('BBF', 'PF' or 'SQ'\) on the STRATUS SharePoint](#) and paste the name of the image file.

Please use the following setup for the identification of the file:

'subnetwork_RI/GP_FIN partner name_serial number.pdf/jpeg/...'

For example: FIN partner ILVO uploads a video of a drone in mp4-format (GP) and a photo in jpeg format of a technique (RI) in the subnetwork 'precision farming'. The files need to be identified as following:

- *video: 'PF_GP_ILVO_1.mp4'*
- *picture: 'PF_RI_ILVO_2.jpeg'*

The serial number starts with '1' and is counted individually per FIN partner.

1.2 Specific question (depending on the network)

1.2.1 General

The questions from the remaining sections are specific for each of the three subnetworks, and therefore, they are listed separately. There are **three types of questions**:

- Questions which require an open answer
- Questions requiring exact one of the listed answers, these are indicated with a round bullet ‘○’
- Questions to which one or more answers may apply, these are indicated with a squared bullet ‘□’

For each subnetwork, questions are bundled according to **five key topics**:

On-farm applicability

On-farm applicability refers to the practical aspects of implementing a new practice in real-life farming situations, including the identification of potential risks.

Farm-economic effects

The ‘Farm-economic effects’ part deals with the economic effects that a practice may have on the farms and farmer’s financials, on both the short and longer term, direct as well as indirect.

Regulatory aspects

It is important to get an understanding of the regulatory aspects of exercising a practice, since this may not only entail substantial administration but also limit its use. Legislation can be regional, national or European, which affects the level of replicability of a practice across different EU regions.

Environmental aspects

Environmental aspects are also dealt with in the profound analysis of the BPs (see further), but for the quick scan, the topics of interest are emissions and the effect of the practice on biodiversity.

Social acceptance

Social acceptance plays a crucial role in the future development of agriculture, since most of its practices are exercised in the vicinity of villages, cities etc., thus affecting people’s physical and mental health, in both positive and negative ways, with varying intensity. To determine whether a GP/RI can be classified as BP, the (feasible) level of social acceptance is crucial. Topics such as the effect on a farmer’s time occupation and the public image of agriculture are addressed in this part.

1.2.2 Bio-Based Fertilizers (BBF)

On-Farm Applicability

For bio-based fertilizers, this part deals with the safety aspects of both the storage and the application of the materials on the field.

QUESTION 1 – In which form is the BBF applied?

- liquid
- solid

QUESTION 2 – How is the BBF applied on the field?

- broadcasting: spreading fertilisers uniformly over the soil surface, using equipment such as spreaders or sprayers, providing nutrients to a broad area for uptake by plants but not targeting specific plant root zones
- band placement: concentrating fertilisers in bands near the seed or plant root zone, ensuring that nutrients are delivered where they are most needed
- foliar feeding: applying liquid fertiliser directly to the leaves
- drip irrigation: liquid fertiliser is added using a system of pipes, tubing and emitters or sprinklers, in low amounts but over long periods of time.

QUESTION 3 – Storage safety risk:

- substantial (*precautions* need to be taken*)
- average (*compared to fertilizers in general*)
- low (*generally regarded as safe*)

Potential risks related to storage are dust formation, fire, contamination... The objective of this question is to have a general idea of the risk level regarding storage.

**Precautions to be considered according to the seller's recommendations.*

QUESTION 4 – Are there any other logistic aspects to consider? (please be specific)

Logistics is another aspect of the applicability and goes beyond storage: loading and unloading, carrier type, conditioning, packaging... Every relevant aspect needs to be mentioned.

QUESTION 5 – Skill/education level required for safe and effective application of the BBF:

- very low
- rather low
- rather high
- expert level

A certain skill level may be acquired by experience and/or education. 'Very low' means that safety and effectiveness can hardly be jeopardized. 'Expert level' needs to be chosen when only highly trained/experienced people know how to apply the BBF in a safe and effective manner.

QUESTION 6 – Availability of the BBF in this region:

- very low
- somewhat low
- sufficiently available
- abundantly available

For BBFs specifically, the availability of the material/compound will play a significant role: this not only has economic implications, but also practical ones. A readily available material will reduce the need for storage and the necessity of ordering large volumes at once. Availability is

also determined by distance: local availability means less transport, potentially smaller loads etc. 'Sufficiently available' means that just enough material is available to cover the needs.

QUESTION 7 - Availability of the BBF in the wider EU:

- very low
- somewhat low
- sufficiently available
- abundantly available

The idea of this question is very similar to the previous one. If the BBF is available in the wider EU, this means that other regions might profit from its use as well. On the other hand, availability in the region is more advantageous than solely in the wider EU, since the latter comes with higher transportation costs, higher CO₂ emissions and potentially less continuity.

QUESTION 8 - Can the BBF be applied to a multitude of cultivation techniques, or is the use limited to one or a few techniques? If the latter is true, please specify which techniques are targeted:

Examples of cultivation techniques are vertical farming, agroforestry, hydroponics, biodynamic farming... In the selection process of 48 BPs, BBF with general application potential are preferred over those with limited potential.

QUESTION 9 - Targeted crop categories (multiple answers possible):

- food: fruits, vegetables, grains, and tubers (e.g., potatoes)
- feed: alfalfa, hay...
- fiber: cotton, flax, hemp...
- oil: corn, sunflower, olive...
- ornamental: plants and trees used for landscaping or for gardening
- industrial: crops that are not consumed, but rather harvested and used in manufacturing processes, machines, or fuel production (e.g., rubber)

The same principle applies as for question 8: BBF with general application potential are preferred over those with limited potential.

QUESTION 10 - Is an influence on soil quality to be expected from using the BBF? (be as specific and complete as possible)

Aspects that need to be considered when assessing the influence of the BBF on soil quality are for example:

- *contribution to the storage of organic material in the soil*
- *influence on soil texture and structure*
- *influence on water holding capacity*
- *influence on the water infiltration pace*

QUESTION 11 - Indicate all soil types suitable for the BBF (multiple answers possible):

- peaty
- sandy
- clay
- loamy
- chalky
- silty
- other

The answer to this question is strongly correlated with the answer to the previous question. The effect on soil quality and the nature of the interaction (biological, physical or chemical) will determine largely which soil types are suitable for treatment with the BBF.

QUESTION 12 - Is it a 'slow release' fertilizer?

- no
- yes
- no idea

A 'slow release' fertilizer, also known as 'controlled release' fertilizer is a type of fertilizer that is designed to gradually release nutrients to plants over an extended period. Unlike conventional fertilizers that quickly dissolve and release their nutrients, slow-release fertilizers may provide a steady supply of nutrients over several weeks or even months. One of the potential advantages is that slow-release fertilizers require less replenishment and thus less deliveries, which may reduce the farmer's time occupation and may even lead to a higher social acceptance.

Farm-Economic Effects

The farm-economic effects of a BBF are mostly indirect, since the BBF affects the nutrient availability of the soil early in the value chain, which in turn affects the crop yield/quality/... and eventually the farmer's income at the end of the value chain.

QUESTION 1 - N-P-K composition of the BBF (when known):

The letters "NPK" stand for nitrogen, phosphorus, and potassium, the three primary nutrients plants need to grow. The numbers in the 'N-P-K' composition indicate the ratio (by percentage) of nitrogen, phosphorus, and potassium in the fertilizer. The sum of the 'N', 'P' and 'K' values indicates the total percentage of nutrients. The remaining percentage represents minor nutrients, fillers...

QUESTION 2 - C:N ratio of the BBF (when known):

The carbon-to-nitrogen ratio means the amount of carbon relative to the amount of nitrogen present in the BBF. It is written as C:N and is usually a single number. The lower the C:N ratio, the more rapidly nitrogen will be mineralised (= released into the soil for immediate crop use). A C:N ratio > 35 results in microbial immobilization, whereas a ratio of 20-30 results in an equilibrium state between mineralization and immobilization.

QUESTION 3 - Expected availability of nitrogen (N) in the BBF (compared to the regional standard mentioned above):

- lower
- similar
- higher
- no idea

QUESTION 4 - Expected availability of phosphorus (P) in the BBF (compared to the regional standard mentioned above):

- lower
- similar
- higher
- no idea

QUESTION 5 - Expected availability of potassium (K) in the BBF (compared to the regional standard mentioned above):

- lower
- similar
- higher
- no idea

QUESTION 6 - Expected effect on crop yield (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question illustrates the importance of benchmarking, as explained earlier. The value of the BBF is only worth expressing in comparison to a known, well-documented fertilizer type which acts as the regional standard. The effect on crop yield is not a stand-alone one: a BBF may cause a decrease in yield, but still be of interest when it is cheap and abundantly available, for example. And vice versa.

QUESTION 7 - Expected effect on crop yield variation (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question is not about the crop yield, but the variation within the yields of different harvests over a certain period.

QUESTION 8 - Expected effect on crop quality (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

QUESTION 9 - Expected effect on crop quality variation (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question is not about the crop quality, but the variation within the quality of different harvests over a certain period.

QUESTION 10 - Which costs may increase upon using the BBF? (multiple answers possible)

- unskilled labour
- skilled labour
- equipment
- mineral or other types of fertilizers
- herbicides
- pesticides
- fuel
- transportation
- storage
- land
- energy
- other
- none
- no idea

Skilled labour is a segment of the workforce that has specialized know-how, training, and experience to carry out more complex physical, or mental tasks than routine job functions. Skilled labour is generally characterized by higher or specialized education, as well as expertise levels attained through training and experience, and likewise generally corresponds with higher wages. This can be contrasted with unskilled labour, which refers to individuals with a limited range of skills to use in the workplace.

Equipment will be machinery in most cases, but a laptop or drone are also considered as equipment.

The use of a BBF may raise the need for other types of fertilizer to complement the BBF with, in order to maintain a good balance of all nutrients.

Fuel costs are mostly linked to the application of the BBF on the field, whereas transportation costs are linked to the transport of the BBF to the farm, in case the BBF is not a byproduct of the on-farm activities.

Costs for land may be impacted in order to maintain yields, in case these are changed due to the BBF.

Energy costs do not include fuel costs, but they do include electricity and gas.

QUESTION 11 - Which costs may decrease upon using the BBF? (multiple answers possible)

- unskilled labour
- skilled labour
- equipment
- mineral or other types of fertilizers
- herbicides
- pesticides
- fuel
- transportation
- storage
- land
- energy
- other
- none
- no idea

QUESTION 12 - Expected long-term/indirect benefits of using the BBF:

Some positive effects of a BBF may not be visible within the first year of application. This kind of long-term or indirect (economic) effects can roughly be classified in the following categories. Please be complete and specific.

- *reduced water use*
- *improved water quality*
- *more biodiversity*
- *lower labour intensivity*
- *reduced need for on-farm presence*
- *improvement of human skills*
- *other*

QUESTION 13 - Is the use as fertilizer the most valuable application of the material at hand?

In case the answer is 'no', please elaborate: which applications seem more valuable? This includes possible applications besides agriculture.

QUESTION 14 - Does the use of the BBF qualify for subsidies?

In case the answer is 'yes', please elaborate: which kind, origin, conditions...?

Regulatory Aspects

For innovative BBFs, it remains sometimes unclear whether it is considered as waste, animal by-product... The following questions are intended to position the BBF within the existing legislative frameworks.

QUESTION 1 - Status of the legal framework that regulates the use of the BBF:

- there is hardly any
- existing, however with gaps
- well-developed
- no idea

Animal manure, for example, is a BBF for which the use is extensively regulated. As a by-product or derived product not intended for human consumption, it is subjected to the European Regulation (EC) No 1069/2009 and regional legislation.

QUESTION 2 - Are there any policy barriers complicating the use of the BBF? Please be specific. For example, if the government in a certain region fails to activate the low-educated unemployed, then a practice which requires unskilled labour might not be a success in that specific region.

QUESTION 3 - Does the BBF contain any hazardous substances, and if this is the case, which one(s)?

Hazardous substances are substances that are categorized as 'hazardous' under the REACH legislation: the Regulation for Registration, Evaluation, Authorisation and Restriction of Chemicals. If the BBF may contain such substances, e.g. when it is derived from a production process involving hazardous chemicals, as a by-product or waste product hereof, please mention these substances and the nature of their hazard, if this information is available. (hazard class table can be found on <https://www.echa.europa.eu/support/mixture-classification/hazard-class-table>). Examples of hazardous qualities are 'explosive', 'flammable', 'irritating'...

QUESTION 4 - Is the use of the BBF compliant with EU organic farming practices?

Since 1 January 2022, Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 is the applicable legislative act, also known as the basic act, laying down the rules on organic production and labelling of organic products, repealing and replacing Council Regulation (EC) No 834/2007 of 28 June 2007. More information is available on https://agriculture.ec.europa.eu/farming/organic-farming/legislation_en

QUESTION 5 - Is the use of the BBF supported by Eco-schemes?

To be supported by eco-schemes (https://agriculture.ec.europa.eu/common-agricultural-policy/income-support/eco-schemes_en), agricultural practices should:

- *cover activities related to climate, environment, animal welfare and antimicrobial resistance.*
- *be defined based on the needs and priorities identified at national/regional levels in their CAP Strategic Plans;*
- *their level of ambition must go beyond the requirements and obligations set by conditionality;*
- *contribute to reaching the EU Green Deal targets.*

Environmental Aspects

QUESTION 1 - What is the expected effect on the leaching of the following nutrients: nitrogen, phosphate, and potassium? Please specify for each nutrient: increase, decrease or none.
In agriculture, leaching is the loss of water-soluble plant nutrients from the soil. Fertilizers (especially the excessive use thereof) may influence this process.

QUESTION 2 - Are there any gaseous emissions to be taken into account upon using the BBF? (multiple answers possible)

- no
- yes: nitrous oxide
- yes: ammonia
- yes: other than nitrous oxide or ammonia
- no idea

QUESTION 3 - Greenhouse gas (GHG) reduction potential of the BBF:

- negative: GHG emissions may increase upon using the BBF
- little or none
- substantial
- no idea

The emission of greenhouse gases such as carbon dioxide and methane may be influenced by the application of the BBF. A substantial reduction of GHG is achieved when emissions are reduced by more than 1 metric ton of CO₂ equivalents per year. The use of CO₂ equivalents corrects for the different global warming potential of different gases. For example, the release of 1 kilogram of methane into the atmosphere is about equivalent to releasing 84 kg of CO₂. More info can be found on <https://climatechangeconnection.org/emissions/co2-equivalents/>.

QUESTION 4 - Indicate all materials present in the BBF (multiple answers possible):

- digestate = *the material remaining after the anaerobic digestion of a biodegradable feedstock (food waste...)*
- animal manure
- industrial waste = *materials originating from industrial companies, harbours...*
- agricultural residues
- municipal sludge
- meat/bone meal
- micro-organisms
- insect frass = *a mixture of excrements derived from farmed insects, the feeding substrate, parts of farmed insects, dead eggs and with a content of dead farmed insects of not more than 5% in volume and not more than 3% in weight (<https://ipiff.org/wp-content/uploads/2021/11/Nov-29-2021-IPIFF-fact-sheet-on-insect-frass-final.pdf>)*
- compost
- biochar = *defined by the International Biochar Initiative as the "solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment"*
- plant extracts
- algae
- no idea

Social acceptance

QUESTION 1 - Indicate all features of the BBF which may hinder its social acceptance:
(multiple answers possible)

- noise
- odor
- dust
- light
- change of the landscape
- logistics (i.e. traffic of big trucks loading the farms)
- not applicable
- no idea

QUESTION 2 - Which effect is expected on the time occupation of the farmer upon using the BBF?

- none
- time-saving
- moderate increase
- substantial increase
- no idea

A practice is considered timesaving if it is less time-consuming for the farmer. The time saved can be used in other professional activities or leisure activities.

QUESTION 3 - May the use of the BBF contribute to a better public image of agriculture?
(if so, please elaborate)

1.2.3 Precision Farming (PF)

On-Farm Applicability

QUESTION 1 - Are there any logistic aspects to consider? (please be specific)

Logistic aspects such as storage, loading and unloading, carrier type, conditioning, packaging... Every relevant aspect needs to be mentioned.

QUESTION 2 - Does the precision farming GP or RI include/involve the implementation of other tools (at the farm) and, if so, is the connection with other tools good or bad?

This question refers to the level of interoperability and convenience, e.g., a drone may interact with an automated tractor, and this is more efficient if both can be steered using the same smartphone app.

QUESTION 3 - Are there any additional requirements for application?

For example, a strong Wi-Fi network may be indispensable.

QUESTION 4 - Skill/education level required for safe and effective application of the practice:

- very low
- rather low
- rather high
- expert level

A certain skill level may be acquired by experience and/or education. 'Very low' means that safety and effectiveness can hardly be jeopardized. 'Expert level' needs to be chosen when only highly trained/experienced people know how to apply the practice in a safe and effective manner.

QUESTION 5 - Can the practice be applied to a multitude of cultivation techniques, or is the use limited to one or a few techniques? If the latter is true, please specify which techniques are targeted:

Examples of cultivation techniques are vertical farming, agroforestry, hydroponics, biodynamic farming... In the selection process of 48 BPs, practices with general application potential are preferred over those with limited potential.

QUESTION 6 - Targeted crop categories (multiple answers possible):

- food: fruits, vegetables, grains, and tubers (e.g., potatoes)
- feed: alfalfa, hay...
- fiber: cotton, flax, hemp...
- oil: corn, sunflower, olive...
- ornamental: plants and trees used for landscaping or for gardening
- industrial: crops that are not consumed, but rather harvested and used in manufacturing processes, machines, or fuel production (e.g., rubber)

The same principle applies as for question 5: practices with general application potential are preferred over those with limited potential.

QUESTION 7 - Is an influence on soil quality to be expected from the practice?

(be as specific and complete as possible)

Aspects that need to be considered when assessing the influence of the practice on soil quality are for example:

- *influence on soil texture and structure*
- *influence on water holding capacity*
- *influence on the water infiltration pace*

QUESTION 8 - Indicate all soil types suitable for the practice (multiple answers possible):

- peaty
- sandy
- clay
- loamy
- chalky
- silty
- other

The answer to this question is strongly correlated with the answer to the previous question. The effect on soil quality will determine largely which soil types are suitable for the practice.

Farm-Economic Effects

The farm-economic effects of a precision farming technique may be very clear and distinguishable, for example when it results in a decreased labour cost, but also indirect financial effects may be established, for example when a scanning technique indicates disease affected crops.

QUESTION 1 - Expected effect on crop yield (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question illustrates the importance of benchmarking, as explained earlier. The value of the BBF is only worth expressing in comparison to a known, well-documented fertilizer type which acts as the regional standard. The effect on crop yield is not a stand-alone one: a BBF may cause a decrease in yield, but still be of interest when it is cheap and abundantly available, for example. And vice versa.

QUESTION 2 - Expected effect on crop yield variation (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question is not about the crop yield, but the variation within the yields of different harvests over a certain period.

QUESTION 3 - Expected effect on crop quality (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

QUESTION 4 - Expected effect on crop quality variation (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question is not about the crop quality, but the variation within the quality of different harvests over a certain period.

QUESTION 5 - Which costs may increase due to the practice? (multiple answers possible)

- unskilled labour
- skilled labour
- equipment
- fertilizers
- herbicides
- pesticides
- fuel
- transportation
- storage
- land
- energy
- internet / data subscription costs
- none
- no idea

Skilled labour is a segment of the workforce that has specialized know-how, training, and experience to carry out more complex physical, or mental tasks than routine job functions. Skilled labour is generally characterized by higher or specialized education, as well as expertise levels attained through training and experience, and likewise generally corresponds with higher wages. This can be contrasted with unskilled labour, which refers to individuals with a limited range of skills to use in the workplace.

Equipment will be machinery in most cases, but a laptop or drone are also considered as equipment.

Fuel costs are linked to the direct application of the practice at the farm, whereas transportation costs are linked to the transport of the necessary equipment to the farm.

Energy costs do not include fuel costs, but they do include electricity and gas.

QUESTION 6 - Which costs may decrease due to the practice? (multiple answers possible)

- unskilled labour
- skilled labour
- equipment
- mineral or other types of fertilizers
- herbicides
- pesticides
- fuel
- transportation
- storage
- land
- energy
- internet / data subscription costs
- none
- no idea

QUESTION 7 - Expected long-term/indirect benefits of the practice:

Some positive effects may not be visible within the first year of application. This kind of long-term or indirect (economic) effects can roughly be classified in the following categories. Please be complete and specific.

- reduced water use
- improved water quality
- more biodiversity
- lower labour intensity
- reduced need for on-farm presence
- improvement of human skills
- other

QUESTION 8 - Does the practice qualify for subsidies?

In case the answer is 'yes', please elaborate: which kind, origin, conditions...?

Regulatory Aspects

The following questions are intended to position the practice within the existing legislative frameworks.

QUESTION 1 - Status of the legal framework that regulates the practice:

- there is hardly any
- existing, however with gaps
- well-developed
- no idea

QUESTION 2 - Are there any policy barriers complicating the practice's application? Please be specific.

For example, a decline in agricultural training options at school may lead to a shortage of skilled workers, which are needed to operate complicated tools or machinery.

QUESTION 3 - Does the practice involve the use of hazardous substances, and if this is the case, which one(s)?

Hazardous substances are substances that are categorized as 'hazardous' under the REACH legislation: the Regulation for Registration, Evaluation, Authorisation and Restriction of Chemicals. A hazard class table can be found on <https://www.echa.europa.eu/support/mixture-classification/hazard-class-table>). Examples of hazardous qualities are 'explosive', 'flammable', 'irritating'...

QUESTION 4 - Is the practice supported by Eco-schemes?

To be supported by eco-schemes (https://agriculture.ec.europa.eu/common-agricultural-policy/income-support/eco-schemes_en), agricultural practices should:

- *cover activities related to climate, environment, animal welfare and antimicrobial resistance.*
- *be defined based on the needs and priorities identified at national/regional levels in their CAP Strategic Plans;*
- *their level of ambition must go beyond the requirements and obligations set by conditionality;*
- *contribute to reaching the EU Green Deal targets.*

Environmental Aspects

QUESTION 1 - What is the expected effect on the leaching of the following nutrients: nitrogen, phosphate, and potassium? Please specify for each nutrient: increase, decrease or none.
In agriculture, leaching is the loss of water-soluble plant nutrients from the soil.

QUESTION 2 - Are there any gaseous emissions to be considered upon application of the practice? (multiple answers possible)

- no
- yes: nitrous oxide
- yes: ammonia
- yes: other than nitrous oxide or ammonia
- no idea

QUESTION 3 - Greenhouse gas (GHG) reduction potential of the BBF:

- negative: GHG emissions may increase upon using the BBF
- little or none
- substantial
- no idea

The emission of greenhouse gases such as carbon dioxide and methane may be influenced by the practice: a technique requiring heavy machinery, for example, will increase the CO₂ footprint due to the energy/fuel consumption. A substantial reduction of GHG is achieved when emissions are reduced by more than 1 metric ton of CO₂ equivalents per year. The use of CO₂ equivalents corrects for the different global warming potential of different gases. For example, the release of 1 kilogram of methane into the atmosphere is about equivalent to releasing 84 kg of CO₂. More info can be found on <https://climatechangeconnection.org/emissions/co2-equivalents/>.

QUESTION 4 - Does the practice involve the application of one or more of the following materials? (multiple answers possible):

- digestate = *the material remaining after the anaerobic digestion of a biodegradable feedstock (food waste...)*
- animal manure
- industrial waste = *materials originating from industrial companies, harbours...*
- agricultural residues
- municipal sludge
- meat/bone meal
- micro-organisms
- insect frass = *a mixture of excrements derived from farmed insects, the feeding substrate, parts of farmed insects, dead eggs and with a content of dead farmed insects of not more than 5% in volume and not more than 3% in weight (<https://ipiff.org/wp-content/uploads/2021/11/Nov-29-2021-IPIFF-fact-sheet-on-insect-frass-final.pdf>)*
- compost
- biochar = *defined by the International Biochar Initiative as the "solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment"*
- algae
- plant extracts
- no idea

Social Acceptance

QUESTION 1 - Indicate all features of the practice which may hinder its social acceptance:
(multiple answers possible)

- noise
- odor
- dust
- light
- change of the landscape
- concerns about data breaches: *recordings from drone flights etc.*
- not applicable
- no idea

QUESTION 2 - Which effect from the practice is expected on the time occupation of the farmer?

- none
- time-saving
- moderate increase
- substantial increase
- no idea

A practice is considered timesaving if it is less time-consuming for the farmer. The time saved can be used in other professional activities or leisure activities.

QUESTION 3 - May the practice contribute to a better public image of agriculture?
(if so, please elaborate)

QUESTION 4 - May the practice improve the farmer's self-image (being proud, e.g.)?

1.2.4 Soil Quality (SQ)

On-Farm Applicability

QUESTION 1 - Are there any logistic aspects to consider? (please be specific)

Logistic aspects such as storage, loading and unloading, carrier type, conditioning, packaging... Every relevant aspect needs to be mentioned.

QUESTION 2 - Skill/education level required for safe and effective application of the practice:

- very low
- rather low
- rather high
- expert level

A certain skill level may be acquired by experience and/or education. 'Very low' means that safety and effectiveness can hardly be jeopardized. 'Expert level' needs to be chosen when only highly trained/experienced people know how to apply the practice in a safe and effective manner.

QUESTION 3 - Can the practice be applied to a multitude of cultivation techniques, or is the use limited to one or a few techniques? If the latter is true, please specify which techniques are targeted:

Examples of cultivation techniques are vertical farming, agroforestry, hydroponics, biodynamic farming... In the selection process of 48 BPs, practices with general application potential are preferred over those with limited potential.

QUESTION 4 - Targeted crop categories (multiple answers possible):

- food: fruits, vegetables, grains, and tubers (e.g., potatoes)
- feed: alfalfa, hay...
- fiber: cotton, flax, hemp...
- oil: corn, sunflower, olive...
- ornamental: plants and trees used for landscaping or for gardening
- industrial: crops that are not consumed, but rather harvested and used in manufacturing processes, machines, or fuel production (e.g., rubber)

The same principle applies as for question 3: practices with general application potential are preferred over those with limited potential.

QUESTION 5 - Indicate all soil types suitable for the practice (multiple answers possible):

- peaty
- sandy
- clay
- loamy
- chalky
- silty
- other

Farm-Economic Effects

QUESTION 1 - Expected effect on crop yield (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question illustrates the importance of benchmarking, as explained earlier. The practice's value is only worth expressing compared to a known, well-documented practice which acts as the regional standard.

QUESTION 2 - Expected effect on crop yield variation (compared to the regional standard mentioned above):

- decrease
- similar
- increase
- no idea

This question is not about the crop yield, but the variation within the yields of different harvests over a certain period.

QUESTION 3 - Expected effect on crop quality (compared to the regional standard mentioned above):

- decrease
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QUESTION 4 - Expected effect on crop quality variation (compared to the regional standard mentioned above):

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This question is not about the crop quality, but the variation within the quality of different harvests over a certain period.

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- skilled labour
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- herbicides
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- reduced water use
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- lower labour intensity
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- improvement of human skills
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QUESTION 8 - Does the practice qualify for subsidies?

In case the answer is 'yes', please elaborate: which kind, origin, conditions...?

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QUESTION 1 - Status of the legal framework that regulates the practice:

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- well-developed
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QUESTION 2 - Are there any policy barriers complicating the practice's application? Please be specific.

For example, a decline in agricultural training options at school may lead to a shortage of skilled workers, which are needed to operate complicated tools or machinery.

QUESTION 3 - Does the practice involve the use of hazardous substances, and if this is the case, which one(s)?

Hazardous substances are substances that are categorized as 'hazardous' under the REACH legislation: the Regulation for Registration, Evaluation, Authorisation and Restriction of Chemicals. A hazard class table can be found on <https://www.echa.europa.eu/support/mixture-classification/hazard-class-table>). Examples of hazardous qualities are 'explosive', 'flammable', 'irritating'...

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To be supported by eco-schemes (https://agriculture.ec.europa.eu/common-agricultural-policy/income-support/eco-schemes_en), agricultural practices should:

- *cover activities related to climate, environment, animal welfare and antimicrobial resistance.*
- *be defined based on the needs and priorities identified at national/regional levels in their CAP Strategic Plans;*
- *their level of ambition must go beyond the requirements and obligations set by conditionality;*
- *contribute to reaching the EU Green Deal targets.*

Environmental Aspects

QUESTION 1 - What is the expected effect on the leaching of the following nutrients: nitrogen, phosphate, and potassium? Please specify for each nutrient: increase, decrease or none.
In agriculture, leaching is the loss of water-soluble plant nutrients from the soil.

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The emission of greenhouse gases such as carbon dioxide and methane may be influenced by the practice: a technique requiring heavy machinery, for example, will increase the CO₂ footprint due to the energy/fuel consumption. A substantial reduction of GHG is achieved when emissions are reduced by more than 1 metric ton of CO₂ equivalents per year. The use of CO₂ equivalents corrects for the different global warming potential of different gases. For example, the release of 1 kilogram of methane into the atmosphere is about equivalent to releasing 84 kg of CO₂. More info can be found on <https://climatechangeconnection.org/emissions/co2-equivalents/>.

QUESTION 4 - Does the practice involve the application of one or more of the following materials? (multiple answers possible):

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- industrial waste = *materials originating from industrial companies, harbours...*
- agricultural residues
- municipal sludge
- meat/bone meal
- micro-organisms
- insect frass = *a mixture of excrements derived from farmed insects, the feeding substrate, parts of farmed insects, dead eggs and with a content of dead farmed insects of not more than 5% in volume and not more than 3% in weight (<https://ipiff.org/wp-content/uploads/2021/11/Nov-29-2021-IPIFF-fact-sheet-on-insect-frass-final.pdf>)*
- compost
- biochar = *defined by the International Biochar Initiative as the "solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment"*
- algae
- plant extracts

Social Acceptance

QUESTION 1 - Indicate all features of the practice which may hinder its social acceptance:
(multiple answers possible)

- noise
- odor
- dust
- light
- change of the landscape
- not applicable
- no idea

QUESTION 2 - Which effect from the practice is expected on the time occupation of the farmer?

- none
- time-saving
- moderate increase
- substantial increase
- no idea

A practice is considered timesaving if it is less time-consuming for the farmer. The time saved can be used in other professional activities or leisure activities.

QUESTION 3 - May the practice contribute to a better public image of agriculture?
(if so, please elaborate)

QUESTION 4 - May the practice improve the farmer's self-image (being proud, e.g.)?

PART B: Data Collection for the detailed analysis

The STRATUS project aims to identify at least 48 Best Practices in fertilizer use in different regions of the European Union. The **Best Practices Protocol** has been established to conduct the evaluation of measures in various countries in a consistent manner. To evaluate the economic effects of measures, it is important to consider whether each measure affects crop, field, or crop rotation. The protocol describes the method used to collect these data. The questions formulated in the Protocol are tightened where necessary if it appears that the question does not provide comparable data in the scope of the study.

1.3 Methodology

Data collection by completing the questionnaire is carried out systematically. The basis for this is the prepared questionnaire for the data collection of the Best Practices measures. The questionnaire is completed with the involved project partners through the following steps.

1.3.1 Preparation

The involved project partner, who has the knowledge of the measures and conditions, is approached to complete the questionnaire in a joint consultation. Before the consultation, the partner receives the necessary information to prepare. This preparation consists of in going through the questions and collecting the economic and other relevant data.

1.3.2 Filling in the questionnaire

The questionnaire is completed during the consultation with the project partner. This is done by jointly going through the questionnaire. For each question, the project partner is asked to provide the required data with source references. Preferably, as much data as possible from primary sources is used, such as market data, research results, and economic statistics. Where data is lacking, expert estimates are requested. It can be helpful to consider what changes or differences are expected compared to the reference, and to make an estimation based on that.

1.3.3 Completion

The completed questionnaire is shared with the project partner afterwards. If any data is lacking during the consultation, they are still collected and provided afterwards by the partner. Once any missing data or corrections have been supplied, the final completed version of the questionnaire is recorded.

1.4 Protocol

1.4.1 General

QUESTION 1 - Title/Name of the practice
Provide the name of the measure here.

QUESTION 2 - Country and region
Indicate in which country or region this measure is suitable and applicable.

QUESTION 3 - Contact information
Provide the name, email address, and phone number of the contact person here.

1.4.2 Applicability

The applicability of a measure is first determined. Using questions about the scale on which the measure has an effect and to which the measure can be compared, the applicability of the measure is delineated.

Relevant definitions

- Best Practice measure: the measure that is examined
- Scale: since measures can be taken at different levels, it is asked at which level the measure is taken. This can be at the farm level, crop rotation, crop level, or plot level.

QUESTION 1 - What is a common Reference measure to which the Best Practice measure can be compared?
Setting a commonly used measure as a reference allows the best practice measures to be compared, which provides more insight into advantages and disadvantages of the measure in various aspects.

QUESTION 2 - Besides the Reference measure, are there alternative measures to compare the Best Practice measure, such as good practices, research innovations, best practices, or other measures being examined within this project?
There may be other measures besides the Reference measure to compare with the Best Practice measure. These can include good practices, research innovations, and best practices from the project, as well as other measures that would be suitable in a comparable context.

QUESTION 3 - Is there specific knowledge required to take this measure that involves additional costs?
Additional knowledge required to take a measure can be associated with, for example, training costs.

QUESTION 4 - Is this measure taken on:

- Farm level: measures affecting the entire operation of the farm.
- Crop rotation: measures related to the sequence and diversity of crops.
- Crop level: specific measures for a particular crop.
- Plot level: measures applied to a specific field or plot.

The level at which the measure is taken provides insight into the delineation. This helps to avoid comparing a measure at one level with a measure at another level.

QUESTION 5 - Is the Reference measure taken on:

- Farm level: measures affecting the entire operation of the farm.
- Crop rotation: measures related to the sequence and diversity of crops.
- Crop level: specific measures for a particular crop.
- Plot level: measures applied to a specific field or plot.

Similar to question 4. The level at which the measure is taken provides insight into the delineation. This helps to avoid comparing a measure at one level with a measure at another level.

QUESTION 6 - Is an adjustment needed in mechanization, buildings, or land?

An adjustment in mechanization, buildings, or land affects the profitability.

1.4.3 Gross margin

For each crop affected by the measure, the questions should be answered separately to allow for the analysis of multiple crops. Each question is twofold: it asks for the value of the Best Practice measure and the Reference measure, expressed in euros per unit (hectare/farm). Additionally, comments can be added per question. Preferably, prices for each question are averaged over four years to minimize the influence of price fluctuations and to obtain a representative picture of costs and revenues. It is possible to deviate from this if specific circumstances require a different approach.

Relevant definitions

- Gross margin: the gross margin is calculated by deducting the allocated costs from the gross revenue of a crop, as explained in Schoorlemmer & Krikke (1997).
- Gross revenue: consists of the sum of the main product, by-product, subsidies, and other yields allocated to the crop.
- Allocated costs: include seeds and plant material, fertilizers, plant protection products, energy (fuel/electricity), delivery, other product-related costs, contract work, and labour. The gross margin makes it possible to compare the financial performance of different crops or activities. Costs for a specific crop should be allocated to a specific crop rather than unallocated costs whenever possible.
- Interest on circulating capital:
 - o Custody interest: interest on custody costs, retained product, and deferred payment after the product is sold.
 - o Cultivation interest: Cultivation interest includes interest on costs up to and including harvest.

QUESTION 1 - Crop name: indicate here the name of the crop to which the following questions apply.

Questions should be completed separately for each crop affected by the measure so that multiple crops can be analysed.

Gross revenue

QUESTION 2 - Main product: the marketable physical yield of the main product in kilograms, tons, or pieces multiplied by the yield price.

QUESTION 3 - By-product: includes the marketable physical yield multiplied by the yield price. *Examples of by-products are straw, beet leaf, or other residual products that have a market value.*

QUESTION 4 - Subsidies and other revenues: list subsidies and other revenues attributable to the crop.

Allocated Costs

QUESTION 5 – Seeds and plant material: this includes the cost of seeds, seedlings, and planting material.

QUESTION 6 – Fertilizers: consists of the cost of the different types of fertilizers and trace elements.

The fertilizers are directly allocated to the crop in which it is applied. A separate gross margin calculation should be made for any green manures.

QUESTION 7 – Plant protection products: this includes the costs of products for controlling diseases, pests and weeds.

QUESTION 8 – Energy: this includes costs of fuel, electricity, gas, and oil; other related expenses including machinery costs; and costs for drying, cooling, and heating batches of product.

When energy costs are not known by crop but only at the farm level, they are included under unallocated costs.

QUESTION 9 – Other raw and auxiliary materials: this includes the cost of other physical materials.

QUESTION 10 – Delivery costs: the costs associated with delivery of products such as cooling, conditioning and storage, auction, pallet and crate rental, auction fees, commission, and transportation to the auction.

QUESTION 11 – Other product-related costs: these include the costs of interest on circulating capital, insurance of the crop and whether or not the product, tare, license fees, collective crop levies, and drying and cleaning by third parties.

QUESTION 12 – Contract work and loose labour: cost of contract work and loose labour hired for a specific crop.

1.4.4 Labour Budget

For each crop or activity affected by the measure, the questions surrounding the labour budget should be completed so that multiple crops can be analysed. For each item asked, the value for both the Best Practice and the Reference is entered, expressed in euros per unit (hectare/farm). In addition, comments can be added per question.

Relevant definitions

For delineation purposes, the relevant definitions are explained here. The definitions of labour demand and labour budget are delineated in KWIN (van der Voort, 2022) and Business budgeting in arable and outdoor vegetable production (Schoorlemmer & Krikke, 1997)

- Labour requirement: represents the labour required for operations, as explained in (KWIN, 2022). These operations are usually attributable to a specific crop. When they are not attributable to a specific crop, they are "general work." The labour requirements include tillage, fertilizing, seeding/potting/planting, watering, crop protection, hand weeding, other crop care, harvesting, and processing.
- Labour budget:
 - o Crop-specific operations: Crop-related operations are operations that can be specifically linked to a crop. The aspects that influence the size of the crop-specific operations are the method of implementation (e.g. type of mechanization); the task time of the operation in hours per hectare (processing time x number of people); the proportion of permanent and casual labour (permanent labour and labour hired from outside the farm: costs extra time indicated via a percentage of permanent labour); timing of operations.
 - o General work: General work is the labour that cannot be linked to a crop. General work can be divided into time-related work and non-time-related work.
 - Time-related work: crop control and product control (preservation); administration; ditch cleaning; making operational decisions; placing orders and arranging sales; preparing labour schedules; minor maintenance on machinery.
 - Non-time-related work: repairing ditches; maintaining plot paths; maintaining yard; maintaining machinery; training.

Crop-Related Activities

As under Gross margin, crop-related activities are entered by crop. Crop-related activities are the activities that can be linked to a crop. Operations are expressed in hours per hectare. For each crop, the labour involved in the operations is included in the following aspects: method of implementation (e.g. type of mechanization); the task time of the operation in hours per hectare (throughput time of operation x number of people); the proportion of permanent and casual labour (permanent labour and labour hired from outside the farm: costs extra time indicated via a percentage of permanent labour); timing of operations.

QUESTION 1 - Crop name: indicate here the name of the crop to which the following questions apply.

Questions should be completed separately for each crop affected by the measure so that multiple crops can be analysed

QUESTION 2 - Tillage: labour required to prepare the seedbed, such as plowing, digging, tilling, harrowing, cultivating, and digging.

QUESTION 3 - Fertilizing: work of applying fertilizers to the crop.

QUESTION 4 - Seeding/planting: work required to seed or plant the crop.

QUESTION 5 - Irrigation: labour required to irrigate the crop.

QUESTION 6 - Crop protection: labour required to apply plant protection products to control pests and diseases.

QUESTION 7 - Hand weeding: required labour performed manually for weed control.

QUESTION 8 - Other crop care: diverse work, around crop care and mechanical weed control.

QUESTION 9 - Harvesting: activities associated with harvesting the crop.

QUESTION 10 - Processing: labour required to sort or wash products, for example.

General Work

General work is included normatively and is composed of an amount of fixed hours per farm and allowance per hectare.

QUESTION 11 - General work: labour required for both time-related work and non-time-related work.

Base hours per farm and allowance per hectare (a large farm has a lower allowance than a smaller farm).

1.4.5 Unallocated Costs

Unallocated costs, unlike allocated costs, are not directly related to the final product and do not vary proportionately with production volume. Unallocated costs include the cost of land, mechanization, buildings, labour and other non-allocated expenses.

Relevant definitions

To delineate the questions, the definitions of aspects covered by unallocated costs are described here. The description of the definitions is limited to the information relevant to data collection.

- Land: an immovable means of production that, for arable farming, serves as the location of the holding and as a means of production for growing crops. The calculation of land costs is based on the continuity assumption that the farm is transferred and not terminated. Only when the farm is terminated can the increase in the value of the land be corrected with the interest on the land. From the continuity point of view, the increase in value is not counted, and the land interest is calculated on the replacement value of the land, which is approximately equal to the rental cost.
- Mechanization: machinery and implements on the farm. In the calculation of costs for mechanization, the costs are depreciated based on the replacement value, taking into account the service life and maintenance of the implements. Furthermore, a constant interest rate is used which does not take into account the decrease in the value of the implement.
- Buildings: For owned buildings, costs consist of depreciation, interest, insurance, and maintenance costs of the particular building for which it is currently used. For leasehold buildings, costs consist of the lease costs plus a normative amount for minor maintenance.
- Labour: Labour included in unallocated costs are the wages of the entrepreneur; wages of the cooperating business successor; wages paid to permanent staff; and other wages paid to casual staff.

QUESTION 1 - Investment name: mechanization (type of machine), building (type of building) or land (number of hectares)

QUESTION 2 - Crop: crop for which the implement was purchased.

QUESTION 2 - Land: lease and/or ownership, leasehold and ownership fees, water board charges, and other land-related charges.

QUESTION 3 - Mechanization: cost for the type of machine/tool.

QUESTION 5 - Buildings: costs for leased and owned buildings.

QUESTION 6 - Labour: annual working hours of the entrepreneur; cooperating successor; permanent staff; loose staff. Rates of entrepreneur; successor; permanent and loose personnel.

QUESTION 7 - Other: fuel costs in euros per hectare; unallocated fertilizer costs; weed control; operating costs such as lighting, car, administration, subscriptions, insurance not belonging to mechanization, buildings, or land.

1.4.6 Risks and Other Effects

This section analyses the risks and other effects of the measure. The questions range from risks of measures to effects the measure may have on crop diversity, circularity, climate mitigation and adaptation, water quality, soil quality, biodiversity, plant health, and the socioeconomic impact on the farmer. The data in this chapter are more qualitative than in the previous chapters. Although qualitative, the data are still systematically retrieved. The risks that a farmer experiences when taking a measure are categorised according to Coping with agricultural risk (Hardaker, Lien, Anderson, & Huirn, 2015). The KPIs are derived from the KPI-K memorandum (Van Doorn et al., 2021) which argues that the KPI system allows for measurable farm performance for various goals (such as improving circularity or restoring biodiversity).

Relevant Definitions

- Risk: any possible current or future event that could have a negative effect (Bachev, 2013). According to Hardaker, Lien, Anderson, & Huirn (2015) the following risks can be distinguished in agriculture:
 - o Production risks: caused by weather conditions, pests and diseases, and the unpredictability of crop yields.
 - o Price and market risks: variability around pricing and currency exchange rates
 - o Financial risks: unexpected increases in interest rates and possible uncertainties in financing (availability and callability)
 - o Institutional risks: risks associated with legislation and political conditions.
 - o Human or personal risks: risks to entrepreneur and employee, such as health risks.

QUESTION 1 - Does this measure cause a change in crop diversity?
Does the measure provide for more diverse crops in the crop rotation?

QUESTION 2 - Does this measure impact circularity?
Does this measure affect inputs and losses, regional circuits, and the use of residual streams?

QUESTION 3 - How does this measure impact climate change coping and mitigation?
Does this measure affect greenhouse gas emissions, and does it influence adaptation to weather extremes?

QUESTION 4 - How does this measure impact water quality?
Does this measure affect water quality, including the goals outlined in the Water Framework Directive?

QUESTION 5 - How does this measure impact soil quality?
To what extent does this measure affect soil quality, for example by influencing the organic matter balance, soil compaction, crop diversity, or the proportion of dormant crops?

QUESTION 6 - How does this measure impact biodiversity?
Does this measure affect biodiversity, for example by supporting the targets in the Birds Directive and Habitats Directive?

QUESTION 7 - How does this measure impact plant health?
Does this measure influence the robustness and productivity of crops?

QUESTION 8 - Does this measure have an impact on the socioeconomic position of the farmer?
Is there a noticeable change for the farmer in his relationship with society and in his relationship with his buyers?

QUESTION 9 - Does knowledge acquisition affect costs?
The implementation of a measure may require additional training, education, or other sources of knowledge that lead to costs.

QUESTION 10 - What risks are associated with taking this measure?
Risks are not included in the gross margin calculation; therefore, it is important to identify them to determine the applicability of the measure.

QUESTION 11 - To what extent does farmers' perception of risk influence the adoption of measures?
By gaining insight into the trade-offs, the importance of risk in farmers' decision-making can be understood.

QUESTION 12 - What mitigation measures can be taken to prevent or reduce risks associated with taking this action?
Provides insight into the potential of the measure and further measures to be explored that support it.

QUESTION 13 - Are risks reduced compared to the reference measure?
Does taking the measure reduce risks compared to the reference measure?

QUESTION 14 - Are there any other indirect benefits of this measure?
Indicate whether there are any other indirect benefits of this measure. Consider significant effects that were not considered.

QUESTION 15 - Are risks increased compared to the reference measure?
Does taking the measure increase risks compared to the reference measure?

QUESTION 16 - Are there other indirect disadvantages of this measure?
Indicate whether there are any other indirect disadvantages of this measure. Consider significant effects that have been left out of consideration.

1.5 Literature

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