ClimateFarming Cycle Manual
ClimateFarming

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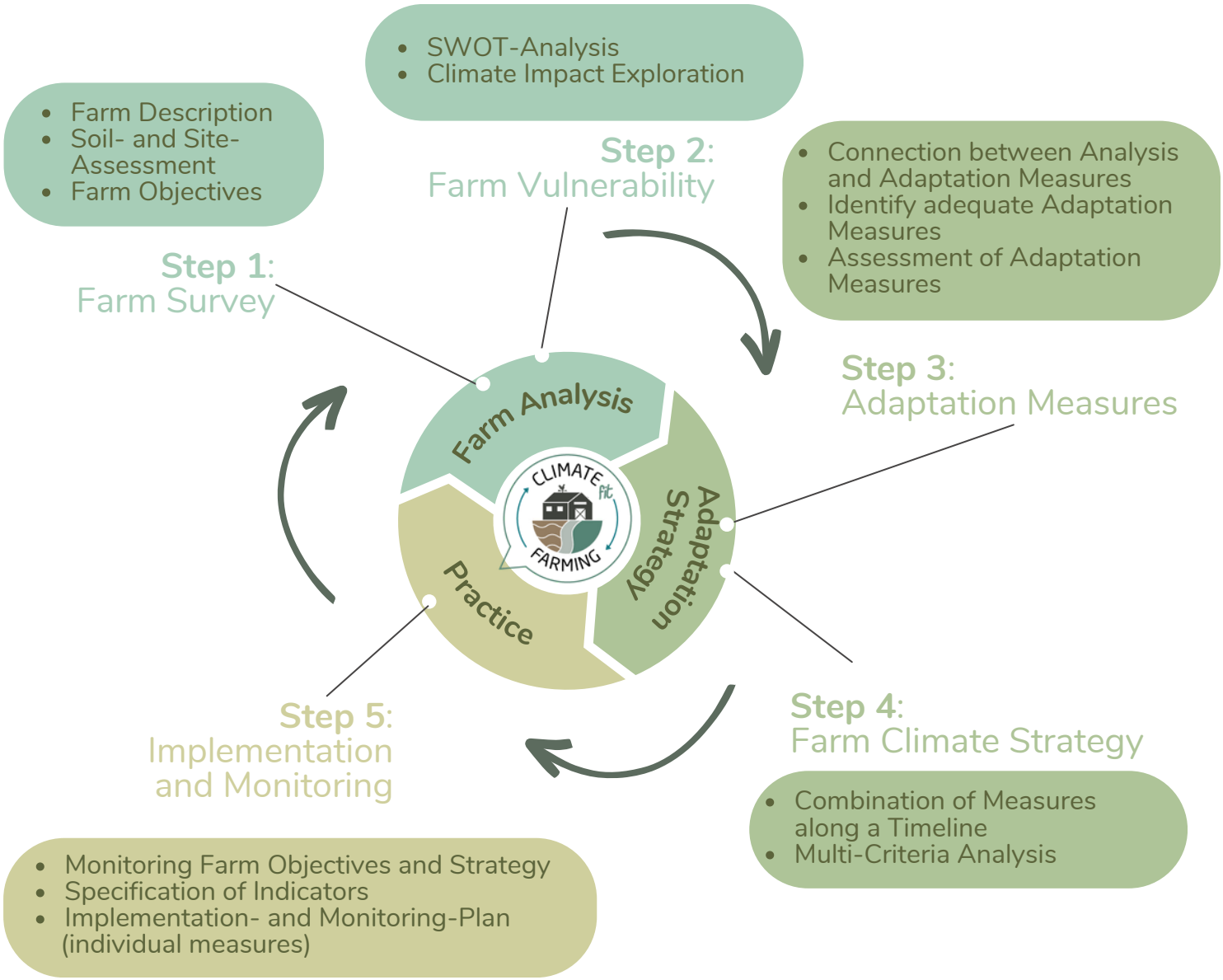
ClimateFarming-Cycle in Practice: Handout for Consultants



*Part of WP2 - A4: Consulting Material

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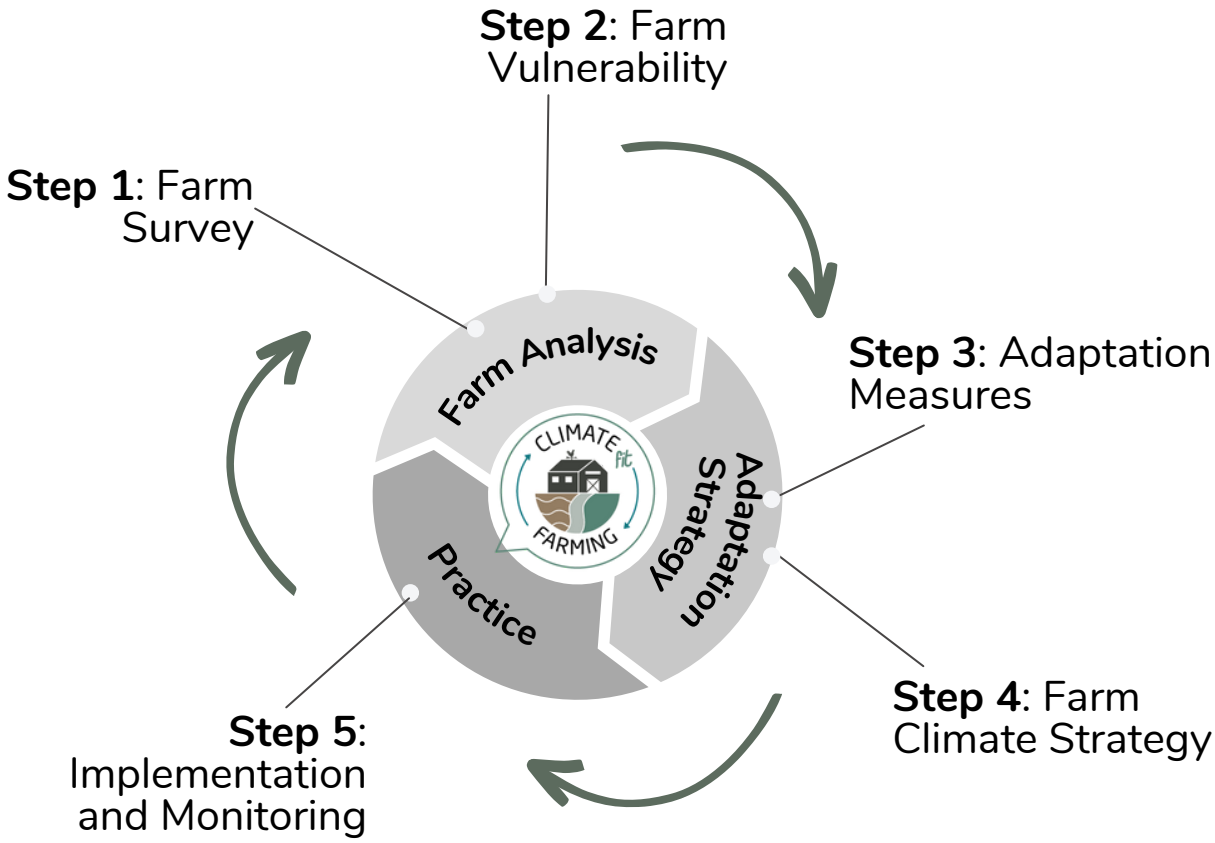
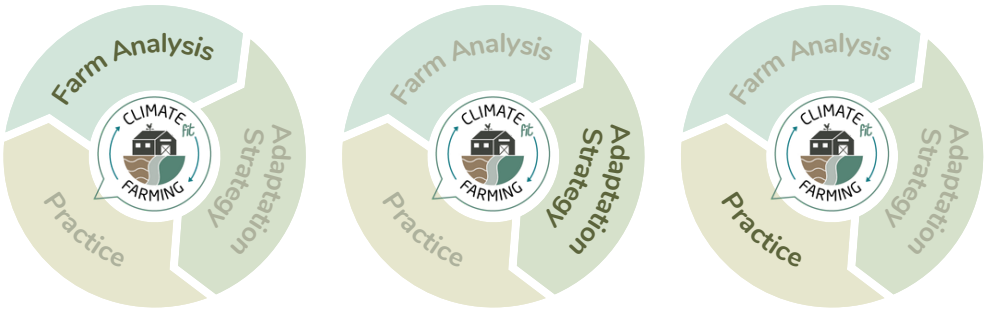




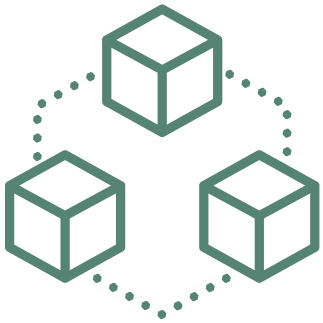
*Part of WP2 - A4: Consulting Material

CLIMATEFARMING-CYCLE HANDOUT: CONTENT

CLIMATEFARMING-CYCLE HANDOUT: INTRODUCTION

Module 2 equips you with a practice-oriented step-by-step guide for the farm-specific application of the ClimateFarming-Cycle.

The individual steps are based on each other, but can also be used in a modular manner. This means that you can choose which steps will be conducted, how they will be conducted and which methods you want to apply with the specific farm. In the course of the ClimateFarming-Cycle, the goal is to develop a farm-specific journal of the whole ClimateFarming process.



This file is the documentation of the ClimateFarming-Cycle application and consists primarily of the filled in templates of this handout, including the results of the individual steps. However, the journal should also be complemented by additional notes, pictures or documents, depending on the specific farm. The journal should also record how the individual steps were conducted. This documentation of the farm's adaptation process is supposed to serve as a foundation for the continuous re-evaluation of the farm climate strategy.

Each step of the ClimateFarming-Cycle Handout includes the following parts:

- a short summary,
- a list with preparations, materials and literature,
- a TO-DO list,
- templates to document results,
- info-sheets with further explanations.

Additionally, you will find these icons throughout the document:

Application notes: Some information to bear in mind when you conduct a task.

Example: What could an implementation of this task look like?

Bonus: These tasks or considerations can be especially helpful when you want to dig deeper encountering specific topics or challenges.

Involve expert: To conclude this task, you may want/need to consult an external expert service.

CLIMATEFARMING-CYCLE HANDOUT: INTRODUCTION

Application Notes

- Regenerative agriculture and adaptation are highly complex topics. Consequently, methods and concepts to deal with them are complex. **In order to use the materials of Module 2 adequately, we advise to first get acquainted with the content of the reading material and take part in a ClimateFarming-Training.**
- **It is important to respect the characteristics of the individual farm and to adjust the methods and scope of the ClimateFarming-Cycle accordingly.** Before application, it is crucial that farmer and ClimateFarming-Consultant discuss expectations and how the process can be designed to fit the farm context.
- The ClimateFarming-Cycle and its steps put high requirements on the ClimateFarming-consultant, as many steps are mainly based on the knowledge and assessment of the involved parties. In doubt, it is always recommended to employ external expert service in order to prevent misinformation or - in the worst case - maladaptive decisions with long-lasting consequences.
- The ClimateFarming-Cycle aims at reducing risk stemming from climate change uncertainty, albeit it can't be eliminated.

The ClimateFarming Framework was developed in Central Europe and thus many ressources and examples may be better suited for this context. The ClimateFarming concept and methods however can be used in a variety of places and contexts. Some additional research may be needed to complement the material.

The ClimateFarming-Consultant is an agricultural advisor who guides the farm members through the ClimateFarming Cycle. The consultant is acquainted with the materials and attended a ClimateFarming Training.

The Farm Members are all involved parties at the farm. This includes the farm manager, all working staff and possibly also familiy members or others that are involved in decision making or may be affected by new decisions.

STEP 1 - FARM SURVEY

Guiding questions: What is the status quo of our farm? What are we already doing concerning climate adaptation? What are our objectives as farmers?

Goals: Extensive farm description; understand the current state of the farm; formulate farm objectives

Preparation	Material and Literature
• Farm members get acquainted with Step 1 • Farm Survey is handed out • Farm members fill in the farm survey If possible: farm member did a first soil-/site-analysis	• Farm Survey + Documentation • Template: Farm Objectives • Info-Sheet: Objectives Literature: • Consultation Material: Introduction + Step 1

Summary:
Step 1 aims at describing the farm in its current state and is the foundation of the ClimateFarming-Cycle. This encompasses information concerning climate, soil, production branches and methods as well as other farm-related information. This information is condensed in the **Farm Survey.** The Farm Survey should be read carefully before conducting Step 1.

Following, farm objectives are formulated. This can encompass various goals, from economic performance to ecological and social aspirations or other farm-related aspects (e.g. working-hours). These objectives can complement or conflict with each other.

In order to find reasonable objectives, the approach is to formulate acceptable (minimum) outcomes for each farm objective. For example, for economic performance, the farm member should not ask "How much money can we maximally earn with the farm" but "**How much money do we need to earn with the farm in order to satisfy our needs?**" More information can be found in the **Info-Sheet: Objectives.**

STEP 1 - FARM SURVEY

To-Do List

- [ ] Optional: First acquaintances between ClimateFarming-Consultant and farm members
- [ ] Introduction to the ClimateFarming-Project, the ClimateFarming-Cycle and the goals of the ClimateFarming-Consulting; alignment with expectations of farm members
- [ ] Explanation of Step 1 and the Farm Survey and its parts, emphasizing its relevance for the ClimateFarming-Cycle
- [ ] The farmer fills in the Farm Survey; filled in Farm Survey is disscused with all farm members
- [ ] Missing parts are discussed and completed together with the ClimateFarming-Consultant
- [ ] If necessary, an additional date for the soil- and site-analysis is scheduled
- [ ] The objective formulation is explained
- [ ] Farm objectives are formulated
- [ ] Document the process and results; clarify open questions; continue with Step 2

Application Notes

An important part of Step 1 is to assess whether adaptation measures are already implemented or planned - intentionally or unintentionally. This provides a basis on which future measures can be based.

BONUS

Optional: If the CO2-footprint of the farm should be tracked, it is crucial to define how the baseline and improvements concerning climate protection will be assessed. One option is to conduct a professional CO2-footprint as provided by some extension services.

TEMPLATE: STEP 1 - FARM OBJECTIVES

Qualitative	Quantitative

TEMPLATE: STEP 1 - DOCUMENTATION

DATE: _____

WHO: _____

What did we do?
How did we do it?
Important discussion points etc.

Open questions, next steps and tasks

INFO-SHEET1: FARM OBJECTIVES

How to formulate Objectives (Consultation Material - Step 1)

- Focus of objective formulation should be on achieving **critical results for multiple objectives** instead of optimal (economic) outcomes
- A combination of guiding qualitative objectives and measurable, quantitative objectives is advisable

Example for objective formulation:

- **Profit-maximizing farmer**: Goal: “I want to earn as much money per year as possible with the farm"
  - This farmer seeks optimal (economic) results. In dairy farming, this farmer would search for the genetics which promise the highest yielding dairy cows. This maximizes profit in good years (no heat stress, good forage qualities), but is highly vulnerable towards unpredictable (climatic) changes, e.g. heat waves.
- **Resilient farmer**: Goal: “I need to generate an average income of 100.000€ per year so my farm can function properly and I'm able to build reserves"
  - This farmer would look for different traits in their dairy cows. Milk yield is important, but tolerance to heat stress or tolerance of low quality forage are likewise vital. The resilient farmer will not receive maximum yields (results) in good years, but is more resilient to variability, unforseen changes and will overall experience lower losses.

Application Notes

It is important that the relevance of objective formulation is well understood by all farm members. Likewise, the relevance of qualitative and quantitative goals should be well established. It must be clear that the farm objectives will have a large influence on which adaptation measures will be considered and finally constitute the farm climate strategy. Furthermore, farm objectives are the main indicator for us to assess whether a farm climate strategy is successful or not.

BONUS

Optional: Other approaches to support objective formulation might be helpful at this point, e.g. SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound).

STEP 2 - FARM VULNERABILITY

Guiding questions: What are strengths and weaknesses of our farm? Which threats and opportunities exist? Which field-specific problems exist? What weather phenomena and extreme events have impacted our farm in the past? How can climate change affect our farming activities?

Goals: Comprehensive analysis of the current state of the farm using SWOT-Analysis; exploring past and possible future climate impacts; prioritize adaptation needs (SWOT aspects and/or climate impacts)

Preparation	Material and Literature
• Step 1 is conducted and all farm members agree wih the farm objectives • Soil- and Site-Analysis is conducted and all farm members understand the results	• Farm Survey • Results Soil and Site Analysis • Template: SWOT-Analysis • Template: Climate Impact Exploration • Consultation Material: Step 2

Summary: Step 2 serves as a farm-specific vulnerability analysis, exploring the potential climate impacts which will affect the farm - positive and negative. This step combines the analysis of current vulnerabilities with the exploration of experienced or potential climate impacts on the farm. The insights developed in Step 2 (together with Step 1) are the basis for compiling farm- and/or field-specific adaptation measures (Step 3).

Application Notes

The term vulnerability has evolved over time and can have, depending on the context, different definitions. In the ClimateFarming Project, “farm vulnerability” describes the predisposition of a farm system to be negatively impacted by changes in climate parameters (precipitation, hot days, etc.).

The assessment of farm vulnerability aims at the identification of climate change induced threats and chances for a specific farm system. Besides the creation of awareness, the goal of the process is to enable the farm members to prioritise certain climate impacts and find corresponding adaptation measures.

To-Do List

SWOT-Analysis

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] Farm members agree on a method how the SWOT-Analysis should be conducted (e.g. open discussion, individual collection, etc.)
- [ ] The points of the SWOT-Analysis will be collected and discussed, if helpful their relative importance can be graded
- [ ] Document the process and results; clarify open questions; continue with the **Climate Impact Exploration**

Application Notes

It's important to acknowledge the temporal dimension of a vulnerability analysis, as vulnerability is developing dynamically with internal and external factors. Consequently, the farm vulnerability analysis is only a snapshot of the current situation and will change with time. As you continuously assess whether adaptation measures are successful, you regularly have to check whether vulnerabilities changed. This includes climatic changes, but also farm internal developments (e.g. staff changes).

INFO-SHEET 2: SWOT-ANALYSIS

SWOT-Analysis

- Step 1: Farm Survey provides the basis for the SWOT-Analysis of the farm
- The starting pointis the examination of the farm and its processes concerning strengths and weaknesses
- Strengths and weaknesses can comprise bio-physical (e.g. soil properties), financial (e.g. high indebtedness) or human resources (e.g. special skills)
- Opportunities and threats are trends and developments happening outside of the farm, e.g. markets, consumer preferences, technology, governance and input prices
- Rule of thumb: Strengths and weaknesses are all factors which can be directly influenced by the farmer, opportunities and threats are beyond the control of the farmer
- The same aspect can be a strength for one farm and a weakness for another farm, e.g. high degree of mechanisation

Example: Excerpt SWOT-Analysis “Sisters Farm“

S Strengths
- High degree of mechanization (low depen-dendence on external service)

O Opportunities
- Many farmers in the area with environmental aspirations: potential for cooperations

W Weaknesses
- Low soil organic carbon content
- Erosion risk

T Threats
- Increasing energy and input prices
- Lack of qualified employees

BONUS

In the case of a complex farming system with different production branches or an excessive high number of identified SWOT aspects, the TOWS-Analysis could be a reasonable addition. A TOWS-Analysis translates the results of the SWOT-Analysis into response strategies. The matrix is comparable to a SWOT matrix but includes four additional blocks which consider the interaction of the different SWOT factors (Strength/Opportunity, Weakness/Opportunity, Strength/Threat, Weakness/Threat). More Information can be found in the ClimateFarming Trainer Handbook.

TEMPLATE: STEP 2 - SWOT ANALYSIS

S
Strengths

W
Weaknesses

O
Opportunities

T
Threats

To-Do List

Climate Impact Exploration

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] Past and recent weather phenomena and extreme events are collected and their impact on the farm analysed
- [ ] Potential future climate impacts are explored and collected
- [ ] The results of the climate impact exploration are set in relation with the SWOT-Analysis results in order to prioritize where adaptation is most necessary
- [ ] Collect the as most important assessed climate impacts (e.g. with the Template: Climate Impact Exploration)
- [ ] If necessary, **external experts** are consulted in order to analyse and interpret the potential climate impacts on production branches
- [ ] Document the process and results; clarify open questions; continue with **Prioritizing Adaptation Needs**

Application Notes

The common, science based procedure to analyse potential impacts of climate change on a system is called Climate Impact Assessment.
This process normally requires a lot of time, resources and expert knowledge concerning climate science and modelling. All three factors are scarce at the farm-level. Still, it is essential to identify core vulnerabilities and prioritize adaptation measures. Consequently, there was the need to adjust and facilitate the climate impact assessment to be useful at the farm-level. The ClimateFarming approach is an explorative approach based on the expert knowledge of the farm members and the ClimateFarming-Consultant.

It is important to acknowledge the limitations of this approach. The results of the climate impact explorations will be influenced by the experiences of the farm members and consequently highly subjective. It is the responsibility of the ClimateFarming-Consultant to guide the exploration in a way that also new or (till now) not experienced climate impacts are considered.

Discussion Questions:

Past Climate Impacts

1. What weather phenomena and extreme climate events have impacted your farm in the past? (e.g. drought periods, heavy precipitation, heat waves)

2. Have you observed any new trends or recent events (e.g. in the last decade)? (e.g. extending spring droughts, more sun hours)

3. What impacts have you observed in the past as a result of these climate events (e.g. loss in yields, increase in disease)?

Application Notes

Past Climate Impacts: The easiest way to conduct and document the climate impact exploration is to use a moderation board where the farm members can first collect and cluster experienced weather phenomena, extreme events as well as recent trends (Question 1 & 2). Following, the farm members can link experienced impacts to the collected weather phenomena, extreme events and recent trends (Question 3).

Example: The farm members add “flooding event 1997” (Question 1) as well as “higher temperatures in spring” (Question 2) to the moderation board. For Question 3, they add experienced impacts. Concerning the “flooding event 1997” these impacts are “damages to the grain storage facility” as well as “heavy erosion”. Concerning the recent trend “higher temperatures in spring”, the farm members add the impacts “earlier sowing” and “partly poor crop development due to limited water availability (higher evapotranspiration)”.

Discussion Questions:

Future Climate Impacts

Temperature: How could it impact your farm when temperatures increase? Is it important whether spring and/or autumn get warmer (important link: late frost days)? Would a mild winter impact my crops?

Hot Days: How could it impact your farm if the number of hot days (>25-30°) and heat waves increase?

Dry periods: How could it impact your farm if dry periods (consecutive days without rain) increase? When are dry periods especially problematic for your farm?

Precipitation: How could a change in precipitation impact your farm? How would a seasonal shift in precipitation affect your farm? Could heavy precipitation events be problematic? Could prolonged wet periods be problematic?

Frost: How could a decrease in frost days (< 0°C) impact your farm? How could a decrease in late frost days impact your farm?

Hail, Wind and Storm: How could a change in hail, wind or storm events impact your farm?

Sun hours: How could an increase in sun hours impact your farm?

Application Notes

Future Climate Impacts: The procedure can be conducted similar to the exploration of past climate impacts. The difference is that you (not the farm members) write down the climate parameters you want to discuss and pin those as headlines on the moderation board. Following, you can use the prepared discussion questions (or your own, farm-specific questions) to provoke the farm members to think and discuss about potential climate impacts on the farm, resulting from a change in the mentioned climate parameters. Depending on the knowledge level of the farm members, you will be in charge to give thought-provoking impulses concerning possible impacts.

Tip: If it is a mixed-farm with different production branches, it might be reasonable to discuss the possible future climate impacts branch by branch.

TEMPLATE: STEP 2 - CLIMATE IMPACT EXPLORATION I

FUTURE CLIMATE IMPACTS

Temperature
incl. heat waves and frost

Precipitation
incl. dry periods and heavy precipitation events

Other
incl. hail, wind, sun hours etc.

Application Notes

This template only provides one possible option how the results of the climate impact exploration analysis can be processed and summarized for further use. For a farm specialized in crop production, it probably would be sensible to note the potential climate impacts for the main crops. Or for a dairy farm, it might be reasonable to categorize the potential climate impacts in the categories grassland management, animal welfare and production inputs (e.g. water, energy, external forage). Obviously, the right form is highly dependent on the individual farm and should be developed accordingly.

Discussion Questions:

External impacts

Energy/ external inputs: How could your farm be impacted by high energy prices? Which external inputs are you dependent on and how would low availability/ high prices impact your farm?

Workforce: How could your farm be impacted if there is a lack of available workforce? Or if weather conditions are so poor that productivity is seriously impaired?

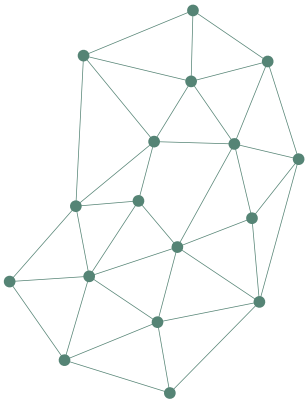
Contractors: How could your farm be impacted if external contractors would not be able to perform their services for you?

Market: How could your farm be impacted if the products you offer are not in demand? Or if your marketing strategy does not work anymore?

Pests and diseases: How could your crops or animals be impacted by upcoming or new pests and diseases?

Other questions: Feel free to develop your own, farm-specific questions to explore how the farm is probably affected by indirect climate impacts

Interactions



Imagine a scenario in which different climate impacts interact with each other or with external impacts. New or unexpexted challenges might arise when several factors change and aggravate problems. Check the chapter **Farming in a changing climate** in the Training Hanbook for more information.
How would your farm be impacted by such scenarios?

Examples

Fuel prices have gone up considerably and at the same time the summer was very dry so your crop will probably not yield as much as anticipated. In terms of revenue, it is not worthwile to even harvest it.

Due to a heatwave, farm workers can only work outside in early morning or late evening hours and tasks start to pile up.

Due to ideal growing conditions for cherries, your harvest was better than expected. Your usual large-scale processor will only take 3/4 of it and you don't have facilities or workforce to process them yourself.

A heavy storm has destroyed the road leading up to your farm. Your customers are not able to get to the pick up station of their weekly vegetable box.

BONUS

TEMPLATE: STEP 2 - CLIMATE IMPACT EXPLORATION II

EXTERNAL IMPACTS

External impacts
incl. fuel prices, pests, workforce

Interactions

Application Notes

Agriculture, the surrounding environment and the socio-economic world are interrelated, impact each other and develop interdependent and simultaneously. Consequently, your farm is indirectly affected by climate impacts on other systems. Farmers need to adapt to the full range of potential impacts, including biophysical, social, cultural, political and economic changes. These indirect impacts are numerous and it is neither possible nor expedient to anticipate all possible impacts. But it is worthwhile to be aware of these possible imapcts, too.

Climate Impact Exploration and Further Information

- The climate impact exploration is a facilitated approach which enables you to include potential climate impacts in the farm vulnerability analysis without the conduction of a full climate impact assessment.
- The exploration is based on the expert knowledge of the farm members (and yourself as the consultant). If you use this approach, it is crucial to communicate its limitations (see Consultation Material: Step 2).

- **https://genial-klima.de/module/klimawandel-checks/**
  - Good starting points concerning changes in climate parameters and vulnerability
- **https://awa.agriadapt.eu/de/:** Quiz for farms which provide a first orientation concerning farm vulnerability; large collection of adaptation measures

- **https://canari-europe.com/**: Comprehensive tool for regionally specific climate projection, including crop specific projections
- **https://www.adapter-projekt.de/klima-produkte/klimakalender.html**: Crop specific climate calender
- **https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.de**: Country Climate Fact Sheets
- **http://climexp.knmi.nl/start.cgi**: Climate Explorer
- **https://climate.copernicus.eu/**: European climate information
- **https://climate-adapt.eea.europa.eu/en/knowledge/c-a-indicators/c-a-indicators**: Climate indicators
- **https://www.nccs.admin.ch/nccs/de/home/klimawandel-und-auswirkungen/schweizer-klimaszenarien.html**

In order to gain or verify information concenring climate impacts for the specific farm, it might be relevant to consult **production branch specific experts.**

Example: In order to analyse what implications increasing heat waves or higher average temperatures will have on the crop production branch of a farm (or a specific crop), the consultation of a crop production expert could be beneficial.

Application Notes

Independent of how potential climate impacts are integrated in the farm vulnerability analysis, it is important to keep in mind that climate change will impact the individual farm not only by a change in climate parameters. Climate change will also cause indirect effects, like changes in markets, policies, input availability, health or value chains. These indirect effects are nearly impossible to project or even predict, but it is helpful to keep in mind that farmers will face various “unknown unknowns”.

To-Do List

Prioritizing Adaptation Needs

- [ ] If the exploration of climate impacts revealed new SWOT aspects, add those to the list
- [ ] Check the SWOT-Analysis: are there any Weaknesses or Threats which are aggrevated by the discussed climate impacts? If yes, add those to the Template: Adaptation Needs
- [ ] Check the SWOT-Analysis: are there any Strengths or Opportunities which are positively influenced by the discussed climate impacts? If yes, add those to the Template: Adaptation Needs
- [ ] If there are still open spaces in the Template: Adaptation Needs, discuss which other SWOT aspects or climate impacts are the most urgent for the farm (try to find at least five adaptation needs)
- [ ] Document the process and results; clarify open questions; continue with Step 3

Application Notes

Bringing together SWOT-Analysis and Climate Impact Exploration:
It is crucial to link the results and insights of the climate impact exploration with the results of the SWOT-Analysis. As climate change can amplify existing SWOT aspects of the farm, this combination of information provides guidance on which weaknesses and threats (or strengths and opportunities) a farm should prioritize and which alterations of the farming activities might be necessary, especially in the short-term.

TEMPLATE: STEP 2 - DOCUMENTATION

DATE: _____

WHO: _____

What did we do? How did we do it? Important discussion points etc.

Open questions, next steps and tasks

STEP 3 - ADAPTATION MEASURES

Guiding questions: Which adaptation measures potentially fit our farm, our farm objectives and correspond with our farm's vulnerabilities? Which adaptation measures address field-specific problems or opportunities?
Goals: Development of a comprehensive collection of various adaptation measures; adaptation measures should cover different time-scales (short-, mid- and long-term measures)

Preparation	Material and Literature
• All farm members agree with the results of Step 2 • All farm members have the Info-Sheet 6: Ressources for Adaptation Measures • There was enough time to search farm-specific adaptation measures (based on Step 1 and Step 2) • The ClimateFarming-Consultant prepared potential adaptation measures	• Results of Step 1 and Step 2 • Info-Sheet 6: Ressources for Adaptation Measures • Step 3: Measure Assessment I & II (Guiding Questions) • Template: Measure Assessment • Info-Sheet 4: Measure Assessment • Info-Sheet 5: Maladaptation I & II • Consultation Material: Step 3

Summary: In Step 3, potential adaptation measures for the specific farm are collected and assessed. The collection is based on the farm characteristics from Step 1, the stated objectives and the analysed vulnerabilities and chances from Step 2. A selection of resources for adaptation measures is provided in the **Info-Sheet 6: Resources for Adaptation Measures**

After collection, the adaptation measures are assessed according to several factors. These factors should include economic potential, mitigative potential and analysis of potential side-effects (ecological and social).

Application Notes

The collection process should be as inclusive as possible, consulting all farm members (managers, family members, employees etc.). The diverse perspectives on existing or potential issues help to diversify the compilation of diverse adaptation measures. The more diverse the adaptation measures, the better the farm will be able to react facing rapid changes and unforeseen events. The ClimateFarming-Consultant is responsible to keep an overview of the collected measures and - if necessary - bring adaptation measures into the discussion which address more unlikely, but probable climate risks (e.g. erosion/flood protection in a drought prone area) in order to further diversify the collection of adaptation measures.

STEP 3 - ADAPTATION MEASURES

To-Do List

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] Farm members present their measures - these are collected without discussion (for now). The ClimateFarming-Consultant adds and explains additional measures from their preparations
- [ ] The collected measures will be discussed. **The Info-Sheet 4 "Measure Assessment" and "Maladaptation (I + II)"** can provide a basis and guideline for this discussion. The ClimateFarming-Consultant notes important points of the discussion
- [ ] Based on the discussion, it will be decided whether adaptation measures will be further used in Step 4 or will be delayed as reserve measures
- [ ] The farm members decide how they want to organize their adaptation measure collection (e.g. production branch specific, climate risk specific etc.)
- [ ] The ClimateFarming-Consultant collects adaptation measures and discussion/assessment results
- [ ] Document the process and results; clarify open questions; continue with Step 4

Application Notes

For measure assessment, it is important to recognize the temporal dimension of adaptation planning. Potential adaptation measures which seem not feasible in the short-term might be feasible in the future when certain conditions change or climate impacts get more severe. This is important for a comprehensive collection of adaptation measures as well as to improve the mental flexibility of the farm members and better connect short-term measures and long-term options.

Example: The implementation of an agroforestry system is possibly not feasible at the moment due to a lack in workforce. This could change in the future when (possibly) partners can be included in the farm business who want to develop this production branch.

INFO-SHEET 4: MEASURE ASSESSMENT I

Measure Assessment | Guiding questions*

Superordinate question: Does the measure support the farm in achieving farm objectives in the face of climate change?

*Questions which are assessed and discussed can be ticked

Climate Adaptation	
Does the measure address our farm's vulnerabilities (Step 2)?	☐
Does the measure increase our farms' vulnerability concerning certain climate impacts?	☐
Do we (the farm members) feel able to implement the measure?	☐
Which uncertainties or risks exist concerning the measure?	☐

Profitability	
Is the measure economically viable for our farm?	☐
If not: Which conditions could change this?	☐
If not: is the implementation reasonable despite a lack of (short-term) economic viability?	☐

Ecological, Social and other Effects	
Will the measure be beneficial for climate protection?	☐
Will the measure entail positive ecological, social or other effects?	☐
Will the measure entail negative ecological, social or other effects?	☐
If negative side-effects can't be avoided: Should the measure be implemented despite the negative side-effects?	☐

INFO-SHEET 4: MEASURE ASSESSMENT II

Measure Assessment | Guiding questions*

Superordinate question: Does the measure support the farm in achieving farm objectives in the face of climate change?

*Questions which are assessed and discussed can be ticked

Maladaptation-Check*	
No-Regret: Will the measure be beneficial, independent of how climate change will develop?	☐
GHG-Emissions: Are there direct negative impacts on climate protection? Are there indirect negative effects on climate protection (e.g. leakage effects)?	☐
Flexibility/Reversibility: Can the measure be modified quickly in order to react to changing conditions? Can the measure be complemented or replaced easily by another measure?	☐
Testing: Is it possible to test the measure (small-scale or low-cost approach)?	☐
Diversification: Is the measure improving the diversification of the farm?	☐
Negative external effects: Will the measure impose negative impacts on other persons, actors or natural systems?	☐
Path-Dependencies: Will the measure entail certain dependencies which could create new risks or hamper future adaptation?	☐

(1) Maladaptation and the categories are further discussed in the **Info-Sheet 5: Maladaptation**

Application Notes

The displayed guiding questions represent only one option how adaptation measures can be evaluated prior to implementation - based on stakeholder discussion. A more comprehensive assessment, based on literature review and external consultation is also possible, but requires more ressources. Independent of the methods used to assess effectiveness and viability of adaptation measures, it is important to also discuss adaptation relevant criteria like uncertainties and maladaptation potential.

TEMPLATE: STEP 3 - MEASURE ASSESSMENT

This template can be used to record the discussion results of the adaptation measure assessment.

ADAPTATION MEASURE: _____

Climate Adaptation

Profitability

Ecological, Social and other Effects

Maladaptation potential

TEMPLATE: STEP 3 - DOCUMENTATION

DATE: _____

WHO: _____

What did we do?
How did we do it?
Important discussion points etc.

Open questions, next steps and tasks

INFO-SHEET 5: MALADAPTATION I

Maladaptation (1)

Several definitions for maladaptation exist, which mostly refer to the “unintended negative consequences of adaptation policies and measures” (P. 79, Neset et al., 2019).

Maladaptation can occur when you ignore complexity and uncertainty in adaptation planning. Insufficiently planned adaptation can lead to **path dependencies** or **lock-in effetcs**. Broadly speaking, this means that adaptation measures (or other decisions) which are probably beneficial in the short term can reduce the adaptation options in the future and so reduce the overall capability of a farm to adapt to new and unforseen developments.

The challenge for adaptation planning is to reduce the risk of maladaptation already in the planning process, before actual measures are implemented.

Example:
The construction of a dairy shed with a sophisticated, but expensive air conditioning system can constitute a reasonable adaptation measure to aggravating heat and heat waves. However, if the measure is not well planned and probably also drought becomes a problem, the reduced forage yields could obstruct the viability of the dairy cow business.
In an extreme scenario, the farmer maybe has to stop dairy production.
If this happens before the air-contioned shed is payed off, the farmer is heavely limited in their financial flexibility and will potentially not be able to implement other adaptation measures or switch to other production branches.

(1) Maladaptation is further discussed in the ClimateFarming Trainer Handbook

INFO-SHEET 5: MALADAPTATION II

Maladaptation Criteria

No-Regret: A No-Regret measure will be beneficial for the farm, independent of the development of climate change. A good example is the accumulation of organic carbon in the soil: it entails many positive effects for farm-level adaptation, but likewise it can improve yields and provides beneficial effects for the farm and the environment

GHG-Emissions: Adaptation measures should in the best case provide beneficial effects also for climate protection. At least, it should not increase farm-level emissions and consequently accelerate climate change. Likewise, the measure shouldn't lead to leakage-effects, increasing GHG-emissions somewhere else. **See "Negative external effects"**

Flexibility: Measures which can easily be modified or replaced without producing high costs are generally less prone to be maladaptive. For example, the cultivation of a new crop is a flexible measure and can be undone easily. The costly renovation of a dairy shed with an air-conditioning system is not flexible and only reversible in the mid- to long-term

Testing: If a measure can be tested without high (financial) risks and is reversible without significant costs or effort, it is less prone to be maladaptive

Diversification: An increase in the diversity of a farming system is generally associated with an increase of resilience. This refers mainly to the diversification of income streams, but can also refer to diversification in the crop rotation, in the landscape or other aspects of the specific farming system

Negative external effects: If adaptation measures implemented at our farm have negative impacts on other persons, actors or natural systems, these are considered as negative external effects. This should be avoided

Dependencies: Dependencies are not per se negative. In the case of cooperations, they can actually be positive for adaptation. However, dependencies increase the uncertainties about how climate impacts will affect the farm and should be analysed with care

ClimateFarming Measure Catalog

https://humus-klima-netz.de/massnahmen-im-ueberblick/

https://genial-klima.de/

https://www.boden-staendig.eu/massnahmen

https://solmacc.eu/climate-friendly-practices/

https://awa.agriadapt.eu/de

https://www.klimahumus.de/#startpunkt

https://www.conservationevidence.com/data/index

https://humusbewegung.at/zwischenfruche/

https://www.klimabauern.ch/ideenkatalog

https://www.thelexicon.org/regen-ag/ten-principles/

https://www.eufarmbook.eu/de/

https://www.bodenistleben.at/mitgliederbereich/

...

STEP 4 - FARM CLIMATE STRATEGY

Guiding questions: How can adaptation measures be combined into a strategy for our farm? Where are synergies and trade-offs? Does the farm climate strategy enable a resilient farm development?

Goals: Development and assessment of a farm climate strategy, with short-, medium- and long-term measures (timeline); optional: formulation of contingency-measures

Preparation	Material and Literature
• The ClimateFarming-Consultant processes the results of Step 3; • Farm members are provided with the results from Step 3	• Results from Step 3 (Adaptation Measures) • Material for the development of the farm climate strategy (e.g. whiteboard, A3-paper); alternatively digital tools (e.g. slides) • Step 4: Strategy Assessment I - IIII • Optional: SWOT-Analysis & Contingency Measures • Consultation Material: Step 4

Summary: The first action is to create a timeline. In this timeline, the different adaptation measures can be combined over the course of the time. The goal is to maximize synergies, reduce trade-offs and to plan short-term measures in accordance with long-term options. The farm climate strategy should provide farmers and advisors with a roadmap that specifies which adaptation measures can be tested or directly implemented (short-term; 0-5 years), which measures should be planned and prepared for (medium-term; 5-20 years), and which perspectives exist for climate-adapted farm development (long-term; >20 years). Overall, the farm climate strategy should enable the farm to take advantage of synergies between adaptation measures and to deal with diverse and potentially aggravating climate impacts. Analogous, the measures can be used to develop field-specific action plans.

STEP 4 - FARM CLIMATE STRATEGY

To-Do List

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] Farm members and ClimateFarming-Consultant agree how the farm climate strategy should be developed (e.g. with a whiteboard, A3 Paper, digital etc.)
- [ ] Every farm member as well as the ClimateFarming-Consultant develop a farm climate strategy individually, combining the adaptation measures from Step 3 and potentially adding additional measures
- [ ] Everyone presents their farm climate strategy. The ClimateFarming-Consultant takes notes, looking for similarities and differences
- [ ] The farm members dicuss and modify the different strategy proposals and try to develop one strategy on which all agree; the ClimateFarming-Consultant moderates the process and provides impulses
- [ ] As soon as a farm climate strategy is composed, the multi-criteria assessment will be conducted; the decision trees provided in Step 4 can serve as a basis for this analysis
    - Should the analysis reveal considerable deficiencies in any of the categories (0 points), the farm climate strategy should be modified

BONUS

- [ ] Optional: A second SWOT-Analysis is conducted in order to reveal weak points and potentially overlooked opportunities of the farm climate strategy. Using the results of the SWOT-Analysis, the farm members formulate contingency-measures in order to hedge the success of the farm climate strategy. More information can be found in **Info-Sheet 7: Robust Strategies**

Application Notes:

Farm climate strategies can be illustrated in various ways. One option is by hand with paper (in the best case A3 or bigger) or whiteboard. Paper is easy to apply, but changes are hard to make. Alternatively, the ClimateFarming-Project provides a Slides Template which enables the users to develop and save different farm climate strategies. The digital approach is especially adviseable for farms with several production branches. However, the used option can and should always be adjusted to the specific farm context.

STEP 4: STRATEGY ASSESSMENT I

Assessment Farm Climate Strategy | Decision-Tree

Resilience-Proxies*

1. Recovery:
Is the strategy able to improve the ability of the farm to recover from climate impacts quickly**?

YES

NO

2. Redundancy:
The strategy entails various adaptation measures which respond differently to climate impacts?

YES

NO

3. Flexibility:
The strategy enables the farm to react quickly in the face of surprising climate impacts, e.g. the occourrence of a new pest or disease?

YES

NO

4. Adaptiveness:
The strategy enables the farm to adjust its goals and methods in the mid- to long-term?

YES

NO

5. Comprehensiveness
In the development of the strategy, various perspectives and potential climate impacts were included and addressed?

YES

NO

Does the strategy fulfill most of the categories with minor trade-offs or deficits? — 3 Points

Does the strategy fulfill most of the categories with some trade-offs or deficits? — 2 Points

Does the strategy fulfill most of the categories, but with major trade-offs or deficits? — 1 Point

Does the strategy only fulfill some of the categories or feature fundamental trade-offs or deficits? — 0 Points

Application Notes

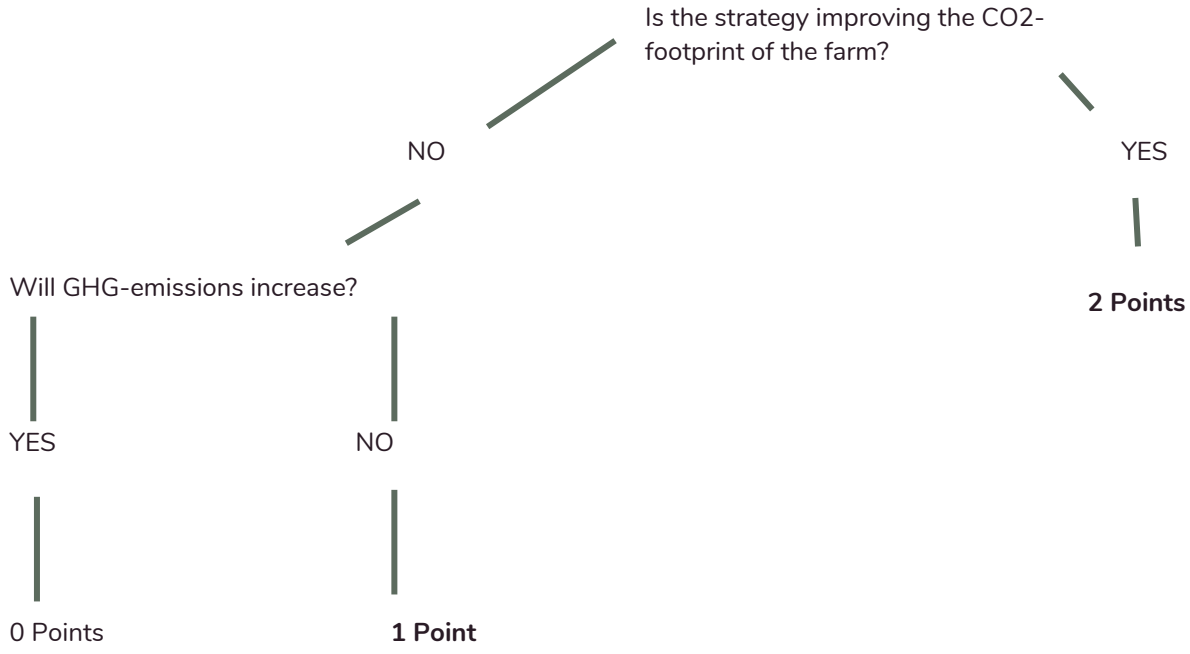
Important is to acknowledge that the different resilience proxies overlap and influence each other. As it is not possible to use a measurable metric for resilience, these qualitative proxies can help you to examine adaptation decision and strategies.

* Resilience-Proxies are further explained in the Consultation Material: Step 4

** Example: An extreme event could be a multiannual drought

Assessment Farm Climate Strategy | Decision-Tree

Climate Protection*



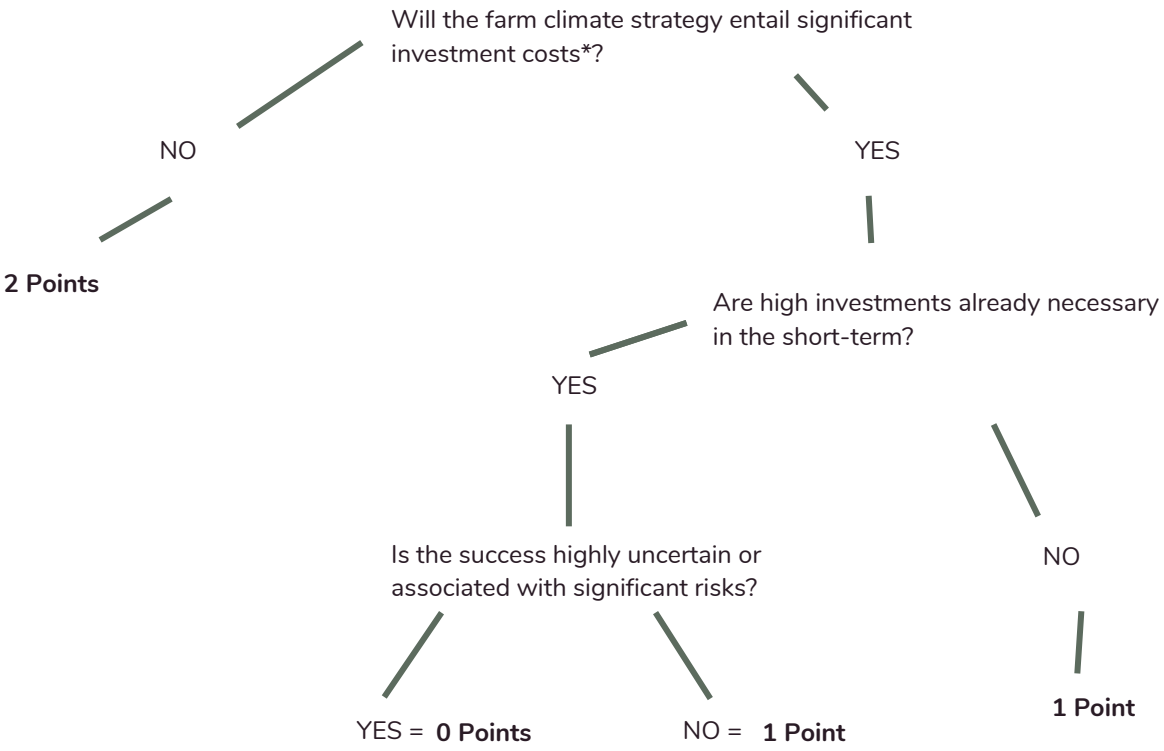
*Climate protection potential compared to the baseline CO2-footprint of the farm, if available

Application Notes

As it is (generally) not possible to analyse all strategy options in a sophisticated and scientifically sound manner, farm members and ClimateFarming-Consultants need to be aware of the level of subjectivity involved in the assessment. Preferences, risk tolerance and personal experience will make certain measure combinations appear more viable or appealing than others - even if other measures and strategies might be more suitable. This can not be prevented completely. Consequently, it is even more important that consultants and farm members are aware of the limited capability of objective reasoning. In some cases, external expert service is adviseable, e.g. a profitability calculation for a potential biogas plant or an external climate balancing to receive more precise information on the climate protection potential of a farm climate strategy.

Assessment Farm Climate Strategy | Decision-Tree

Investment Costs*



*Investment costs are defined as significant if they exceed regular operational investment costs in the considered time period (e.g. over a 15-year period)

Application Notes

Important is to acknowledge that costs can have different sources. Not only are investment costs relevant, but also rising labour costs or expenditures for the acquisition of knowledge. Another crucial aspect are **transfer costs**. Transfer costs arise when you need to change from one adaptation measure to another which do not complement each other.

Example

A farmer with a boarding horse husbandry income branch decides to invest in a very specialized infrastructure, a barn hay dryer. This investment is only paying off if there is enough forage to dry. This could be obstructed if grassland yields fall drastically, e.g. due to persistent drought events. If the boarding horse husbandry becomes unprofitable, the transfer costs to switch to another income branch rose higher due to the investment in the barn hay dyer.

Transfer costs are hard to quantify, but should be considered in decision-making.

TEMPLATE:
STEP 4- STRATEGY ASSESSMENT

Assessment Farm Climate Strategy | Decision-Tree

Ecological, Social and other Effects*

Positive	Negative

*Here, you can list potential positive and negative side-effects. If necessary, produce an extra document to note all identified side-effects

Application Notes

The multi-criteria assessment of a farm climate strategy is mostly based on the insights from Step 3 concerning the individual adaptation measures. However, it is central to not only see the sum of the individual measures constituting a farm climate strategy, but the synergies and trade-offs resulting from the combination of the different measures.

TEMPLATE: STEP 4 - STRATEGY ASSESSMENT SUMMARY

Resilience proxies

Score:

Discussion Notes:

Climate protection

Score:

Discussion Notes:

Investment costs

Score:

Discussion Notes:

Ecological, Social and other Effects

Discussion Notes:

TEMPLATE: STEP 4 - SWOT ANALYSIS & CONTINGENCY MEASURES

SWOT	Contingency-Measures
S Strengths	
W Weaknesses	
O Opportunities	
T Threats	

TEMPLATE: STEP 4 - DOCUMENTATION

DATE: _____

WHO: _____

What did we do?
How did we do it?
Important discussion points etc.

Open questions, next steps and tasks

BONUS

INFO-SHEET 7: ROBUST STRATEGIES

Contingency Measures

More Information: Consulting Material: Step 4

Contingency-measures are supposed to increase the robustness of the farm climate strategy via different mechanisms. These measures are not necessarily additional adaptation measures.

- **Defensive action (DA)**: actions taken to preserve the original strategy or meet (not climate change related) challenges which could obstruct the farm climate strategy
- Corrective action (CA): actions which alter the farm climate strategy in order to react to new knowledge, changed conditions or trigger events
- **Opportunity action (OA)**: actions which take advantage of opportunities arising in order to further improve performance and/or resilience of the farm climate strategy

Example (DA): One part of the farm climate strategy is to install an agrophotovoltaic system. The farm members identified the disapproval of the installation by the local citizens as a potential threat. A contingency measure could be to initiate a town-hall meeting in order to convince the people of the benefits.

What-if Scenarios

What-if scenarios are supposed to motivate the farm members (and the ClimateFarming-Consultant) to not only think in plausible scenarios (which seem realistic from a present perspective), but in scenarios which might have a low probability, but are still possible. These scenarios are also called **High-Impact, Low-Probability Events**. This is important, as it confronts the farm members with more severe trajectories of climate change impacts. Like all other methods, also this one is supposed to improve the consideration of climate change uncertainty into the adaptation planning process and consequently improve the resilience of the farms adaptation decisions.

Examples:

- What if the farm is confronted with an energy blackout over several days?
- What if temperatures regularly become so high that working outside in harvest times becomes unbearable for humans?
- What if three very dry summers are followed by two very wet summers or vice versa?
- What if time-sensitive transportation of goods (e.g. for processing milk) becomes less predictable due to heat/ storms/ etc.?

STEP 5.1 - MONITORING

Guiding questions: How can you monitor the effectiveness of your farm climate strategy? Which indicators are relevant for your farm and strategy?

Goals: Decide how the achievement of farm objectives is monitored; decide on relevant indicators which should be monitored; clarify responsibilities; set up a regular review event to examine and discuss objective achievement, the farm climate strategy and adaptation measures

Preparation	Material and Literature
• All farm members agree with the developed farm climate strategy and its assessment	• Results: Farm Climate Strategy and Assessment • Template: Monitoring-Indicators • Template: Regular Review Event • Cheat-Sheet: Indicators for Monitoring • Consulting Material - Step 5

Summary: Monitoring, evaluation and learning are central elements in farm management and adaptation processes. Only through regular monitoring you can assess the success or failure of adaptation measures - not only in monetary terms, but also concerning environmental or social objectives. Step 5.1 aims at developing a farm-specific monitoring. This should enable farmers to recognise relevant changes at an early stage and to act proactively. The montoring entails several aspects:

- Specification of farm-specific indicators - “Which climatic and non-climatic developments affect our farm and our climate strategy?”
- Monitor these indicators and control the success of the farm climate strategy - “Are we achieving our farm objectives?”
- Based on this information, the monitoring signals the necessity of modifying the farm climate strategy or individual adaptation measures - in the face of fundamental changes (e.g. unforseen retirement of a core employee), this could entail complete reassessment of the strategy

Furthermore, Step 5.1 entails the development of a **regular review event**. This is a event which aims at controlling adaptation measures, the farm climate strategy and objective achievement in fixed time intervals, additionally to the ongoing monitoring.

STEP 5.1 - MONITORING

To-Do List

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] The farm members explore which indicators are relevant for the farm and the climate strategy that should be monitored; the **Cheat-Sheet: Indicators for Monitoring** can provide a starting point, especially for the measure-specific monitoring
- [ ] The responsibilities for the monitoring are clarified - "How do we want to monitor the indicators?"; "Who monitors what?"
- [ ] The farm members design a regular review event; they decide how and when a regular review event could be integrated in the regular farm management - see **Info-Sheet 8: Regular Review Event**
- [ ] Document the process and results; clarify open questions; continue with Step 5.2 - Implementation

Application Notes

Monitoring of climatic changes is complicated by the differentiation between natural variability and real trend changes. This does not only apply to climatic changes, but also to other factors, e.g. market prices for agricultural products. Also the determination of a critical value that determines the implementation of a new adaptation measure is highly subjective.

Example

A three-year drought leads Farmer A to shift to drought-resistant crops, while Farmer B perceives this as regular variability.
Additionally, monitoring and evaluation suffer under time constraints in the regular farm management. This issue makes the periodic trigger event even more worthwhile.

TEMPLATE: STEP 5.1 - FARM MONITORING INDICATORS

STEP 5.1 - MONITORING

Farm Monitoring Indicators

Application Notes

In the case of a complex farm with different production branches, it is probably reasonable to separate indicators into external and internal indicators or to collect branch specific indicators.

Example

External indicators can exemplarily comprise climatic and environmental changes, technological innovations, market developments and political and cultural changes. Internal indicators could be working hours, yield, income or job satisfaction. This should enable farmers to recognise relevant changes at an early stage and to act proactively.

INFO-SHEET 8:
REGULAR REVIEW EVENT

Regular review events are another approach to effective monitoring. These are regularly scheduled events at which all farm members meet to discuss and check the farm climate strategy and the underlying assumptions* in a systematic manner. This means deciding when the event will take place, who is reporting on what and how the general agenda should look like. Exemplarily, a regular review event could be scheduled once a year, for example in late autumn after sowing.

During the event, basically the same questions and aspects as during regular monitoring are discussed, but collectively. Consequently, the guiding questions for monitoring can also provide guidance for the regular review event.

- **Guiding question(s)**: Do the implemented climate measures meet our farm objectives? What works, what does not work? What can we learn from this? What changes can we observe (indicators)? How do we have to react to them or act preventively?
- **Monitoring of the implemented measures, farm objectives and the defined indicators.**
- **Decision on**
  - Modification of the adaptation measures implemented
  - Implementing contingency measures
  - Introduction of new adaptation measures
  - Modification of the farm climate strategy
  - Necessity to re-plan the farm climate strategy or re-run the ClimateFarming Cycle.
  - Integrate new knowledge and lessons learned into the farm climate strategy and its implementation.

*Underlying assumptions in this context means the cornerstones of the farm climate strategy. Examples could be the availability of land (lease agreements), the sufficient availability of irrigation water, a secure sales market for direct marketing or the expertise of certain farm members.

TEMPLATE: STEP 5.1 - REGULAR REVIEW EVENT

STEP 5.1 - MONITORING

Here you can specify when and how the regular review event will be conducted

When is the event scheduled?

What will be the agenda?

Who will present what?

STEP 5 - DOCUMENTATION

STEP 5.1 - MONITORING

DATE: _____

WHO: _____

What did we do?
How did we do it?
Important discussion points etc.

Open questions, next steps and tasks

STEP 5.2 - IMPLEMENTATION

Guiding questions: Which measures can you implement directly? Which measures can be tested? Which measures do you need to plan and prepare? Who will take care of what?

Goals: Development of an implementation plan/timeline for the near-term implementation; develop measure-specific monitoring; clarify responsibilities

Preparation	Material und Literature
 Engage external (expert) consultants for specific adaptation measures	• Results: Measure Catalog • Results: Farm Climate Strategy and Analysis • Template: Implementation Plan • Template: Adaptation Measure Monitoring • Consultation Material - Step 5

Summary: In Step 5.2, it will be specified how adaptation measures will be practically implemented on the farm. Test- and field-trials are developed and responsibilities clarified. For mid-term measures, the planning starts.

How this Step will be realized is completely dependent on the farm members and the ClimateFarming-Consultant. If the necessary time-resources are available, it might be beneficial to develop an elaborated implementation-plan including experimental design and monitoring of measure success. Likewise, preparation for the mid- to long-term adaptation should be started, as these measures are generally more complex and associated with higher investments. This includes research, identification of key actors and probably the development of a preliminary timeline of tasks.

Simultaneously with the implementation, the monitoring starts. This entails the compilation of baseline values for monitoring indicators of implemented measures as well as the monitoring of farm objective achievement.

STEP 5.2 - IMPLEMENTATION

To-Do List

- [ ] The ClimateFarming-Consultant explains the step, its goals and methods
- [ ] Based on the results of Step 4, the farm members discuss which adaptation measures can be implemented right away (especially no-regret measures) and which can be tested or for which a test-/field-trial can be set up
- [ ] The implementation of the different adaptation measures is roughly scheduled
- [ ] The farm members discuss which measure should be planned and specify first steps
- [ ] The farm members clarify responsibilities for the different adaptation measures and the related tasks (planning, implementation, monitoring)
- [ ] The responsible persons compile baseline values for the different monitoring indicators in order to control measure success
- [ ] Optional: It is checked whether certain contingency-measures could be implemented right away

Application Note

Regarding the implementation, it is crucial to adjust the speed to the specific farm and its means. Should the farm be able to provide the necessary financial- and time-ressources to quickly implement and test several measures, this should be supported. A good option, also for rather cautious farmers, is to visit a farm on which the specific adaptation measure is already in use.
Dependent on the complexity of the adaptation measures, the implementation should be planned together with expert service.

STEP 5.2 - IMPLEMENTATION

PRODUCTION BRANCH OR MEASURE: _____

RESPONSIBLE: _____

TIME HORIZON: _____

Measure(s)

What do we do? When do we do it?

Cost and Time Estimate

TEMPLATE: STEP 5.2 - ADAPTATION MEASURE MONITORING

STEP 5.2 - START OF MONITORING

PRODUCTION BRANCH OR MEASURE: _____

RESPONSIBLE: _____

TIME HORIZON: _____

Goals

Indicators

Indicator Baseline*

DATE OF INITIAL ASSESSMENT:

Indicator Development

An additional document (e.g. a table) might be useful to track the development of an indicators

* The **Indicator Baseline** is the starting point for your measurement or assessment of an indicator. For example, if you introduce cover cropping as an adaptation measure, you might chose aggregate stability as one of your indicators for soil health. You will regularly check aggregate stability on the specific field in order to monitor improvements. The first soil assessment and its results (see Step 1, Farm Survey) are the baseline for this indicator.

STEP 5 - DOCUMENTATION

STEP 5.2 - IMPLEMENTATION

DATE: _____

WHO: _____

What did we do?
How did we do it?
Important discussion points etc.

Open questions, next steps and tasks

HOLISTIC RESOURCE MANAGEMENT FOR
CLIMATE RESILIENCE OF FARMING

Farm Survey (Instructions)
ClimateFarming

2022-1-DE02-KA220-VET-000090163

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Contents

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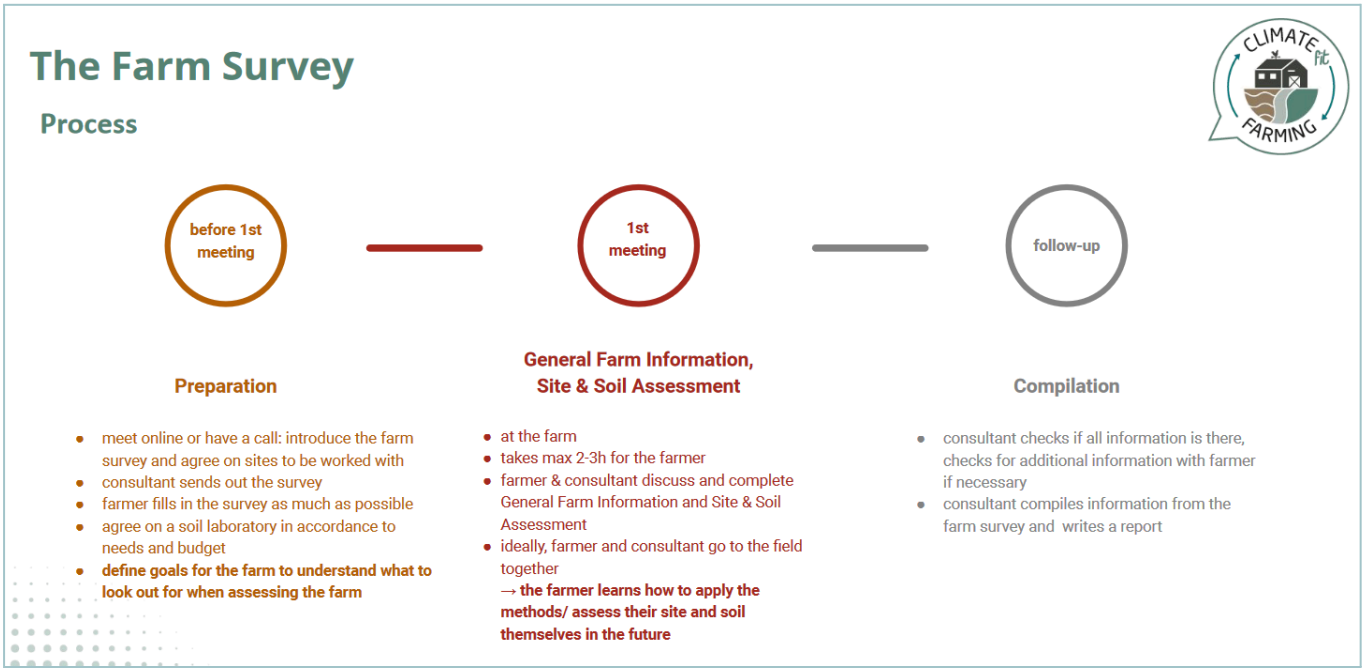


Some of the information may seem excessive to collect at this stage of the assessment but might become relevant in the process. You can skip parts of the survey now, and come back at a later stage when the strategy and goals become more tangible (e.g. ownership of specific fields). Some questions concern sensible farm information one might be reluctant to share with an external consultant. However, it is important to keep in mind that the consultation process will be more effective and overall successful if all involved parties have the same information level. As a guidance, you can follow the 🌱 base case scenario, if you want to collect the most necessary information only, and the ⭐ best-case scenario if you want to do a comprehensive farm analysis.

Icons

🏞️ **On-site assessment**
💻 **Internet research, (online) maps or geodata**
You will find this symbol where (online) maps can support the collection of relevant information. Such can include aerial images, erosion maps, elevation profiles, contour maps, slope and exposition maps, precipitation and temperature maps, various soil maps, geological maps, drainage plans, and protection areas, among others. Here you can find a list of helpful online map services for Germany.
🚜 **This task can be done by the farmer**
💼 **This task should be done by the consultant (or an experienced farmer)**
📷 **Please take pictures** of everything that might be interesting or helpful for interpretation of the results (e.g. color changes within a soil horizon, a lot of soil attached to roots, compacted soil layers, a root is oriented in a different direction than all the others, etc.) and to track your progress! Ideally, photos should be standardized at **1m distance** from the targeted object, e.g. from the soil surface. It could also be helpful to establish fixed photo points to monitor changes. If possible, automatically link the pictures to GPS coordinates, or save them separately. For more information check out this document: CF_Taking Photos_in progress
⏰ **Time this task**
👫 **Should be done with at least 2 persons**
🌱 **Base-case scenario**
⭐ **0 Best-case scenario**
ℹ️ **Why do we look at these indicators?**

1. General farm information

🚜🌱

Guiding questions:

- What is the total farm area?
- Which different production branches do you have on the farm?
- e.g. Feed production, Sheep herding, Market garden
- How many animals? Which cultures? etc.
- What is your farming practice?
- conventional, organic, conservation agriculture,
- Do you have any certifications?
- e.g. EU-organic, other organic, KAT, QS
- How do you market your products? What are your sales channels?
- e.g. direct marketing, own processing, regional/ interregional/ international partners, bulk purchasers from the agricultural sector, cooperatives, large-scale processers
- Which other establishments belong to the business? (e.g. affiliated restaurant)
- Are there any special geographical features?
- e.g. lee side of mountain range, viticultural climate, special bedrock
- How is the farm located regionally?
- e.g. proximity to villages/ cities, distributors, processors, storage units, etc.
- What is the main soil type and soil texture on your farm?
- Find site-specific questions below

Describe the regional climate around your farm:

- What is the main wind direction? What are peak velocities you experience?
- Precipitation (mean, min, max, per season)
- old and new long-term means, as well as personal estimations
- Do you get most of the precipitation in spring/summer/autumn/winter? Or is it equally distributed over the year?
- Temperature (mean, min, max, per season)
- old and new long-term means, as well as personal estimations
- How many days with temperatures below 0°C do you experience? When do you have temperatures below 0°C during the year? How low do temperatures go in the spring? Are there late frosts in the spring?
- Recall experienced and historic extreme weather events (strong rain, drought, etc.).
- Are there changes in weather patterns/ extreme events/ seasonal shifts in your farming area? Do you observe “new” patterns that have developed over the last year?
- e.g. earlier budding, increased pressure from invasive organisms, less rain events, higher peak temperatures
- Which of your sites are most vulnerable and how?

1.1. Farm overview

🚜 ⭐ Please fill in the area that is available on your farm for the different branches in the table, how much of it is your own property and how much is used under leasing agreements. How many different fields do you have per branch and what are their particularities?

Please state all crop rotations and their approximate output on the farm to get an overview. Specific information on the crop rotations for the concerned site(s) that you want to work with can be stated in the Site Assessment below.

- If you have livestock, please state species, amount, husbandry system, and what the outputs are. How do you source the animal feed?
- e.g. buying feed pellets, grazing your own/ rented land, buying/ making your own silage
- If you graze your animals, can you describe your grazing system?

1.2. Ownership structure and decision making

🚜 🌱 Guiding questions:

- Who are the legal owner(s) of the farmed areas?
- Are there existing lease agreements? What is the duration of such? What is the relation with the owner(s)?
- Are there past or upcoming generation changes/ farm transfers (on both owned and leased land)?
- Do you have partnerships, dependencies or other involved parties that necessitate inclusion in decision making?

1.3. Workforce, facilities and machinery

🚜 🌱 Guiding questions:

- How many people work in each production branch? (Indicate overlaps)
- What is the training and education of farm staff?
- Which special knowledge and skills are available from farm staff?
- Is additional workforce available if needed for workload peaks?
- Which facilities do you have at your disposal?
- differentiate between on-farm and contractors
- Which machinery do you have at your disposal? List your vehicles with their operating widths.
- differentiate between on-farm and contractors
- Do you use agricultural contractors, and if so which?

1.4. Economic background

🚜 🌱 Guiding questions:

- How would you describe the economic situation of your farm (e.g. stable, insecure, potential to grow, need to consolidate, etc.)?
- What is the average farm investment sum in a five-year period?
- Are there any major expenditures planned or necessary (e.g. replacement of machinery)?

- How is the relative contribution of the different production branches to the farm income (e.g. crop production: 70% + pig production: 30%)?

1.5. Climate change measures

🚜 ⭐ Guiding questions:

- Is a farm climate balance (carbon footprint) available? If not, is it planned to do one?
- Are measures implemented or planned which aim at improving the farm climate balance (mitigation; e.g. increasing soil organic carbon)?
- Are measures implemented or planned which aim at adapting the farm to climatic changes (adaptation; e.g. irrigation, undersowing, agroforestry)?

1.6. Formulation of goals and priorities

🚜 What is important to you as a farmer? What is the motivation behind your work? Which topics would you like to develop further on? Formulate your goals and try to order them according to your priorities.

2. Site Assessments

This part of the questionnaire concerns the site(s) on your farm that you would like to assess in more detail. Please copy this section in the documentation form and fill it out separately if you are assessing more than one site.

2.1. General information

🚜 💻
🌱 Guiding questions:

- Note the name, lot number, location, GPS coordinates, and area of this site.
- Who is/ are the current land manager(s) and what is the current land use and vegetation or crops?

- How far away is the concerned site from the main production building?
- Which means of transport do you use to get there?
- How long does it take to get there?
- How relevant is the concerned site within the farm? Is it a formerly merged site, high-yield site, etc.?
- How often is management and/or observation necessary/ reasonable?
- Why did you choose this site for new measures?

💼 🏞️ 🌱 Continue by checking the field for heterogeneity:

- Are there relevant differences within the field?
- e.g. in terms of weeds, harvest, soil quality, soil depth, water logging, compaction
- If so, **divide the field into different zones** according to these differences.
- Visualize zones on a map, note the respective GPS coordinates and possibly measure dimensions. Note what characterizes each zone and give them IDs.

💼 🏞️ 🌱 Continue with the assessment of the total area; or if zonation, then every zone respectively. Depending on the geometry of the field, chose according locations for soil sampling

- Walk through the field in an N or X-shape and sample in 4-5 locations
- Borders and irregular areas within the zone should be avoided

The goal for all methods is to get a **representative impression** of the respective zone/ area, but keep it pragmatic and don't divide it into too many subareas.

2.2. Management history

💼 💻 🌱

Tip: Use for example Google Earth (web application), or Google Earth Pro (desktop application with more functions) to determine e.g. cultivation borders, which can be seen especially well on winter imagery after seeding. Look at different seasons over several years to get a good impression of the conditions.

Guiding questions:

- How long have you been the farm manager? Do you know the previous farm manager/ have information on their management practices?

- What has been grown in the last 5-10 years?
- Have there been additions of fertilizers/ pesticides/ herbicides/ manure/ compost/ etc.? Which approximate amounts?
- e.g. fertilizers: pig slurry, farmyard manure, NPK fertilizer
- e.g. other amendments: soil improvers, biotite, liming
- Did you leave crop residues on the field?
- What was the tillage regime (frequency, depth)?
- Which machinery has been used on the site? Has work been done with heavy machinery?
- Have there been any other noteworthy management practices?
- e.g. soil cultivation/ harvesting under unfavorable conditions

2.3. Protection status

💼💻🌱

- Are any of the fields or nearby areas under special protection?
- E.g. Water protection area, Birds Directive, Habitats Directive
- How does the protection status influence your farming decisions?

2.4. Climate/weather

💼💻

Describe the climate **specifically on the concerned site**. If it does not differ from what was noted in 1. General farm information, you can omit this step.

🌱 Guiding questions:

- What is the main wind direction? What are peak velocities you experience?
- Precipitation (average, min, max, per season)
- old and new long-term averages, as well as personal estimations
- Temperature (average, min, max, per season)
- old and new long-term averages, as well as personal estimations
- Recall experienced and historic extreme weather events (strong rain, drought, etc.).
- Which of your sites are most vulnerable and how?

2.5. Topography & Terrain

💼🏞️/💻

🌱 Guiding questions:

- What is the altitude of the site (min-max)? Is there a lot of elevation change/ are there steep slopes?
- Where do you get the most sunlight/ shade/ rain?
- Which areas are prone to surface runoff or water erosion? Are there wide open areas that are exposed to high wind velocities?

⭐ Outline the terrain/ topography in min. 2 directions (e.g. N-S and E-W) on Google Earth Pro (free Desktop app) or GIS services.

2.6. Landscape elements, compaction, drainage & surrounding vegetation

💼🏞️/💻

🌱 Guiding questions:
- Do you have areas/ zones in your field where puddles form easily after rain? How long does the water take to infiltrate?
- Are there any especially compacted areas in your fields? What causes the compaction?
- Do you have drainage systems in place? Which? Where?
- What is the regular water table on the site?

🌱 Describe shortly if / where you can find such elements on your fields:
- Trees, shrubs and other perennials
- Wetland areas or ponds
- Depressions, hills
- Power lines
- Underground cables, pipes, power lines

⭐ Guiding questions:
- What is the usual time of budding of surrounding vegetation?
- compare with phenological calendar (e.g. flowering of forsythia), especially interesting over the course of several years
- What is the species composition on the site?
- Which plant communities do you find in the area?
- What is the growth rate of local plants (especially shrubs/ bushes/ trees)?
- What is the yield of local plants? How regular is it?
- (e.g. irregular yield of walnuts might indicate critically late frosts)

2.7. Existing cultures

💼🏞️/💻
🌱 Guiding questions:
- Do you have an existing field journal of cultures and activities on the field?

🌱 Guiding questions:
- Describe the following elements on the concerned area:
  -
  - Are you struggling with diseases or pests?
  - Are there root or harvest residues left on the field?
  - What is the height of your culture? Is it uniform?
  - How high is/ was your yield?
  - Do/ did you observe any deficiency or excess symptoms on the culture?

⭐ Guiding questions:
- Identify the phenological development stages of your culture using the BBCH scale.
- For grasses: What are the tillering rates?
- Use a refractometer to measure the Brix level (=sugar content; indicator for crop quality) of the leafsap.
- Get micro- and macronutrients of leafsap checked.
- or check in the field with e.g. Yara-N-Sensor, HORIBA plant sap device

- Do you observe indicator plants indicating:
  - Nitrogen
  - Water
  - Compaction
  - Salt

  → You can e.g. use the Ellenberg indicator values, that can be found for various regions in Europe, for orientation
  (e.g. http://botanik.mettre.de/alpha_liste.shtml (German))

2.8. Issues & Optimisation

💼🏞️💻
🌱 Are there problems or optimisation needs currently, or have been in the past concerning e.g.:

- Microclimate: e.g. solar radiation/ shade, wind
- Weeds, pests
- Yields
- Erosion: water or wind
- Water balance/ management: Is there too much or too little water? Is it raining at the "wrong" time? Can all the water infiltrate or does it run off? Do you employ measures to keep water in the landscape?
- Biodiversity: Is your farming area genetically diverse? How many species grow on your fields? Are annual or perennial plants dominant? Are animals part of your rotation? Is the surrounding landscape heterogeneous and diverse (e.g. different trees/ forests, bushes, water areas, buffer stripes, wildlife habitat zones)?
- Wildlife: Do you experience game pressure? Are your fields located in proximity to a forest? Do you observe many (beneficial) insects?
- Others: Are there any other issues or optimisation potentials that have not been listed above? Please describe.

3. Soil Assessment

In the soil assessment we will collect information about the state of the soil before interventions, and regularly afterwards.

Timing: The ideal time to do the in-field assessment is in autumn or spring, at least two days after the last rain (depending on the quantity). More importantly, the sampling should be consistent, and always be repeated under similar conditions, ideally by the same person. If one year, you sample after harvest and before sowing, keep doing so in the next years (or at least document what activities have been carried out previously).
Don't assess during frost, in very wet or very dry conditions, as this will influence the results of soil health indicators. Wait for 6-8 weeks after tillage or slurry application to get unadulterated data. Record any information that may help to remember the sampling or interpret the results later on.

Frequency: Some soil tests like earthworm counts, spade analyses or infiltration tests can be carried out several times a year, to see the development e.g. at the beginning and end of the vegetation period or to get a feeling of the impact of certain interventions.

Depth: For some assessments below (like the Extended Spade Analysis), specific sampling depths are given. If you are specifically sampling for soil organic matter/ carbon analysis, sampling at greater depths e.g. 0-15 cm, 15-30 cm, >30 cm is advisable. Check which specifications for sampling (depth, sampling frequency and distribution, separate or aggregated samples) are required, for example by your chosen soil laboratory and/ or carbon credit scheme.

You can choose between two scenarios: If you have little time and want to make a basic soil assessment, please follow the 🌱 base case scenario, which includes a analyses of surface, aggregate structure, water stability, and roots. If you want an in-depth field assessment with added indicators for a more thorough understanding of the state of the soil, please first follow the base case scenario and then proceed to the ⭐ best-case scenario. It includes counting earthworms, a lime test, infiltration measurements, and noting some more soil characteristics.

For comparison you could also perform one test in an undisturbed area, e.g. a grass strip next to the field. This can be comparable to "natural conditions" and may help to understand the site-specific soil development under undisturbed, permanently vegetated conditions.

⏰ Please time how long it takes you to assess every method and one zone/ field. It is interesting for both the farmer and the advisor to know the amount of time needed.

👫 You should be **two persons** to carry out the soil assessment.

3.1. Visual Soil Assessment and Extended Spade Test (according to Beste 2003 and Junge)

💼 🏞️ 🌱 This is a standardized in-field soil assessment that allows us to calculate an overall soil score at the end.

ℹ️ Aggregate stability is a major indicator for soil health. Soil minerals stick together with organic materials like fungi, bacterial cells, roots and their exudates, to form small and large aggregates. A well-aggregated soil will enable healthy root growth, water infiltration, and soil aeration, and decrease the chances of soil erosion, among others. Aggregation is also the most important process

in soil organic carbon stabilization, as it protects organic matter from biodegradation. Disturbances like tillage and heavy machinery, and bare soil (and thus erosion) decrease aggregation.

ℹ️ Roots supply plants with water, nutrients and oxygen. They stabilize the soil against erosion and compaction, are a primary material for the formation of humus and habitat for many soil organisms. Root exudates stimulate microbial growth and are important carbon inputs to the soil. Root-fungi symbioses are important for nutrient acquisition. The space close to the roots is called the rhizosphere.

Required material: spade, soil probe, hydrochloric acid, tweezers, 3 ice cube trays, distilled water, stopwatch, camera, cardboard, sieves 3 mm and 5 mm

3.1.1. Surface analysis, organic matter, root and harvest residues

🏞️ Describe what the surface looks like:
Do you see pores, crumbs, aggregates, algae, organic residues, crusting, cracks, etc.? Is the surface dry/ wet/ do you see surface ponding? Do you see signs of erosion (rills/ gullies/ sheet erosion)?

Horizon	Description	Score
Surface (0-1 cm)	rough surface, single aggregates are visible, not platy, worm castings, no slaking, no crusting	100
	transition	75
	aggregates are slaked, platy, no/ little worm castings, initiating crusting (cracks)	50
	transition	25
	platy aggregates, crusts, cracks, slaking, sealing	0

ℹ️ Soil organic matter is material like microbial, plant and animal residues that is alive and in various stages of decomposition. It is an important indicator for soil health as it feeds microbial activity, influences soil physical and chemical properties and all soil ecosystem services like carbon and nutrient cycling, infiltration, and water holding capacity.

🏞️ Do you find any organic materials or residues on the soil surface? Describe which & how much.

3.1.2. Soil sampling

🏞️ Sample a soil block of about 30 cm depth with a spade. Mark at 15 cm depth, as we will analyze the block from 0-15 cm and 15-30 cm separately.
📷 Take a picture of the sample.

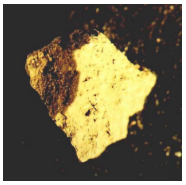
3.1.3. Soil structure assessment

🏞️

Term	Diameter	Surface	Shape	Emergence
fine crumb	few millimetres	rough surface	round	mainly biologically built structure
polyhedron	few millimetres	smooth surface	angular	swelling-shrinking cycles, mechanical cultivation
fragments	**general term for aggregates in centimeter and decimetre range**			
large crumbs	=< 5 cm	rough, round edges, fracture surface rough	round	built up structure
clumps	> 5 cm	rough or	rather round,	swelling-shrinking

(also called clods)		smooth	very compact	cycles, mechanical cultivation

Polyhedron:
smooth surface, no pores



Sub-polyhedron:
smooth surface, few pores

Fine crumb:
rough surface, lots of pores

Horizon	Description	Score
Topsoil (0-15 cm)	more than 80% fine crumbly structure, at high clay content also small polyhedra, loose, few crumbs	100
	transition	75
	(after slight pressure disintegration in) mixed structure of differently sized aggregates, small polyhedra and single particles, disintegrates easily with low pressure	50
	transition	25
	dominated by large crumbs and sharp-edged fragments or clumps with smooth surface or unaggregated structure, only a few crumbs	0

Horizon	Description	Score
Subsoil (>15-30 cm)	(after slight pressure disintegration in) mixed structure of differently sized aggregates, small polyhedra and single particles	100
	transition	75
	Large crumbs and dense, large fragments/ clumps, with partially smooth surfaces, disintegrate with low pressure	50
	transition	25
	more than 80% sharp-edged fragments/ clumps, larger and distinctively smooth surfaces, coherent structure	0

3.1.4. Root assessment

📷 Detailed pictures are especially interesting for documentation/ evaluation over several years and consultation.

Horizon	Description	Score
Topsoil (0-15 cm)	high root penetration, many roots and fine roots, strongly branched, evenly distributed and glued together with small soil aggregates (large contact area between roots and soil)	100
	transition	75
	moderate root penetration, few fine roots, slightly branched, partially in irregular tufts, growing in coarse pores of larger fragments and large crumbs	50
	transition	25
	very irregular root growth, tufts and partly horizontal root felts, growth mainly in large pores through (or on the surface of) larger, angular fragments and large crumbs	0

Horizon	Description	Score
Subsoil (>15 - 30 cm)	high root penetration, many roots and fine roots, strongly branched, evenly distributed and glued together with small and large soil aggregates (large contact area between roots and soil)	100
	transition	75
	moderate root penetration, few roots and fine roots, poorly branched, partially: several roots grow in parallel in coarse pores through (or on the surface of) larger angular fragments and large crumbs	50
	transition	25
	very irregular root growth in tufts, partially: several roots grow in parallel in large pores through (or on the surface of) larger angular fragments and crumbs, partially horizontally kinked and flattened	0

3.1.5. Aggregate sampling

Sample aggregates from different locations in the soil block 0-15 cm and >15-30 cm. Aim at getting a representative sample. Sieve the aggregates, first through a 5 mm- sieve and then through a 2 mm- sieve to obtain aggregates of size 2-5mm. Count 45 aggregates from both soil blocks respectively. If you are short on time in the field, you can store the sieved aggregates in a small jar or closable test tube and continue with the aggregate stability test later (but the aggregates should still be field fresh).

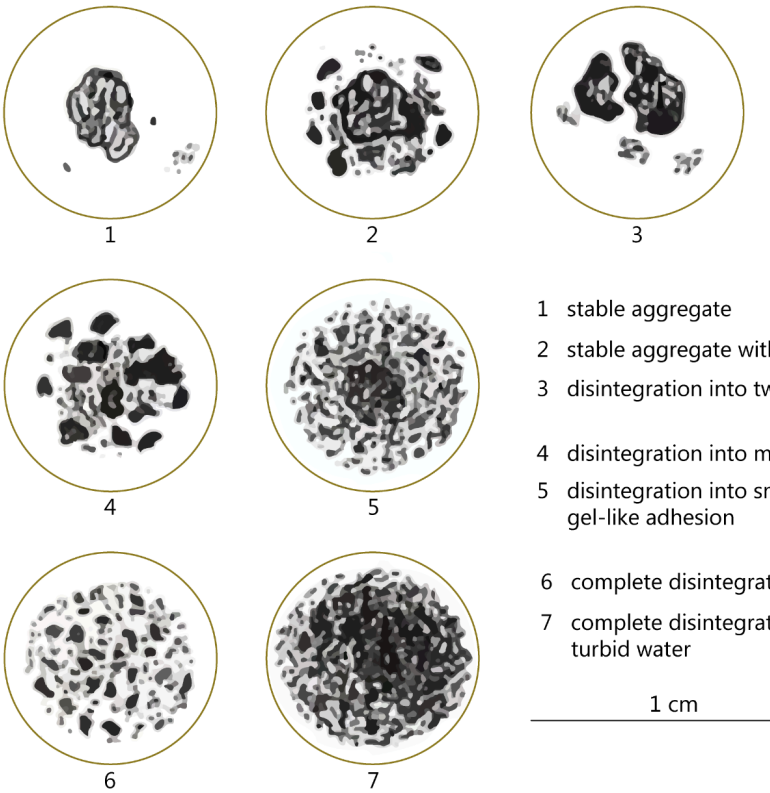
3.1.6. Aggregate stability test / Slaking test

Distribute the aggregates in the ice cube trays: two aggregates per small compartment. Carefully pour deionized water in the trays, wait for *one minute* and then tap the individual compartments repeatedly. Did the aggregates disperse? Check the figure below to score the slaking of the aggregates.

3.1.7. Calculation of the Assessment score

$$Soil\ structure\ index\ = \left(\frac{soil\ score_{topsoil} \times aggregate\ stability_{topsoil}}{2}\right) + \left(\frac{soil\ score_{subsoil} \times aggregate\ stability_{subsoil}}{2}\right)$$

→ Score: 0 – 100 points for topsoil and subsoil together. However, it is important to also look at the results from topsoil and subsoil separately. They might develop differently, or there may be a specific problem in one horizon, which is not represented in the total score.



3.2. Root indicators:

💼🏞️🌱

Root tips: Are no/ few/ many/ all root tips white?
ℹ️ Root tips are especially important for water, oxygen and nutrient uptake and thus are essential for sound plant growth. Active and healthy root tips are white.

Soil attached to roots: Is there no/ little/ moderately/ a lot of soil attached to the roots?
ℹ️ Root exudates are substances that are secreted from living and active plant roots and are one of the major driving force for interactions between plants and microorganisms in the soil. The more exudates, the more soil is attached to the roots, even when shaking strongly.

Smell: Smell the roots. Do you smell anything distinct? Is it a foul or putrid, fungal or pleasant smell?

Root nodules on legumes: Do you see nodules (little bulbs) on the roots? How many? What is their colour? Actively N-fixing nodules are reddish/pink inside, indicating that the bacteria are alive and active. Dead or inactive nodules are greyish green or brown inside.
ℹ️ Roots of legumes (and a few other plants like alder) form small bulbs, called nodules, that are in a symbiotic relationship with nitrogen-fixing bacteria, called rhizobia (or frankia in the case of alder). Rhizobia (or frankia) bacteria convert atmospheric nitrogen to plant-available forms of nitrogen. In exchange, the plant root supplies sugars to the rhizobia (or frankia).

Root orientation: Are all roots oriented in the same direction? Do you see one or a few roots that are growing in a different direction? Is there a visible obstacle (mechanical/ chemical) they avoid?
ℹ️ Roots grow in response to resource availability and constraints like compaction. Thus, limitations in the soil can often be recognized looking at root orientation and depth.

Root depth: How deep are most of the roots reaching? How deep are the very deepest roots reaching? Do you see a layer/ area that is prohibiting root growth? E.g. compaction, water logging, rocks.

Mycorrhizae: Do you see mycorrhizae? How much?
ℹ️ Mycorrhizae are symbiotic associations between plant roots and fungi that play an important role in plant nutrition. The plant root supplies sugars to the fungus which in return acquires nutrients and water for plant uptake by exploiting a larger soil volume than the plant roots alone.

🌱 **If you are doing the base case scenario, you have finished the Soil Assessment and can proceed to 3.7. Soil sampling.**

⭐ **For best-case scenario, continue:**

3.3. Soil texture

💼🏞️⭐ Use the flow diagram “Determine Soil Texture by the Feel Method” (= Soil Ribbon Test) at the end of this document.

3.4. Other soil indicators

💼🏞️⭐

Carbonate testing with Hydrochloric acid: Add hydrochloric acid dropwise to different depths on the spade sample.
ℹ️ If you see foaming or bubbling, there is are carbonates in your soil, which usually means that the soil is well buffered against acidification and thus the pH is naturally higher than in soils without carbonates.

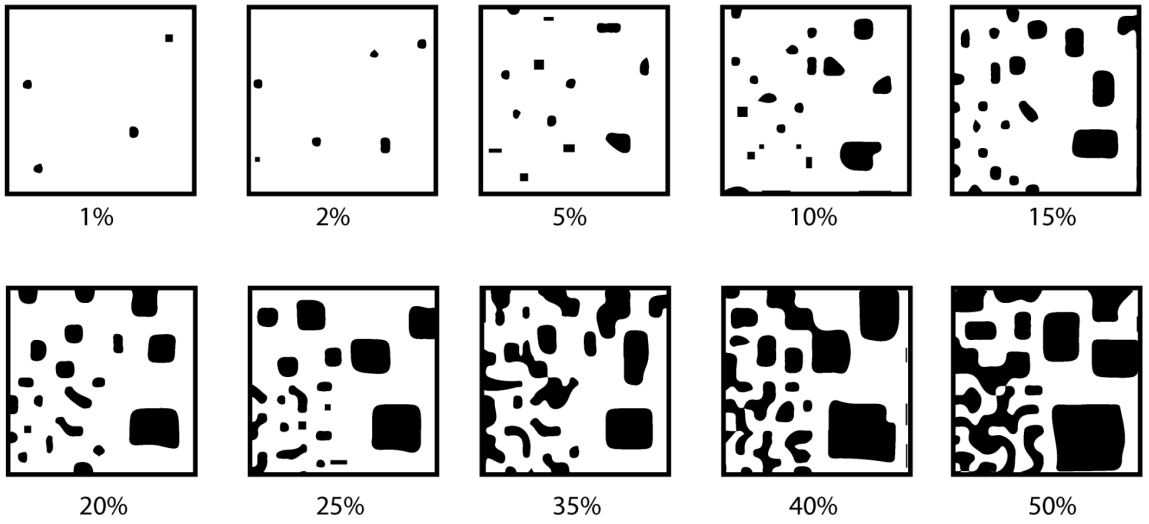
Moisture: Assess the soil moisture by looking at and possibly squeezing some soil in your hand.

Smell: Take a handful of soil and smell it. Do you smell anything distinct? Is it a foul or putrid/ fresh forest soil smell?

Color, color gradient: Note: dark/ light brown, gray, greenish, white, other (describe). You can also compare your sample with a handful of soil from an undisturbed area (e.g. grass strip next to the field). Do you see any difference in color, is it paler/ darker than the undisturbed soil?
ℹ️ Typically, a darker soil contains a higher amount of organic matter. Gray or greenish colors indicate disturbed soil respiration, poor drainage or water logging.

Mottles: Describe the color and percentage (compare with percentage chart below) of mottles (=spots with distinctly different color than the surrounding soil).
ℹ️ They are a good indication about whether a soil is well- drained and aerated. Mottles can also indicate poor soil structure and compaction with a lack of soil pores.

Percentage chart (own representation after FAO)



Soil pit: Horizon formation, Soil depth, Bedrock depth, Groundwater depth: Do you see distinct layers in your soil profile? These can be characterized by differences in color, texture or other soil attributes. Describe and make a sketch. Note how deep the A-horizon reaches in several locations. Do you know how deep you can dig until you reach bedrock? Is groundwater coming up when digging deeper?
ℹ️ Usually, we find a distinct “A-horizon” at the top with a darker color because of its higher organic matter content.

Compaction: Penetrate the soil with a soil probe in several locations and note if you feel higher resistance at a specific depth.

ℹ️ Compaction is promoted by the use of heavy machinery, overgrazing and intensive tillage. It impairs root growth and thus plant development, reduces water infiltration, and soil aeration. Often a plough pan (= compacted layer) can be detected at around 25-40 cm depth. Does the soil on the spade break open "like a book" at specific depths?

Volumetric stone content: Determine the percentage occupied by stones in the A-horizon of the soil. You can compare with the percentage chart below.

3.5. Earthworms

💼🏞️⭐ To get a feeling of the population in your soil, dig out a pit of 20cm x 20cm x 20cm and count the number of earthworms, in this volume of soil , ideally in several locations on your field. This is especially interesting to do repeatedly over the season/ years. You can also work with this more detailed method:
https://ahdb.org.uk/knowledge-library/how-to-count-earthworms (attached in the end of this document).
ℹ️ Earthworms provide essential services like improving soil structure by burrowing, mixing, aerating and recycling nutrients. They are excellent indicators of soil health and the presence of accessible organic materials, acting as feed for the worms.

3.6. Infiltration test

💼🏞️⭐ *Required material: piece of wastewater pipe, ~10L water, stopwatch, possibly mallet and piece of wood*

- Note some information about the place where the infiltration test is done. Is there a slope? On bare ground or vegetation? Is the surface crusted?
- The wastewater pipe is smacked into the soil (~5 cm), so no water runs out on the side of the ring.
- Mark a distance of 10 cm from the ground on the pipe.
- Pour water into the ring up to the 10 cm- mark and time how long it takes for all the water to infiltrate (no more visible water puddles on the surface).
- Repeat 3 times around the sampling plot, note all 3 results and calculate the mean value.

ℹ️ In the infiltration test we estimate the infiltration rate, i.e. how well the soil can take up precipitation. This depends highly on soil texture, but can also be influenced by organic matter content, nutrient content, soil fauna, rooting systems, surface crusting etc..

The infiltration rate is often given in mm (e.g. weather reports), but can also be expressed in liters / m^2. Thus, **mm / hour = L / m^2 / hour**. We measure how long it takes for a 10cm (=100mm) water column to infiltrate, thus we can calculate the infiltration rate:

$$infiltration\ rate\ (mm/hour) = \left(\frac{water\ column\ (mm)}{infiltration\ time\ (sec)}\right) \times 3600$$

3.7. Soil sampling for laboratory analysis

💼🏞️🌱 We are sampling soil for analysis in soil laboratories. You can also easily estimate bulk density and soil moisture of the sampling day yourself.

Please attach any available soil results from earlier analyses.

Required material: shovel/ soil auger, sampling rings of known volume, sealable plastic bags (~2L), sharpee

Note on each bag: farm, field, sample ID, date, which horizon/ depth, purpose of sample (e.g. for SoilBalancing, for freezing, for BD). Note the sample IDs under 2.1. General information.

Per homogenous area/ zone:

🌱 **One or several (composite) sample(s), depending on soil laboratory requirements**

⭐**Three samples with sampling ring**: for bulk density in the A-horizon (top horizon, below vegetation). The bag with the three samples should be weighed field moist, then dried until constant weight (at 105°C, e.g. in an oven for 2 hours) for a few days and weighed again. Like this, we can calculate bulk density and volumetric soil moisture on the sampling day.

$$Bulk\ Density\ [g/cm^3] = \frac{mean\ weight\ of\ air{-}dried\ soil\ [g]}{sampling\ ring\ volume\ [cm^3]}$$

$$Volumetric\ Water\ Content\ [\%] = \frac{mean\ weight\ of\ moist\ soil\ [g] - mean\ weight\ of\ air{-}dried\ soil\ [g]}{sampling\ ring\ volume\ [cm^3]} * 100$$

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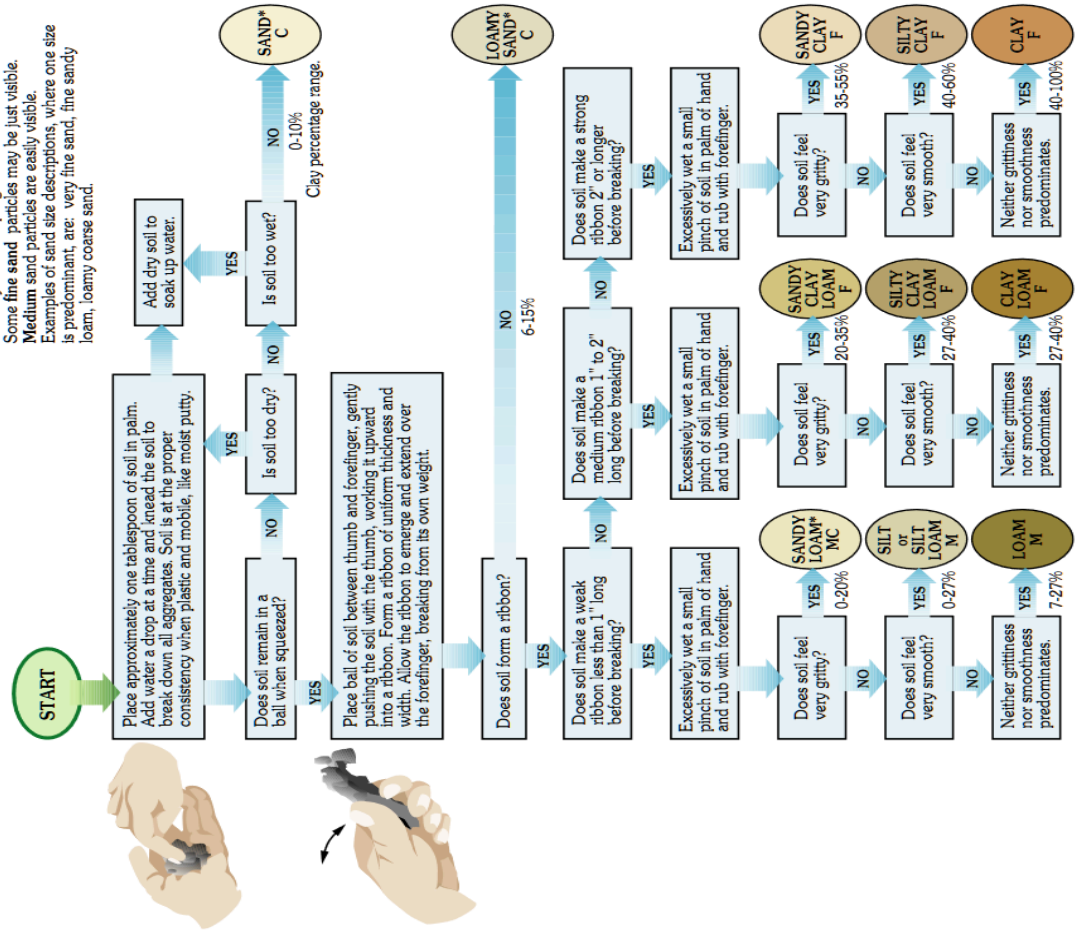
Determining Soil Texture By the Feel Method

TEXTURE CLASSIFICATION
C = Coarse
MC = Moderately Coarse
M = Medium
F = Fine

Sand particle size should be estimated (very fine, fine, medium, coarse) for these textures. Individual grains of **very fine sand** are not visible without magnification and there is a gritty feeling to a very small sample ground between teeth. Some **fine sand** particles may be just visible. **Medium** sand particles are easily visible. Examples of sand size descriptions, where one size is predominant, are: very fine sand, fine sandy loam, loamy coarse sand.



Modified from: Thien, Steve J.; Kansas State University, 1979 Jour. Agronomy Education.

Identifying adults and juveniles

Adult earthworms have a clearly developed **saddle** (reproductive ring) and juveniles do not.

You may need to rinse worms with water to determine if a saddle is present.

Size is not a good indicator of maturity as adult earthworms typically range in size from 2cm to 15cm, depending on species.

Assessing earthworm populations in just 60 minutes

When is it best to count earthworms?

Spring and autumn are the best times to carry out earthworm assessments.

Timing the sampling after warm, wet conditions often provides the best earthworm population estimates.

How to assess the earthworm populations

Tools: Spade, pot, bottle of water, mat and a record sheet available to download at **ahdb.org.uk/greatsoils**

Procedure: Dig 10 soil pits per field following a standard W-shape field-sampling pattern. Aim to spend five minutes hand-sorting the soil from each pit.

1	2	3	4
Dig out a soil pit (20cm x 20cm x 20cm) and place soil on mat	Hand-sort the soil, placing each whole earthworm into the pot	Count and record the total number of earthworms	Separate earthworms into adults and juveniles (see above)
5	**6**	**7**	**8**
Return juveniles to the soil pit	Count and record the number of each type of adult earthworm (see overleaf)	Return earthworms to the soil pit and backfill with soil	Repeat steps 1–7, until 10 soil pits per field have been assessed

HOLISTIC RESOURCE MANAGEMENT FOR
CLIMATE RESILIENCE OF FARMING

Farm Survey (Documentation)
ClimateFarming

2022-1-DE02-KA220-VET-000090163

Provided by: Triebwerk
Date: May 2023; Version March 2024

Co-funded by the European Union

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Farm Survey

Documentation form

Alena Holzknecht[1], Nils Tolle[1], Janos Wack[1]

Contact

Name	
Address	
E-Mail	
Telephone	

1. General farm information 🌱

Total farm area [ha]	
Production branches	
Certifications (EU-organic, other organic, etc.)	☐ yes ☐ no if yes, please specify:
Marketing / sales channels	
Other on-farm establishments	

Farm location within region	
Main soil type & texture	

Wind (direction, peak velocities)	
Precipitation [mm] (mean, min, max, per season, peaks)	

[1] kontakt@triebwerk-landwirtschaft.de
TRIEBWERK - Regenerative Land- und Agroforstwirtschaft UG
Im Rothenbach 49, D-37290 Meißner
https://www.triebwerk-landwirtschaft.de/

Temperature [°C] (mean, min, max, per season)	
Average amount of days < 0°C per year	
Experienced/ historic extreme weather events	☐ yes ☐ no if yes, please specify:
Personal estimation of future climatic tendencies	
Vulnerable sites within farm	

1.1. Farm overview ⭐

Farm areas	Own property [ha]/ leased [ha]	Total [ha]	Number of fields	Remarks
Arable land				
Grassland				
Vegetables				
Orchards				
Other perennials				
Forestry				

Cropping

Culture(s)/ Rotation	Area [ha]	Yield [t/ha]	Marketing/ Use

Animals

Species	Amount	Husbandry system	Output	Marketing/ Use

Source of animal feed:	
If applicable, grazing system:	

1.2. Ownership structure & decision making 🌱

Legal owners	

Lease agreements, generation changes or farm transfers	
Other involved parties for decision making	

1.3. Workforce, facilities and machinery 🌱

Staff per production branch	
Training and education of persons involved at the farm	
Special knowledge and skills	
Additional workforce	
Facilities	
Machinery	
Agricultural contractors	

1.4. Economic background 🌱

Economic situation	
Average farm investment sum (5-year period)	
Planned/ necessary expenditures	
Relative contribution of branches to income	

1.5. Climate change ⭐

Farm climate balance	☐ available ☐ planned ☐ neither
Observed climatic changes	
Climate mitigation measures	
Climate adaptation measures	

1.6. Formulation of goals and priorities

How important are…	Very Important	Important	Positive side effect	Not important
Economic performance				
Providing a livelihood for yourself/ family/ employees				
Diverse product range				
Self-sufficiency				
Higher yields				
Local/ heritage varieties				
Processing				
Biodiversity				
Biotope connectivity				
Promoting beneficial insects/ animals				
Wind protection				
Improving soil health/ soil quality				
Preventing soil compaction				
Improving water balance (on landscape level)				
Preventing nutrient leaching				
Reducing greenhouse gas emissions / climate mitigation				
Carbon storage				
Climate adaptation				
Shade for animals				
Fodder quality				
Scenery/ landscape design				
Independence from external inputs				

Other:				

2. Site Assessment

2.1. General information 🌱

Site name	
Lot number / Site ID	
Site location	
GPS coordinates	
Site area [ha]	
Land manager	
Current land use 📷	
Vegetation/ crops 📷	

Distance from main production facilities [km]	
Means of transport & time needed	
Relevance of site within farm	
Reasonable intervals for management/ observations	
Reasons for choosing this site	
Zonation short explanation: (Please attach sketch with GPS coordinates of zones)	

Per zone:

GPS coordinates/ Zone map:	
Characterize zone: 📷	Zone ID:
Sample IDs:	

2.2. Management history 🌱

Previous farm manager(s)	
Crops /-rotations	
Amendments, incl. crop residues	
Tillage regime	

Machinery use	
Other practices	

2.3. Protection status 🌱

Any/ which protection status?	
Influence on farming decisions	

2.4. Climate/weather 🌱

Wind (direction, peak velocities)	
Precipitation [mm] (mean, min, max, per season, peaks)	
Temperature [°C] (mean, min, max, per season)	
Average hours of sunlight per year	
Average amount of days < 0°C	
Local climate projections	
Experienced/ historic extreme weather events	
Personal estimation of future climatic tendencies	
Vulnerable sites within farm	

2.5. Topography & terrain 🌱 (⭐)

Altitude [m a.s.l.]	
Slope inclination, exposition	
Sunlight, shade, rain	
Surface runoff, erosion areas	

2.6. Landscape elements, compaction, drainage & surrounding vegetation 🌱 (⭐)

Waterlogging / Infiltration	
Compacted areas	
Drainage structures	
Water table [m]	

Trees, shrubs, other perennials	
Wetland areas, ponds	
Depressions, hills	

Power lines, pipes, underground cables	

⭐ Phenological indicators	
⭐ Species composition	
⭐ Plant communities	
⭐ Growth rate, yield	

2.7. Existing cultures 🌱 (⭐)

Field journal	☐ yes ☐ no
Diseases, pests	
Root or harvest residues	
Height & uniformity of cultures	
Yield	
Deficiencies, excess	
⭐ Phenological development stages	
⭐ Grasses: tillering rates	
⭐ Brix level of leafsap	
⭐ Micro-, macronutrients of leafsap	
⭐ Indicator plants: - nitrogen - water - compaction - salt	

2.8. Issues & optimisation 🌱

Microclimate (e.g. late frosts)	
Weeds or pests	
Erosion (water/ wind)	
Water balance/ management	
Biodiversity	
Wildlife	
Others	

3. Soil Assessment

Date & Time:
Authors:
Weather:    Air temperature: _____ °C

3.1. Visual Soil Assessment and Extended Spade Test 🌱

3.1.1. Surface analysis

☐ wheel tracks ☐ wind erosion ☐ water erosion (rills/gullies) ☐ surface ponding ☐ crusting ☐ cracks 📷

Ground cover: ☐ <30% ☐ 30-70% ☐ >70%

3.1.2. Organic matter, root and harvest residues

☐ none ☐ little ☐ moderate ☐ many

Describe: _____

3.1.3. Soil structure assessment

Horizon	Score	Notes
Surface (0-2) cm		📷
Topsoil (0-15 cm)		📷
Subsoil (15-30 cm)		📷

3.1.4. Root assessment:

Horizon	Score	Notes
Topsoil (0-15 cm)		📷
Subsoil (15-30 cm)		📷

3.1.5. Aggregate stability test / Slaking test

Horizon	# stable aggregates	# completely slaked aggregates	% stable aggregates	Notes
Topsoil (0-15 cm)				📷
Subsoil (15-30 cm)				📷

3.1.6. Assessment Score

$$Soil\ structure\ index\ = \left(\frac{soil\ score_{topsoil} \times aggregate\ stability_{topsoil}}{2}\right) + \left(\frac{soil\ score_{subsoil} \times aggregate\ stability_{subsoil}}{2}\right)$$

Zone ID	Horizon	Root score	Soil structure score	% stable aggregates	Overall soil structure index
	Surface (0-1 cm)				
	Topsoil (0-15 cm)				
	Subsoil (15-30 cm)				
	Total (=Topsoil + Subsoil)				

3.2. Root indicators

- **White root tips:** ☐ none ☐ few ☐ moderate ☐ many ☐ all 📷

- **Soil attached to roots:** ☐ none ☐ little ☐ moderate ☐ a lot

- **Smell:** ☐ pleasant/earthy ☐ foul/putrid/rotten eggs☐ fungal/ fresh forest soil ☐ like the plantation (e.g. carrots) ☐ no smell (also not earthy) ☐ other, describe: _____

- **Root nodules on legumes (per plant):** ☐ none ☐ few ☐ moderate ☐ many ☐ on every root

→ **nodule colour on the inside:** ☐ reddish/pink ☐ greyish green or brown ☐ other, describe: _____

- **Root orientation/ root barriers (mechanical/ chemical):**
_____

- **Root depth:** most roots: _____ cm, deepest root: _____ cm

- **Visible Mycorrhizae:** ☐ none ☐ few ☐ moderate ☐ many

Space for additional notes:

📝 **Remember to:**

- draw a map of zones within every field
- take pictures of the soil pits with a measuring tape
- take soil samples and note sample IDs

⏰ **Time needed to assess this zone:** _____

🌱 **If you are doing the base case scenario, you are done with the Soil Assessment. Well done!**

⭐ **For best-case scenario, continue:**

3.3. Soil texture (Soil Ribbon Test) ⭐

Coarse: ☐ sand ☐ loamy sand ☐ clayey sand

Medium: ☐ sandy loam* ☐ silt or silt loam ☐ loam

Fine: ☐ sandy clay loam ☐ silty clay loam ☐ clay loam

☐ sandy clay ☐ silty clay ☐ clay

*moderately coarse

3.4. Other Soil indicators ⭐

- **Carbonate testing:** ☐ no bubbling ☐ only audible ☐ slight bubbling ☐ strong bubbling

- **Moisture:** ☐ dry ☐ slightly moist ☐ moist ☐ very moist ☐ wet

- **Smell:** ☐ pleasant/earthy ☐ foul/putrid/rotten eggs ☐ fungal/ fresh forest soil ☐ like the

plantation (e.g. carrots) ☐ no smell (also not earthy) ☐ other, describe: _____

- **Colour:** ☐ dark brown ☐ light brown ☐ grey/blue/greenish ☐ white ☐ reddish/orange ☐ other, describe: _____

- **Mottles:** ☐ none ☐ gray/blue/greenish ☐ orange/red; **if present, how many?** _____ %

- **Soil pit:** describe and sketch:

_____
_____
_____
_____
_____
_____
_____
depth of A-horizon:_____ cm

- **Compaction:** ☐ yes ☐ no; if yes, at which depth: _____ cm/ _____ cm/ _____ cm

- **Soil depth:** _____ cm, **Bedrock depth:** _____ cm,
Groundwater depth: _____ cm

- **Volumetric stone content:** _____ %

Space for additional notes:

3.5. Earthworms ⭐

Earthworm number in 20cm x 20cm x 20cm of soil:

3.6. Infiltration test ⭐

Infiltration time #1:	Infiltration time #2:	Infiltration time #3:

Infiltration rate:

⏰ **Time needed to assess this zone (base+best-case scenario):** _____ + _____ min.

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Monitoring Success of Measures

	Explanation	Measurement/necessary data	expressiveness	Measuring frequency*	DIY?
Floor			in terms of indicators		
Carbon storage	How does the organic carbon content (=TOC) change in the soil?	TOC from soil samples, possibly different soil layers	Soil health indicator	with regular soil analysis; approx. every 1-3 years	in the soil laboratory
Water holding ability	How well can the soil hold water?	Soil laboratory	Resilience in the event of prolonged absence of		
Water infiltration	How quickly does water infiltrate the soil surface?	Infiltration test (see instructions in Farm Survey)	Erosion risk indicator	can be repeated several times per year (e.g. at different stages of vegetation, before and after plowing); at least once per year	x
evaporation	How much water evaporates from the surface?	Evaporation measurement (see agroforestry monitoring document)	Loss of water from the area	can be repeated several times per year (e.g. at different stages of vegetation, before and after plowing); at least once per year	
Structural stability	How many stable aggregates are there? How big are these? What shape are they?	Aggregate stability test (see instructions in Farm Survey)	Indicator of soil health, carbon storage, soil management (e.g. compaction)	can be repeated several times per year (e.g. at different stages of vegetation, before and after plowing); at least once per year	x
Edaphone activity	How many soil creatures are there?	Earthworms as a proxy?	Mixing, mineralization, formation of aggregates higher soil health	Once a year at a similar time	x
Ground cover	What level of ground cover was achieved by the measures (e.g. catch crops)?	% ground cover calculated over the year (i.e. not just in full vegetation); alternatively: Duration of fallow land/when the ground is not covered		document continuously throughout the year	x
Temperature on the surfaces	What is the temperature at the ground surface? Higher temperature = higher evapotranspiration, risk of drought	Surface temperature measuring device	Cooling effect of vegetation, especially shading from trees/shrubs	document continuously throughout the year and during special events	x
Nitrogen losses	Where are there losses in the system, for example due to erosion?	?? Possibly calculation of fertilization, nutrient analyzes of plants and soil	Can the nutrients be retained in the soil?	document continuously throughout the year and during special events	
Erosion by leaching	Can the top layer of soil be kept on the area?	?? through observation	Removal of the top layer of soil = loss of fertility	document continuously throughout the year and during special events	x
Erosion by drifting	Can the top layer of soil be kept on the area?	e.g. MWAC masts, see agroforestry monitoring	Removal of the top layer of soil = loss of fertility	document continuously throughout the year and during special events	x
soil moisture	How high is the soil moisture? When during the day/year is it particularly low?	Soil moisture meter	Covering soil can hold more water; However, too high soil moisture can also be	document continuously throughout the year and during special events	x

Crop production					
weeds	Are there new or more/fewer weeds? How many compared to previous years?	Records, documentation	Does the system promote the “right” organisms?	document continuously throughout the year	
Perspiration rate	How much water do plants lose to the environment? (Water use efficiency)	??	?		
camp	How often does the crop go into storage? When/at what events?	Records, documentation	Low stability of the culture, e.g. due to too high a nitrogen content	document continuously throughout the year and during special events	
Water consumption	If irrigated: How much water is needed? When? On which areas?	Records, documentation		document continuously throughout the year	x
Failure rate	What proportion of the harvest failed due to stress factors, external influences, etc.?	Records, documentation	Influence of factors that cannot be controlled: weather, climate change, pests, infrastructure, etc.	at harvest	x
Development of the pest population	How high is the pest pressure compared to before the measures? Are there new parasites or other diseases?	Records, documentation	Does the system promote the “right” organisms?	document continuously throughout the year and during special events	x
Development of the beneficial insect population	How high is the population of beneficial insects (species, quantity) compared to before the measures?	Records, documentation	Does the system promote the “right” organisms?	document continuously throughout the year and during special events	x
Monitoring of malicious images	What does damage to plants look like?	Records, documentation		document continuously throughout the year and during special events	x
ower nutrient absorption due to drought and stress	Is nutrient absorption prevented by stress factors? Are nutrients present but not mobilized/in the wrong form?	Documentation of stress symptoms, nutrient content of the plant sap	Does the plant's nutrient absorption function properly?	document continuously throughout the year and during special events	(x)
Nitrous oxide emissions	When are fertilizers applied? How much per hectare? Which product?	documentation	Where do greenhouse gas emissions arise that could be prevented?	document continuously throughout the year and during special events	(x)
livestock farming					
sunburn	Do the animals get sunburned? How many? When? How often?	Observation of symptoms, documentation	Indicator of heat stress, general herd health	document continuously throughout the year and during special events	
Parasites	Do the animals have parasites? How many? When? How often?	Observation of symptoms, documentation	Herd health indicator, pasture management	document continuously throughout the year and during special events	
Movement patterns	Are the animals acting more restless than usual? When?	Observation of symptoms, documentation	Indicator of stress, e.g. due to heat or high humidity	document continuously throughout the year and during special events	x
Water consumption	Are the animals drinking more than usual? When?	Document water intake	Indicator of heat stress	document continuously throughout the year and during special events	x

Feed intake	Are the animals eating less than usual? When?	Document feed intake	Decreasing feed intake (up to -25%) is an indicator of heat stress	document continuously throughout the year and during special events	x
Departures diseases	How many sick animals are there? Where do the diseases come from? Were the animals already weakened beforehand? If yes why?	Recording, documentation	General herd health	document continuously throughout the year and during special events	x
Purchase	How much feed must be purchased? What? What quality does it have?	Recording, documentation	Indicator of self-sufficiency, availability of high-quality feed	document continuously throughout the year and during special events	x
Nitrous oxide emissions	How is the herd managed? How is the manure stored and applied?	Recording, documentation	Proper livestock/grazing/manure management	document continuously throughout the year and during special events	
Biodiversity fauna	How high is the diversity of animals in the area? e.g. species of birds, bats, insects (ground beetles, wild bees, grasshoppers, etc.), small animals	Recording, documentation	Higher biodiversity = better use of ecological niches -> higher resilience	document continuously throughout the year	(x)
Biodiversity flora	How high is the diversity of plants on the area?	Recording, documentation	Higher biodiversity = better use of ecological niches -> higher resilience	document continuously throughout the year	(x)
Soil biodiversity	How high is the biodiversity in the soil (micro and macro fauna)	Recording, documentation	ecosystem function; Nutrient cycles, utilization of organic material, carbon storage, greenhouse gas emissions, etc. higher biodiversity = higher resilience against pests and diseases	document continuously throughout the year	(x)
Economy/Logistics/Transportation					
Number of irrigation days	How many days a year is watered? How much water is needed?	Recording, documentation	Dependence on irrigation, level of water consumption	document continuously throughout the year	x
Drone operations monitoring number	How often per year is monitoring carried out with a drone? What is recorded?	Recording, documentation	Density of data points for monitoring	document continuously throughout the year	x
Fuel consumption	How much fuel is used per year? What are the costs for this?	Recording, documentation	Costs, dependence on external resources	document continuously throughout the year	x
Fertilizer consumption	When are fertilizers applied? How much per hectare? Which product?	Recording, documentation	Costs, dependence on external resources	document continuously throughout the year	x
Use of pesticides	When are pesticides discharged? How much per hectare? Which product?	Recording, documentation	Costs, dependence on external resources	document continuously throughout the year	x
Water & energy supply					
natural surface water	How high is the water level on lakes/rivers in the area at certain times? Is the water clear/cloudy/algay?	Recording, documentation or research/inquiries with authorities	Availability and quality of water	document continuously throughout the year and during special events	(x)

artificial water reservoirs	How full are water reservoirs in the area? When will they be fed?	Recording, documentation	Availability of water	document continuously throughout the year	(x)
PV yield	How high is the annual yield of photovoltaic systems? To what extent does it cover the needs?	Recording, documentation	Independent energy supply, effectiveness	document continuously throughout the year	x
Wind yield	How high is the annual yield from your own wind turbines? To what extent do they cover the need?	Recording, documentation	Independent energy supply, effectiveness	document continuously throughout the year	x
Bioenergy yield	How high is the electricity yield of bioenergy systems per year? To what extent do they cover the need?	Recording, documentation	Independent energy supply, effectiveness	document continuously throughout the year	x
fossil energy use	How much energy from fossil fuels is needed per year? What proportion is obtained from fossil energy sources? What are the costs	Recording, documentation	Energy supply, dependence on external resources	document continuously throughout the year	x
Hydropower?	How high is the annual yield from your own hydropower plants? To what extent does it cover the	Recording, documentation	Independent energy supply, effectiveness	document continuously throughout the year	x
Other					
Employee satisfaction	How satisfied are employees with the working environment/workload/distribution of tasks? Do you support new measures and implement them conscientiously?	Regular employee discussions, questionnaires, feedback sessions, failure/change rate	Satisfied and happy employees create a pleasant working environment, are more productive and usually stay with the company longer	continuously throughout the year and fixed regular appointments for employee discussions, feedback, etc.	x
CO2 balance	What do the greenhouse gas flows look like on the farm? (Energy, machines, materials, etc.) How have they changed compared to previous years?	Recording, documentation, possibly also external help/special programs/apps; important: define system boundaries!	Reducing greenhouse gas emissions on the farm directly contributes to curbing climate change and thus its consequences	Keep records throughout the year and calculate a balance sheet once a year	(x)
* Depends heavily on the context and what you want to achieve with the measures. Therefore, determine the appropriate frequency yourself					
Climate change consequences					
Categories/Indicators	Explanation	Measurement	expressiveness	Measurement frequency	
Crop production					
sunburn	Was there sunburn? What value has been lost as a result? Were there measures taken to contain the damage?	Records, documentation	Assess the effects of climate change at the location and any expected worsening of the problem	at special events	
Symptoms of heat stress	Do the plants show symptoms of stress at high temperatures?	Records, documentation: folded/rolled leaves, brown/dry spots, hanging plant parts	Assess the effects of climate change at the location and any expected worsening of the problem	In the event of special events, check regularly (approximately every 2 years) whether there are new climate models	

sowing date	Has the sowing date changed in recent years? How?	Records; Possibly also documentation of trafficability, soil moisture, frost, etc. depending on the individual crop	Assess the effects of climate change at the location and any expected worsening of the problem	continuously, regularly (approximately every 2 years) check whether there are new climate models	
Hail damage	Was there hail damage? What percentage of the area did they affect? Possibly what value was lost as a result?	Records, documentation	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	In the event of special events, check regularly (approximately every 2 years) whether there are new climate models	
Frost damage	Was there frost damage? What value has been lost as a result? Were there measures taken to contain the damage?	Records, documentation	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	In the event of special events, check regularly (approximately every 2 years) whether there are new climate models	
Heavy rain	How often/how early were heavy rain events? What damage did they result in?	Documentation of events and damage, e.g. soil erosion -> brown, cloudy rivers (topsoil was washed away), washing away of seeds and small plants	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	In the event of special events, check regularly (approximately every 2 years) whether there are new climate models	
Ecosystems					
Beginning of the growing season	When do certain plants start to grow/bloom?	Recording, documentation	Estimate how the growing season may shift	continuously, regularly (approximately every 2 years) check whether there are new climate models	
meteorology					
humidity	How does air humidity change on a daily/annual basis? Is there a change compared to long-term averages? When is it particularly high?	recording, documentation; Research into long-term average values and climate forecasts	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	continuously, regularly (approximately every 2 years) check whether there are new climate models	
wind speed	How does the wind speed change on a daily/annual basis? Is there a change compared to long-term averages?	recording, documentation; Research into long-term average values and climate forecasts	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	continuously, regularly (approximately every 2 years) check whether there are new climate models	

Temperature ø, >30°, <0°	How does the temperature change daily/yearly? Is there a change compared to long-term averages? When do temperatures >30°C or <0°C occur?	recording, documentation; Research into long-term average values and climate forecasts	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	continuously, regularly (approximately every 2 years) check whether there are new climate models	
Precipitation values	How does precipitation change on a daily/annual basis? Is there a change compared to long-term averages? When is there particularly much/little rain?	recording, documentation; Research into long-term average values and climate forecasts	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	continuously, regularly (approximately every 2 years) check whether there are new climate models	
Heat periods, heat waves	When do heat waves occur? Will these be longer compared to previous years?	recording, documentation; Research into long-term average values and climate forecasts	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	In the event of special events, check regularly (approximately every 2 years) whether there are new climate models	
Economy/Logistics/Transportation					
Frost protection days number	How many days a year are frost protection measures required? When? Which?	Recording, documentation	Assess the effects of climate change at the location and any expected worsening of the problem; Check regularly (approximately every 2 years) whether there are new climate models	continuously, regularly (approximately every 2 years) check whether there are new climate models	
Water & energy supply					
Groundwater supply/level	How high is the groundwater level? Can groundwater be used without restrictions?	Research/inquiries with authorities (regional measurement of groundwater levels); If you are more interested, you can also install a pipe that is inserted into the ground until the groundwater is reached, then measure the distance from the ground surface to the groundwater surface; can remain installed at the edge of the field for years	Availability of water, supply of groundwater through infiltration	1x per year and during special events (e.g. long droughts, heavy rain events)	

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