



HOLISTIC RESOURCE MANAGEMENT FOR  
CLIMATE RESILIENCE OF FARMING

# Theoretical Description of the ClimateFarming Cycle ClimateFarming

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## The ClimateFarming Cycle: SUMMARY

**Aim:** Address the challenges of climate change adaptation at farm level.

**Target group:** Experts and consultants from the agricultural sector. Possible for farmers that are able to invest some hours and can get support from a consultant if needed.

**Background:** Combining different methodological approaches, including "Decision-making Under Deep Uncertainty" (DMDU) and "Strategic Farm Management" with findings from practical projects. More information provided in the CF Trainer Handbook

Consists of **five modular process steps:**

1. farm survey
2. farm vulnerability analysis
3. adaptation measures
4. farm climate strategy
5. monitoring and implementation

The individual steps can be used independently of each other and adapted to the individual farm conditions.

The main product is a farm-specific climate strategy with a strategy-specific monitoring system.

Monitoring is a core element of the process to ensure regular evaluation of the success of adaptation measures, to identify necessary changes in measures and strategies and to stimulate learning processes.



## Introduction

Agriculture is affected by climate change like hardly any other sector. This poses new and unknown challenges for agriculture as a whole, but also for each individual farm. In order for farmers to be able to identify, assess and manage these complex challenges, a holistic approach is required. This approach must take into account the specificities of the individual farm and integrate the regionally specific impacts of climate change. Furthermore, it must support the use of synergies between different protection and adaptation measures and enable proactive, far-sighted farm management. In addition, the approach must incorporate the risks resulting from uncertainties (associated with climate change) into the planning process and minimise them as far as possible. However, some risks cannot be foreseen or minimised. Therefore, farm-level strategies need to be resilient and flexible so that they can be easily adapted and modified in case of unforeseen changes.

The ClimateFarming Cycle is a Decision-Support-Tool<sup>1</sup> in the form of a modular planning framework divided into five steps. The basis is the *ClimateFarming Handout*, in which the different steps of the ClimateFarming are compiled in a practice oriented manner. This includes To-Do's, templates and info-sheets with which the individual steps can be conducted. The handout, and the ClimateFarming Cycle as a whole, is intended to support consultants in developing climate strategies for individual farms together with farmers.

The aim of the ClimateFarming Cycle is to enable advisors, experts and farmers to act proactively despite the dynamic and uncertain course of climate change. The focus is not on individual measures and their implementation. Instead, the ClimateFarming Cycle is intended to direct the actors' attention to the interaction of short-, medium- and long-term measures in the field of climate protection and climate adaptation and help them to fit these measures to individual farm objectives and conditions. In doing so, the risks of misalignment are minimised, synergies between different measures are used and possible conflicts of objectives are actively dealt with. The ClimateFarming Cycle serves as a template for how different methods from the field of farm planning and adaptation management can be used at the farm level. Since the focus is on the individual farm, the methods used in the ClimateFarming process should always be designed according to the individual farm. The modular structure of the ClimateFarming Cycle helps here, making it possible to apply individual steps independently to best fit the use case.



Example for the modular structure of the ClimateFarming Cycle: The five steps of the ClimateFarming Cycle can be applied independently of each other. For example, if a farm does not have enough time to go through all five steps, only a comprehensive farm analysis (step 1 and step 2) can be carried out, followed by a collection of adaptation measures (step 3). This does not result in a climate strategy for the farm in question, but it gives the farm managers an overview of possible adaptation measures for their farm and enables them to make better decisions for farm development.

It is up to the users to decide which parts of the ClimateFarming Cycle and the different methods are used or how they are adapted to individual operations. However, this should always be done in a

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<sup>1</sup> Decision-Support: Collection of processes which serve the purpose to generate and use information relevant for decision-making (US National Research Council, 2009). Three aspects are emphasized by Marchau et al. (2019):

- (1) The way how knowledge is integrated into decision-making processes is as relevant as the knowledge or information itself
- (2) The co-production of knowledge by the provider of information and the user of information
- (3) The decision-making processes must be designed in a way that the users (decision-makers) are able to learn



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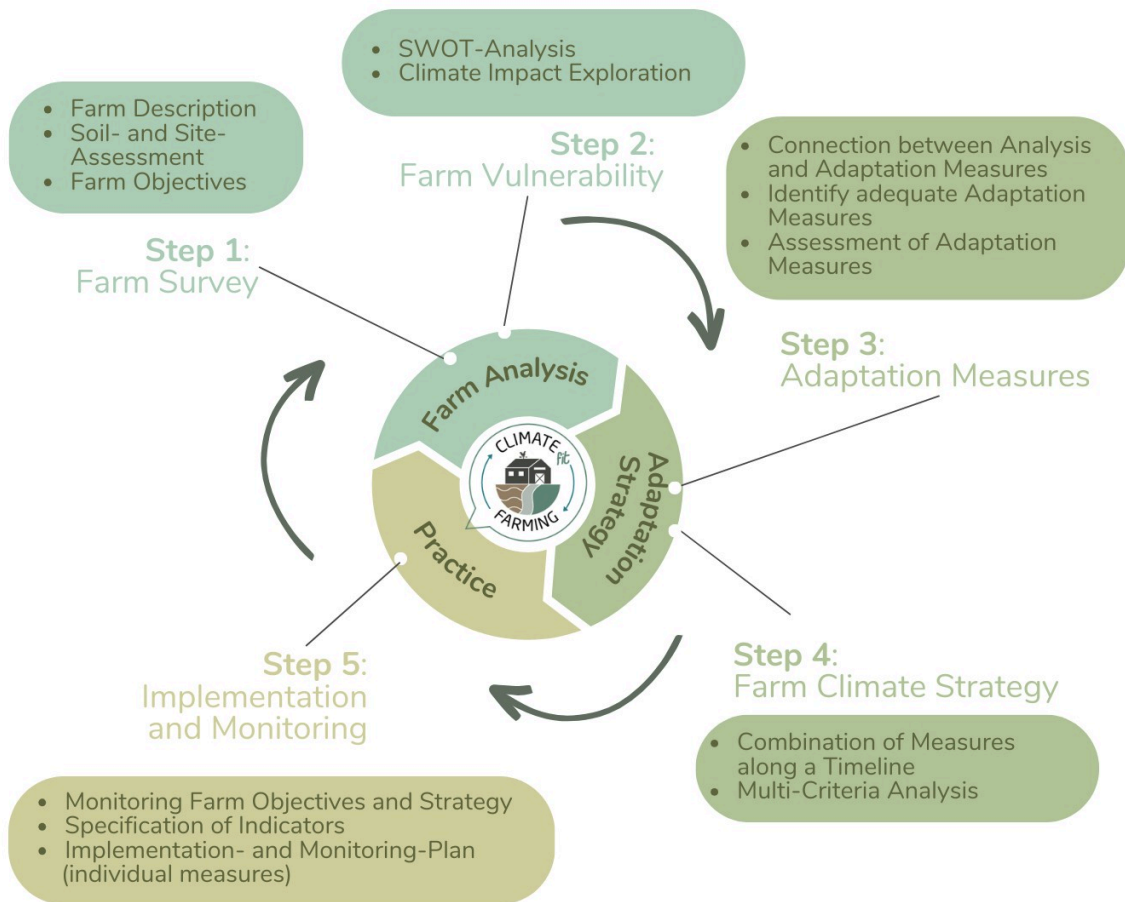
well-considered manner and, if in doubt, in consultation with experts, so that the effectiveness of the ClimateFarming Cycle is maintained. Furthermore, the ClimateFarming Cycle is also a dynamic tool and is constantly being further developed on the basis of new practical and scientific findings. Accordingly, the present version only shows the current state of development of the ClimateFarming Cycle.

Due to the high - but necessary - complexity of the ClimateFarming Cycle and the interaction between agriculture and climate change, this chapter is primarily aimed at agricultural consultants. Although the methods and planning process are described in a generally understandable way, the practical implementation on most farms will not be possible without external support due to the time required. Nevertheless, all practitioners are invited to use the ClimateFarming Cycle themselves to develop a farm-specific farm climate strategy or to adopt individual steps and insights from this guide in their own farm management.

## Theoretical Description of the ClimateFarming Cycle

### IN A NUTSHELL

The five steps of the ClimateFarming Cycle are explained below. Where reference is made to the **ClimateFarming-Consultant**, this is the person who goes through the process with the farm members and adapts the steps to the individual farm. As this is usually not a member of the farm but an external professional (an external consultant), it is divided into ClimateFarming-Consultant and the **Farm Members**. The farm members are all involved parties at the farm. This includes the farm manager(s), all farm workers and possibly also family members or others who are involved in decision making or may be affected by new decisions.



Overview ClimateFarming Cycle

## Step 1: Farm Survey

### IN A NUTSHELL

- Guiding question(s): What is the status quo on your farm? Are you already implementing or planning to implement specific adaptation measures? What are the farm objectives?
- Step 1 sets the stage and the framework for the following application of the ClimateFarming Cycle. This framework determines the scope, and (time) resources needed and consequently the depth of the application. The ClimateFarming Consultant gets acquainted with the farm and its characteristics. This is their foundation to plan and conduct the application of the ClimateFarming Cycle. Additionally, the farm members are required to get a clear idea of what they want to achieve with their farm and their activities. They formulate Farm Objectives, which will be the guide for all that follows. These farm objectives will be the foundation for exploring vulnerabilities, collecting adaptation measures and ultimately the bar to measure success or failure of an adaptation strategy.
- Step 1 entails the following tasks:



- Introduction to the ClimateFarming-Project, the ClimateFarming-Cycle and the goals of the ClimateFarming consultation; alignment with expectations of farm members
- Deciding of the scope of the ClimateFarming Cycle and its implementation (e.g. going through the complete cycle or only using individual steps)
- Establish a status quo of the farm using the Farm Survey and the Site- and Soil-Analysis
  - The Farm Survey is a questionnaire which will be filled in by the farm members and the consultants to provide basic information concerning the farm, incl. implemented or planned adaptation measures
  - The Farm Survey also entails a step-by-step guide for how a field-specific analysis should be conducted, called the Site- and Soil-Analysis
- The farm members formulate farm objectives. These objectives should not only comprise economic objectives, but also other aspirations (e.g. ecological, social or other). Important is to formulate guiding objectives (qualitative goals) and measurable objectives (quantitative) if possible

The purpose of this step is to describe the farm and its characteristics and to formulate farm-specific objectives. This knowledge is important for the vulnerability analysis in step 2 and the identification of farm-specific adaptation measures in step 3. The farm objectives serve as indicators to evaluate the success or failure of the farm climate strategy.

Recording and describing the current situation of the farm is the basis for all further steps. This includes information on climate, soil, land, production branches and methods as well as other important information, summarised in the Farm Survey. An important part of the farm description is to determine the extent to which climate adaptation measures have already been implemented or planned. This provides a basis on which future measures can be built.

If a CO<sub>2</sub>-footprint is planned, it is relevant to define the methods as well as system boundaries for the assessment, so that these are consistent when evaluating measures and strategies. In addition to the farm description, the soil and site analysis of the Farm Survey serves to identify problems specific to different farm sites and fields and to subsequently formulate solutions (in later steps). Read more in the Farm Survey.



## Objective Formulation

In classical business management, the goals of entrepreneurial action usually include profit maximisation with certain restrictions resulting from the values and norms of the business managers. The ClimateFarming Cycle recommends moving away from this type of goal formulation and instead formulating goals on the basis of so-called critical results. In economic terms, this means defining the minimum profit necessary rather than the desired maximum profit. Example A is supposed to illustrate the concept in a practical manner.

This approach of “critical results” is helpful when different adaptation measures or development paths for a farm are possible and the farm members must decide between different options. The advantage of using critical results is that it provides guidance on how to choose between different options. Instead of considering which option yields the highest (financial) benefit, the farm members are required to check whether an option is potentially able to satisfy the farm objectives (critical results) and then examine how risky or uncertain the success of an option is. Example B is supposed to illustrate the concept in a practical manner.



Example A: A resilient farmer:

Arable farmer A pursues the goal of profit maximisation and wants to earn "as much money as possible" from the farm. That is why the farm only grows high-yielding varieties. This guarantees very high yields in optimal years with balanced weather, and low disease and pest pressure. However, in years that do not meet these optimal conditions, the farm suffers high losses. Arable farmer B has set “critical results” that the farm must meet in order to function. One of these results is to achieve a five-year average output of at least 80,000€ net margin. In order to achieve this critical result even in bad years, she grows different varieties. This includes drought-tolerant varieties. These varieties do not produce as high yields as farmer A's varieties in optimal years, but losses in dry, non-optimal years are lower and the farm is able to achieve critical results.



Example B: How the approach of “critical results” influences deciding between options:

The agricultural activities of the example farm must generate a surplus of 60,000€ per year in order to pay the farm managers and build up reserves. In order to achieve this goal, the farm is looking into setting up an additional production branch. There are two alternatives: Branch A and Branch B. If Branch A is implemented, the annual profit could increase to 65,000€ - with Branch B up to 80,000€. However, when analysing the two alternatives, it becomes clear that the potentially higher profit of Branch B is subject to much greater uncertainties and risks. In terms of resilience and achieving the critical results, the less vulnerable Branch A is favoured, despite lower profit prospects (under optimal conditions).

For agricultural practice, the reduction of yield variability by giving up optimal yields is basically not new and part of strategic farm management. However, it makes sense to be aware of these decisions and also to formulate corresponding qualitative and quantitative objectives. The guiding question asks what results the farm activities need to achieve in order to be satisfactory for all farm members. The process of formulating farm objectives should be as inclusive as possible, including all farm members.

It is important to remember that many different objectives may be important to a farm and its members, including economic outcomes, ecological demands, social factors or other farm-specific





aspects. These goals may overlap, complement or conflict with each other. The goal must be to find the adaptation measures and strategies which perform the best across the various farm objectives.

## Step 2: Farm Vulnerability Analysis

### IN A NUTSHELL

- Guiding question(s): What are the strengths and weaknesses of our farm? What opportunities and threats can arise for our farm? What climate changes and impacts do we need to prepare for? Which are the most pressing vulnerabilities adaptation needs?
- Step 2 serves as a farm-specific vulnerability analysis for the potential threats and opportunities that may arise from climate change. This step combines the analysis of current vulnerabilities with the exploration of experienced or potential climate impacts on the farm. Like in all other steps, the value of its results is highly dependent on the participation of the farm members and a clear understanding of all participants concerning the goals, scope and methods of the farm vulnerability analysis. The insights developed in Step 2 (together with Step 1) are the basis for compiling farm- and/or field-specific adaptation measures (Step 3).
- Step 2 entails following tasks:
  - Plan the farm vulnerability analysis
  - Conduct a farm vulnerability analysis
    - Analyse the current vulnerability of a farm based on SWOT-Analysis: *Strengths, Weaknesses, Threats and Opportunities*
    - Collect past and recent climate impacts and explore which future climate impacts could be negative or beneficial for the farm
    - Connect the SWOT results and the exploration of climate impacts in order to prioritize certain farm aspects and/or climate impacts where adaptation is necessary (called *Adaptation Need*)
    - Analogous, a *field-specific vulnerability analysis* can be conducted (based on Farm Survey)
- Optional: If appropriate resources and skills are available, you can further expand the vulnerability analysis by:
  - Identification of (regionally specific) climate projections
  - Deriving potential impacts relevant for long-term farm development (>30 years)

Broadly speaking, a vulnerability and climate impact assessment aims at the identification of climate change induced threats for a specific system (UBA, 2017). This system could be a nation, a city, or a farm. The general goal of the process is to prioritise certain climate change threats and



corresponding adaptation measures. The common, science based procedure is to identify climate projections which cover the geographical location of the considered system, derive climate information, e.g. increase of hot days, and assess what climate impacts this change in hot days will have on the considered system. This process normally requires a lot of time, resources and expert knowledge. All three factors are scarce at the farm-level. Still, it is essential to identify core vulnerabilities and prioritize adaptation measures. Consequently, we need to adjust and facilitate the approach of vulnerability and climate impact assessment to be useful at the farm-level.

### SWOT-Analysis

The farm vulnerability analysis consists of two steps. First, the current vulnerability of the farm is analysed. In the ClimateFarming Cycle, a simple SWOT-Analysis is used. The SWOT-Analysis serves to identify farm-specific *Strengths* and *Weaknesses* as well as possible *Opportunities* and *Threats*. *Strengths and Weaknesses* refer to internal factors, while *Opportunities and Threats* include external factors, which are normally collected in a SWOT-Matrix. Internal factors include physical, financial and human resources (e.g. soil quality and land area, equity for investments, available knowledge and skills, etc.). External factors include input prices, markets, consumer habits and trends, technology and policy frameworks. The Farm Survey (Step 1) can serve as a basis for the analysis.

The aspects collected in the SWOT-Analysis are not necessarily related to climate change - other factors can be relevant too, e.g. a well functioning direct-marketing channel (*Strength*) or high weed pressure (*Weakness*). However, if the farm members identify the increase of spring droughts at this point as a threat, this can and should be integrated in the SWOT-Matrix and will be discussed again later in the climate impact exploration. The goal of the SWOT-Analysis is to get a good insight of the present situation of the farm, as many of the current issues of the farm can be amplified by climate change. Consequently, the vulnerability of a farm can already be reduced by addressing its current issues without implementing actual adaptation measures.



Example: A dairy farm suffers from low clover-grass yields with low quality and consequently low milk yields. The investigation of the farm in the scope of the Farm Survey and the Soil- and Site-Analysis shows a nutrient imbalance which most probably causes the low yields and qualities. This imbalance can be addressed by specific inputs or adjustments in the crop rotation, which should stabilize yields and improve farm profitability.

This exemplary issue is not caused by climate change, but could be aggravated by extending drought periods or erosion events. As a consequence, addressing current farm issues (or taking advantage of chances) is not always directly connected to climate change, but can help to reduce a farm's vulnerability to future climate impacts. It can be stated: a well functioning and profitable farm with healthy soils and animals in the present is less likely to be negatively impacted by climate change in the future. However, in order to secure this success, climate impacts must be considered in the planning too, which leads to the second part of the farm vulnerability analysis

### Additional Method 1: TOWS-Analysis

In the case of a complex farming system with different production branches and/or an excessive high number of identified SWOT aspects, the TOWS-Analysis could be a reasonable complementation of the vulnerability analysis. A TOWS matrix is comparable to a SWOT matrix, but contains four additional blocks which focus on the interactions of the individual SWOT elements and serves the preliminary formulation of strategies to address the different SWOT aspects. More information on the method can be found in the *ClimateFarming Trainer Handbook*.



## Climate Impact Exploration

As mentioned in the beginning, an elaborated climate impact assessment based on regionally-specific climate projections is in most cases not possible to be conducted at the farm-level. Still, it is important to explore how certain changes in climate parameters and especially in extreme events can affect the specific farm system.

For this purpose, the ClimateFarming Cycle takes an explorative approach, mostly based on *“The Vulnerability Sourcebook”*, published by the *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH* (2017).

Based on the expert-knowledge of the farm members and the advisor, past weather phenomena and extreme events are collected and their impact analysed (compare Step 1: Farm Survey). Following, observed trends and possible future climate impacts are collected and clustered. Afterwards, these different impact clusters can be graded and prioritized.

## Past Climate Impacts

The participatory process starts with the following discussion questions (*GIZ, 2017 - modified*)

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 (i.e. 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)?

First, the past weather phenomena and events are collected. Especially interesting are extreme events like floods, drought periods etc. Likewise, the farm members collect rather recent trends they experienced. Following, the farm members write down how these past phenomena and events impacted their farm and connect the impact with the corresponding event.

## Future Climate Impacts

Following, the possible future climate impacts on the farm will be explored. For this purpose, the discussion questions below can support this process:

1. 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)?
2. Hot Days: How could it impact your farm if the number of hot days (>25-30°) and heat waves increase?
3. 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?



4. 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?
5. Frost: How could a decrease in frost days (< 0°C) impact your farm? How could a decrease in late frost days impact your farm?
6. Hail, Wind and Storm: How could a change in hail, wind or storm events impact your farm?
7. Sun hours: How could an increase in sun hours impact your farm?

These questions are just examples of how to structure a discussion in order to examine how different changes in climate parameters could impact a specific-farm. These questions do not cover all possible changes due to climate change and can and should be adapted to the individual farm, its structures and the specific region.

### External and indirect Climate Impacts

Like the direct climate impacts above, indirect climate impacts and other external factors may influence your farm. The guiding questions below can be used to explore eventualities, so the farm can be as prepared as possible when unforeseen events happen.

1. **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?
2. **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?
3. **Contractors:** How could your farm be impacted if external contractors would not be able to perform their services for you?
4. **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?
5. **Pests and diseases:** How could your crops or animals be impacted by upcoming or new pests and diseases?
6. **Other questions:** Feel free to develop your own, farm-specific questions to explore how the farm is probably affected by indirect climate impacts

### Limitations

The exploration of climate impacts based on expert knowledge (farm members and ClimateFarming Consultant) is an approach of integrating potential climate impacts in the farm-specific vulnerability analysis without being dependent on the availability of adequate climate projections and the expert knowledge to understand and interpret these projections. This approach is optimized for the usage at the farm-level, but it is important to be aware of its limitations. The results are highly dependent on the persons assessing the climate impacts and also how they perceive related risks. Consequently, the climate impact exploration is a way to integrate climate impact considerations in farm-level decision-making, but it is not comparable to a sophisticated climate impact assessment, based on a scientific procedure with higher input of resources and specialized knowledge. When in doubt, it is always advisable to contact expert services to analyse how a certain climate impact can impact a specific farm. In the case of long lasting investment decisions, it might also be helpful to consult services which are capable of providing and analysing regionally specific climate projections, so that potential climate impacts can be derived with more certainty.



After collecting past and possible future climate impacts, the next stage is to prioritize the different potential impacts. For this purpose, the findings of the previous SWOT-Analysis are used.

## Combining SWOT-Analysis and Climate Impacts

In order to prioritize climate impacts, the farm members take the SWOT-Analysis and assess which *Weaknesses* or *Threats* could be aggravated by the identified climate impacts. The *Weaknesses* and/or *Threats* which are getting worse when the climate impacts are considered can be marked as priorities for the following formulation of adaptation measures (Step 3).

Furthermore, it can be possible that the climate impact exploration revealed new and/or not discussed aspects for the SWOT analysis. If this is the case, also these additionally discovered *SWOT* aspects should be added.

Should the results of SWOT-Analysis not be further impacted by the potential climate impacts, a prioritization can also be achieved by discussion. A simple option is to grade the *Weaknesses* and *Threats* regarding their relative importance for the farm and its future development. Analogous, the grading procedure can be applied to the explored climate impacts.

## Excursus 1: Climate Projections

Climate projections are always subject to uncertainty, as explained in section Climate Change Management in the Trainer Handbook. However, they can still provide valuable information about the future climate and support the planning of climate strategies. In the Climate Farming Cycle, climate projections are not directly integrated, as the usefulness of climate projections for farm-specific vulnerability analysis is highly dependent on the resources available, as well as the expertise of the consultant. The knowledge and time needed to find, understand and interpret appropriate climate projections is generally outside the scope of an agricultural consultant. Furthermore, the importance of climate projections for farm-level adaptation planning should not be overrated, as an individual farm is not predominantly affected by the average changes in climatic parameters, but the inter- and intra-annual weather variability as well as extreme events.

Nevertheless, climate projections can provide guidance on the overarching trends and long-term developments. Consequently, the utilization of climate projections is especially useful for long-term planning (>30y), for example long-lasting investment decisions like a new dairy cattle house.

Different sources for professionally prepared climate information exist. For instance, the Climate Service Center Germany (<https://www.gerics.de/>) offers fact sheets on individual districts in Germany. These are written in a generally understandable way and form a good basis for discussion.

If a consultant decides to work with climate projections, they should become familiar with the theoretical background of climate projections and how to interpret the available data. A good starting point is the publication “*Leitlinien zur Interpretation regionaler Klimamolldaten*” (2023), available at <https://ifu.brandenburg.de/sixcms/media.php/9/Leitlinien-Klimamolldaten.pdf>.



## Sources for Climate Information (Climate Projections)

- [https://www.climate-service-center.de/products\\_and\\_publications/fact\\_sheets/climate\\_fact\\_sheets/index.php.de](https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.de)
- <http://climexp.knmi.nl/start.cgi>
- <https://www.nccs.admin.ch/nccs/de/home/klimawandel-und-auswirkungen/schweizer-klima-szenarien.html>
- <https://climate.copernicus.eu/>
- <https://climate-adapt.eea.europa.eu/en/knowledge/c-a-indicators/c-a-indicators>

## Sources for Agricultural Climate Information

- <https://canari-europe.com/>
- <https://www.adapter-projekt.de/klima-produkte/klimakalender.html>

## Step 3: Collection of adaptation measures

### IN A NUTSHELL

- Guiding question(s): 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?
- In step 3, various adaptation measures are collected and evaluated on a farm-specific basis. The overall goal of all adaptation measures should be to address the concerns and/or chances identified in Step 2. Adaptation measures can reduce risk, moderate negative effects and/or exploit opportunities arising from climate change. It is important to be aware that adaptation measures can also entail new risks and uncertainties. It's not always possible to name and deal with these before actual implementation, but discussing potential trade-offs is a first approach to reduce the risk.
- Step 3 entails following tasks:
  - Equipping the farm members with adequate resources to search for farm-specific adaptation measures
    - Links are provided in the ClimateFarming Cycle Handout
  - Collecting a wide variety of adaptation measures
    - If applicable: collect field-specific adaptation measures
  - Assessing adaptation measures:
    - Categories: Climate adaptation; profitability; ecological, social and other effects; maladaptation potential
  - Deciding which adaptation measures are further used for Step 4 and which are categorised as “reserve measures”



## Selecting Adaptation Measures

The aim is to collect a wide variation of different adaptation measures in order to address uncertainty by increased redundancy and flexibility. If possible, different time scales should be covered. How to set these different time-scales should be adjusted to the individual farm. In the scope of the ClimateFarming Cycle, short-term refers to the upcoming 0-5 years, medium-term to 5-20 years and long-term to >20 years. As there is a high diversity of different adaptation measures in agriculture, it is important to use the findings from Step 1 and Step 2 as a basis for a pre-selection.



Example of farm-specific collection of adaptation measures: If the vulnerability analysis of a farm reveals mainly problems associated with prolonged dry periods in the specific region, the research should focus on measures that increase water storage capacity, infiltration rate and overall water use efficiency. If necessary, income diversification measures should even be considered in the long term in order to moderate farm losses during dry periods. However, the consultant should ensure that a wide variety of measures are included in the catalogue so that still various possible developments are covered. For example, the risk of heavy rainfall and corresponding precautionary measures should be discussed - even if drought is the acute problem. Above this, the consultant is obliged to motivate the farm members to think outside existing structures and habits, for example whether new production branches could be possible.

## Assessing Adaptation Measures

As soon as an adequate number of adaptation measures has been collected, these go through an assessment based on discussion questions. This should be done in a systematic manner in order to reduce the influence of subjectivity. First, it is determined whether a measure is theoretically capable of addressing the farm's vulnerabilities, as assessed in Step 2. Due to limited resources at farm level, this evaluation will be based largely on the expert knowledge of the ClimateFarming Consultant and the farm members, including the results from the field-specific Soil- and Site-Analysis.

Although detailed analyses cannot be conducted for all measures, insights from scientific work or practical examples can provide orientation for the evaluation. It is important that not only the adaptation potential of a measure is analysed, but also aspects like economic viability, labour input, climate protection potential and other ecological or social effects. Important for consultants and farm members alike is not to get lost in the acquisition of knowledge due to the vast availability of resources, data and potentially contradicting information.

The following is the maladaptation check. The maladaptation check will be based on the *Precautionary Framework* and the *Pathway Framework* (Magnan et al., 2016; Hallegatte, 2009; Barnett and O'Neill, 2010). As there is no measurable parameter for the risk of maladaptation, the maladaptation check can only be conducted qualitatively. The individual categories and explanations are summarised below. It should be noted that the categories may partly influence each other and overlap.

- **No-regret measure:** A no-regret measure has a positive effect on the farm, regardless of the development of climate change. An example of this is humus build-up, which fulfils



important functions in the context of climate change, but also delivers many benefits for the farm and the environment apart from climate adaptation.

- **No increase in GHG emissions:** If possible, a measure should not worsen the farm's CO<sub>2</sub>-footprint and thus not further intensify climate change in terms of intensity and speed.
- **Reversible and flexible:** Measures that can be easily modified (flexible) or reversed (reversible) are generally less likely to lead to maladaptation. Testing new crops (e.g. chickpeas) is a flexible measure and can be changed again in the following crop year (reversible), whereas the construction of a new air-conditioned cattle shed is only flexible to a limited extent and not reversible (in the short to medium term).
- **Shifting negative effects:** Adaptation measures can reduce one's own vulnerability, but at the same time have negative effects on other persons, actors or environmental systems. This should be prevented.
- **Testability:** If a measure can be tested without major (financial) risks and is reversible without major costs/circumstances, this reduces the risk of maladaptation.
- **(Income) diversification:** The diversification of the farm, particularly of production branches and farm income, enables the farm to deal with extreme events and shocks. For example could the income derived from animal husbandry moderate losses in arable crop production due to new pests or a severe hail event. In order to safeguard the success of diversification, it must be assessed whether the individual production branches depend on each other and/or are susceptible to the same (climatic) impacts.
- **Reduced dependency:** Dependencies on certain inputs (e.g. import of animal feed, fertilizers, fossil fuels etc.) increase the farms vulnerability concerning disturbances in the supply chains (e.g. due to extreme weather events) and price volatility. Reduced dependencies are consequently associated with reduced risks. However, dependencies in general do not necessarily entail higher risks and can actually support farm-level adaptation, e.g. via cooperation with other farmers. Still, it must be considered that dependencies increase the uncertainty how climatic and non-climatic impacts will affect the individual farm.

As soon as an adaptation measure passes through the individual assessment steps, it will be categorised as potential measure for the *Farm Climate Strategy* (Step 4) or set back as reserve measure until new developments probably change the utility of the measure.





## Step 4: Farm Climate Strategy

### IN A NUTSHELL

- Guiding question(s): Which adaptation measures fit together? Where do synergies or conflicts arise? What climate resilient development opportunities exist for our farm?
- Step 4 aims at organising the individual adaptation measures from Step 3 in a Farm Climate Strategy. The farm climate strategy should provide the farm members with a roadmap that specifies which adaptation measures can be tested or directly implemented, which measures should be planned and prepared for, and which perspectives exist for climate-adapted farm development. The overall goal is to maximise synergies between adaptation measures, reduce conflicts and link short-, medium- and long-term measures.
- Step 4 entails following tasks:
  - Arranging adaptation measures from Step 3 along a time axis to develop a farm climate strategy
  - Assessing the farm climate strategy with Multi-Criteria-Analysis to identify possible deficits of the farm climate strategy
    - Recommended categories are:
      1. Resilience proxies
      2. Climate protection
      3. Costs (investment)
      4. Side effects (e.g. biodiversity)
  - Modifying the farm climate strategy if necessary
  - Analogous, a field-specific adaptation strategy can be developed
- Optional: Evaluation of the farm climate strategy with a second SWOT-Analysis and formulation of Contingency Actions

Once a comprehensive collection of farm-specific adaptation measures has been compiled, this collection can be used for the development of the farm climate strategy, which should not only comprise the next five years, but also entail long-term goals (e.g. >20 years).



**Example farm climate strategy:** In order to react to recent drought periods, the farm members decide to implement the diversification of their crop rotation as a short-term measure. For the mid-term, the farm members plan to develop a first agroforestry system in order to reduce evapotranspiration on the field. For the long-term, they formulated different adaptation measures, depending on how climate change will develop. These long-term measures include the expansion of agroforestry, the usage of irrigation systems or income diversification.



After the farm members decide on a farm climate strategy, the developed farm climate strategy is going through an assessment. Basically, this can be done with many different methods, mainly depending on the available knowledge and resources of the consultant and the farmers. Due to the focus on the farm level, multi-criteria analysis is used in the ClimateFarming Cycle. The aim is to examine different aspects that are important for the success of the farm climate strategy. Which aspects these are generally depends on the individual farm and strategy, but the ClimateFarming Cycle recommends an investigation and evaluation in the areas of resilience, investment costs, climate protection and side effects. The decision trees from the ClimateFarming Cycle handout can provide guidance here. As mentioned in Step 3, the level of detail of the evaluation should be adapted to the specific farm. If the evaluation identifies strong deficits in one or more of the categories, the farm climate strategy should be modified.

In practice, it has been shown that the evaluation of the farm climate strategy is mainly based on the adaptation measure assessment from Step 3. However, it is important not only to look at the sum of the measures, but also at synergies and conflicting goals between the individual measures.

## Multi-Criteria Analysis

### Resilience proxies:

The resilience proxies of the ClimateFarming Cycle are based on Ben-Haim (2019), who defined five different proxies that can provide guidance in assessing an adaptation measure or a strategy. It is important to note that the different factors overlap and influence each other.

- **Recovery:** Rapid recovery from negative, surprising developments. Recovery is defined as reaching the farm objectives.
- **Redundancy:** Many different options (adaptation measures) exist to deal with new developments. Higher resilience is attained by a high variety of response options to surprises.
- **Flexibility:** The farm and its characteristics can be changed quickly as conditions change.
- **Adaptivity:** The flexibility of a farm to adapt itself in the medium to long term. This includes the modification of goals and methods according to changing conditions.
- **Comprehensiveness:** Resilient decision-making integrates multiple perspectives and seeks to consider all factors that make up a problem (e.g. technological and cultural aspects, socio-economic factors, etc.).

The consultant and company staff now examine the extent to which the farm climate strategy that has been developed fits with the demands of the five categories. Since there is no way to assign a measurable value to resilience, this is done qualitatively with the help of discussion questions.

### Costs:

Future costs of an adaptation measure - and a farm climate strategy - can have different sources. On the one hand direct costs associated with investments, e.g. for new machinery. On the other hand, costs can occur from rising labour requirements, losses from experimentation and learning or time-investment in knowledge acquisition. Another important aspect are transfer costs, which arise when a farm must change from one adaptation measure to another. These costs are difficult to calculate beforehand, but should be considered in decision-making.



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Due to this uncertainty about the actual future costs of adaptation, the ClimateFarming Cycle pursues the approach to evaluate investment cost based on the comparison with the average investments of the specific farm in the considered time period. The process can be conducted analogous for the labour costs or other factors.

How the economic evaluation of the farm climate strategy is ultimately carried out depends on the available capacities of the farm and the ClimateFarming Consultant. The more detailed an economic assessment can be carried out, the better for decision-support. However, attention must be paid to not get lost in the preliminary evaluation.



Example of transfer costs: A farm with intensively irrigated vegetable production invests in a more efficient, but very expensive, new irrigation system. However, due to declining groundwater levels, the usable amount of fresh water for irrigation is constantly rationed and vegetable production is no longer possible in its original form. Should the farm now consider switching to water-extensive cropping or other income-generating activities, the investment in the new irrigation system has increased the transfer costs. This means that the costs of moving from one adaptation measure to the next adaptation measure have increased due to the investment.

#### Climate protection:

How the climate protection potential of a farm climate strategy is evaluated is again limited by the available resources. For example, a trend can be derived on the basis of the individual adaptation measures and their climate protection potential, based on literature research. This approach was used in the SOLMACC project, in which innovative management practices on 12 European farms were researched (<https://solmacc.eu/>). More sophisticated are calculation tools, such as the *Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V.* (KTBL) standard for individual farm climate accounting (*Berechnungsstandard für einzelbetriebliche Klimabilanzen* (BEK); KTBL, 2021). The BEK "[...] enables interested parties to carry out greenhouse gas calculations themselves, to develop their own calculation programmes according to the BEK or to compare existing calculation programmes with the BEK." (<https://www.ktbl.de/themen/bek>). It is important to acknowledge that the climate protection assessment in the ClimateFarming Cycle only serves the purpose of orientation and can not replace a sophisticated CO<sub>2</sub>-footprint.

#### Ecological, Social and other Effects:

Ecological and social side-effects, whether positive or negative, are usually difficult to measure (e.g. biodiversity). However, to ensure that these important factors are not forgotten when assessing a farm climate strategy, possible side-effects should be recorded at least qualitatively.

#### Additional Methods 2: SWOT-Analysis and contingency measures

Using SWOT-Analysis and contingency measures is not pivotal for the success of Step 4 and the ClimateFarming Cycle and can be skipped if necessary. However, it is a worthwhile method to evaluate the developed farm climate strategy, as it motivates the farm members and the ClimateFarming-Consultant to critically analyse the developed strategy and open up options on how to further improve the resilience of the farm climate strategy.



The SWOT-Analysis of the farm climate strategy serves to identify uncertainties, new vulnerabilities and opportunities arising from the farm climate strategy. The analysis is the basis for the formulation of contingency actions. Contingency actions have the purpose to increase the resilience of the farm and its plans by hedging its success or exploiting arising opportunities. Three categories exist, namely *defensive*, *corrective* and *opportunity actions* (Walker et al., 2019). More information can be found in the ClimateFarming Trainer Handbook.

### Additional Methods 3: Adaptation Tipping Points and Opportunity Tipping Points (ATP and OTP)

When implementing the farm climate strategy, the question arises when a new or a complementary adaptation measure should be introduced and implemented. In difficult cases, the concept of Adaptation Tipping Points (ATP) can help. If a farm climate strategy has a large number of adaptation measures, especially in the medium and long term, ATPs can help to guide the implementation or introduction of adaptation measures. In theory, an ATP is a defined threshold value of an indicator that indicates that a current adaptation measure is no longer effective and a new one should be implemented (Haasnoot et al., 2013).

In addition to ATPs, opportunity tipping points can be defined. In contrast to ATP, these indicate when it would be viable to implement an adaptation measure. Such a tipping point can be certain threshold values of an indicator, but also certain events or developments. More information can be found in the ClimateFarming Trainer Handbook.

### Step 5: Monitoring and implementation

#### IN A NUTSHELL

- Guiding question(s): How can we monitor the effectiveness of our farm climate strategy? Which adaptation measures can we implement directly, which can be tested, which do we need to plan and prepare? Do the implemented adaptation measures work properly? What can we learn from this? What changes can we observe? How do we have to react to them?
- Step 5 is the transition from planning to practical implementation. It provides an orientation on how the success of the farm climate strategy should be monitored and how to start the practical implementation of the first adaptation measures. The monitoring has two parts: The first part is the subordinate monitoring, which controls whether the farm climate strategy as a whole is successful (=fulfillment of farm objectives). This should inform the farm members whether modification of the farm strategy is necessary. The second part of monitoring is connected with the individual adaptation measures. Planning and conducting the practical implementation of a measure is always accompanied by a measure specific monitoring plan.
- Step 5 entails the following steps:



- Collecting indicators that specify which internal factors (e.g. yield, income, workload, etc.) and external developments (changes in climate parameters, technology, market changes, etc.) are important for the achievement of farm objectives and should be monitored.
- Clarifying responsibilities concerning monitoring
- Designing a regular review event: check the farm climate strategy and the achievement of farm objectives in regular intervals (e.g. once a year).
- Scheduling the implementation of short-term measures; clarifying responsibilities for implementation
- For measures which should be implemented right away: develop an implementation and monitoring plan
- Optional: Checking whether certain contingency actions can be implemented
- Tip: The Cheat-Sheet [Indicators for Monitoring](#) supports farm members and consultants in monitoring the individual adaptation measures and selecting meaningful indicators.

Monitoring and learning are fundamental aspects of adaptation planning and strategic farm management. The first action is to collect relevant indicators which should be monitored in order to control the success of the farm climate strategy and to track the achievement of farm objectives. The aim of these indicators is to inform the farm members concerning the development of internal and external changes. Based on the monitoring of these indicators, the farm members (and the ClimateFarming-Consultant) can decide whether new or complementary adaptation measures are needed or if the farm climate strategy needs to be fundamentally revised or replanned.

The indicators should entail external factors such as climate and environmental changes, technological development, economic, political and cultural changes, but also internal aspects such as working hours, yield, income or job satisfaction. The continuous monitoring of these indicators is supposed to enable the farm members to recognise relevant changes at an early stage and to act proactively. Together with the collection of indicators, the question of who, when and how certain indicators are checked should also be clarified.

The indicators and related monitoring should be developed as farm-specific as possible, so that they fit the farm's climate strategy, can be monitored by the farmers and provide important information for the farm. The same applies to the field-level, as described in the Soil- and Site Analysis.

Regular review events are another approach to effective monitoring. These are regularly scheduled events at which the farm climate strategy and the underlying assumptions<sup>2</sup> are checked, for example once per year after harvest. Here, the farm members can discuss whether farm objectives are fulfilled, which adaptation measures are working fine, which must be modified, complemented or exchanged by other measures. Likewise, the status of mid- and long-term measures can be reported. If necessary, the modification or the re-planning of the farm climate strategy can be discussed at the regular review event. In essence, basically the same questions and aspects as during regular monitoring are discussed, but in a systematic manner. Consequently, the guiding questions of monitoring can also provide guidance for the regular review event.

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<sup>2</sup> 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.



- 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? How do we have to react to them?
- Based on the monitoring, the farm members decide on:
  - Modification of implemented adaptation measures
  - Introduction of new or complementary adaptation measures
  - Modification of the farm climate strategy
  - Necessity to re-plan the farm climate strategy or re-run the ClimateFarming Cycle.
  - Integration of new knowledge and lessons learned into the farm climate strategy and adaptation measure implementation
  - Optional: Implementing contingency measures

### Start Implementation and Monitoring

In Step 5, the adaptation measures that were categorised as short-term measures in Step 4 are planned and prepared for implementation or testing. If applicable, contingency measures that directly address these measures or current deficits of the farm climate strategy can also be prepared for implementation. Short-term measures that are not supposed to start in the near-future (e.g. the next year) are planned. In addition, responsibilities for the various adaptation measures and their implementation and monitoring are discussed and determined.

At the same time as the first measures are implemented, monitoring begins. This applies to the farm climate strategy as a whole, but also to the individual, implemented measures. Depending on the measure, it should be a minimum requirement to develop and adhere to a measure-specific monitoring plan at the latest with the implementation. Here, too, external consultants can be involved.

For the farm climate strategy, the specified indicators as well as the defined farm objectives should be monitored. Here, the regular review event in particular should be mentioned as a central tool.

If monitoring indicates the implementation of a new measure, it will be prepared and implemented. Same applies to contingency measures if applicable. If the monitoring identifies fundamental deficits in the farm climate strategy or detects profound internal or external changes, a new planning of the farm climate strategy and, if necessary, a new run of the ClimateFarming Cycle must be initiated.

In addition to monitoring the farm climate strategy, the selected indicators should be regularly reviewed (e.g. during the regular review event) for their information content and practicability.



**Example variability:** The distinction between interannual variability and actual climatic changes is problematic and must be kept in mind when making decisions. The drought-period in Germany between 2018 and 2022 is a good example. Although dry conditions were the prevalent issue for farmers in Germany (and many parts of Europe) at this time, a farmer should not be tempted to think that these years are evidence for how the next five years (or the future in general) will look like. There will be drought periods again, but likewise, wet years and heavy precipitation events can occur. At this point, climate projections can help to distinguish outliers and actual trend changes.

However, this does not only apply to climate change, but also to fluctuations in market prices or consumer preferences, for example. How certain signals are interpreted is usually very subjective and depends on the experiences and assessment of the individual person.



## Excursus 2: Indicators for Monitoring

In order to ensure the measures that are implemented on a farm are working, a monitoring and evaluation plan needs to be made. Find a list of indicators in this external Excel File: [Indicators for Monitoring: Success of Measures and Climate Change Impacts](#).

This list should help you to find indicators that are suitable for an evaluation of the impacts of the implemented measures. However, this list is not exhaustive by far, it should rather give you some ideas on what to look for. A monitoring plan, just like a new measure, needs to be tailored to the needs and context of the farm and the people implementing it. The consultant needs to thoroughly understand, or possibly exchange with a specialist consultant, what impacts the measures could possibly have. However, some impacts might be unexpected, so it is also good to not only look for the obvious.

You can also find other indicators and methods for monitoring from an agroforestry monitoring project (that can also be used in different contexts) here:

<https://agroforst-monitoring.de/Methodenkatalog/>. You could also check out certification schemes like <https://regenorganic.org/> or <https://savory.global/eov/> or this offer that calculates the value of socio-ecological services on farms <https://www.regionalwert-leistungen.de/about-us/> to see what indicators they use. Feel free to do your own research and find the indicators and methods that fit your context and resources the best.

This list is divided into indicators that evaluate the success of your measures directly and indicators that help you understand the impact climate change has around your farm over the years. On top of this, you could also monitor other external factors like market prices, new technologies, changes in consumer patterns, etc. to further monitor the food and farming system and thus the conditions you are working with. These factors may lead to different preconditions in some years and thus may necessitate filling out the Farm Survey anew and running the ClimateFarming Cycle again.

Which indicators are relevant and how you measure them is dependent on your context. Some indicators could be measured by yourself with simple methods, or be measured by an expert. E.g. analyse your soil with an extended spade analysis regularly with minimal cost, or you could send soil samples to a laboratory every few years. The frequency of measurements in the list should rather be seen as an approximate suggestion, in some contexts it might make sense to measure indicators more or less often than indicated. The degree of accuracy and frequency depends highly on the goals you set. Sometimes it may be enough to see a tendency whether a measure leads in the right direction of success or the opposite, sometimes you may want or need to prove the impact on paper. It could also be an option to get involved with universities, research institutes or citizen science initiatives for monitoring your progress.

Further on, one tends to be biased when investing time and resources into developing new ways of managing our fields, or building new infrastructure, marketing channels etc.. So of course one wants the measures to succeed and may unconsciously rate the baseline worse than it actually is, and the progress better than it is. This is called confirmation bias. The other way around might be true too if the potential of a measure is doubted from the beginning, which is called status quo bias. The best is to be aware of these biases and try to be as objective as possible. Further on, it is important for the same person to evaluate an indicator over the years, in the same place and take many notes and photos on the specifics of the measurements. It may seem obvious how and where you took soil



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samples today, but it may not be as obvious in 3 years from now and you will be thankful for any kind of information about the last sampling.

This documentation of a farm's adaptation process is supposed to serve as a foundation for the continuous process of farm adaptation.

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# ClimateFarming Cycle Manual

## ClimateFarming

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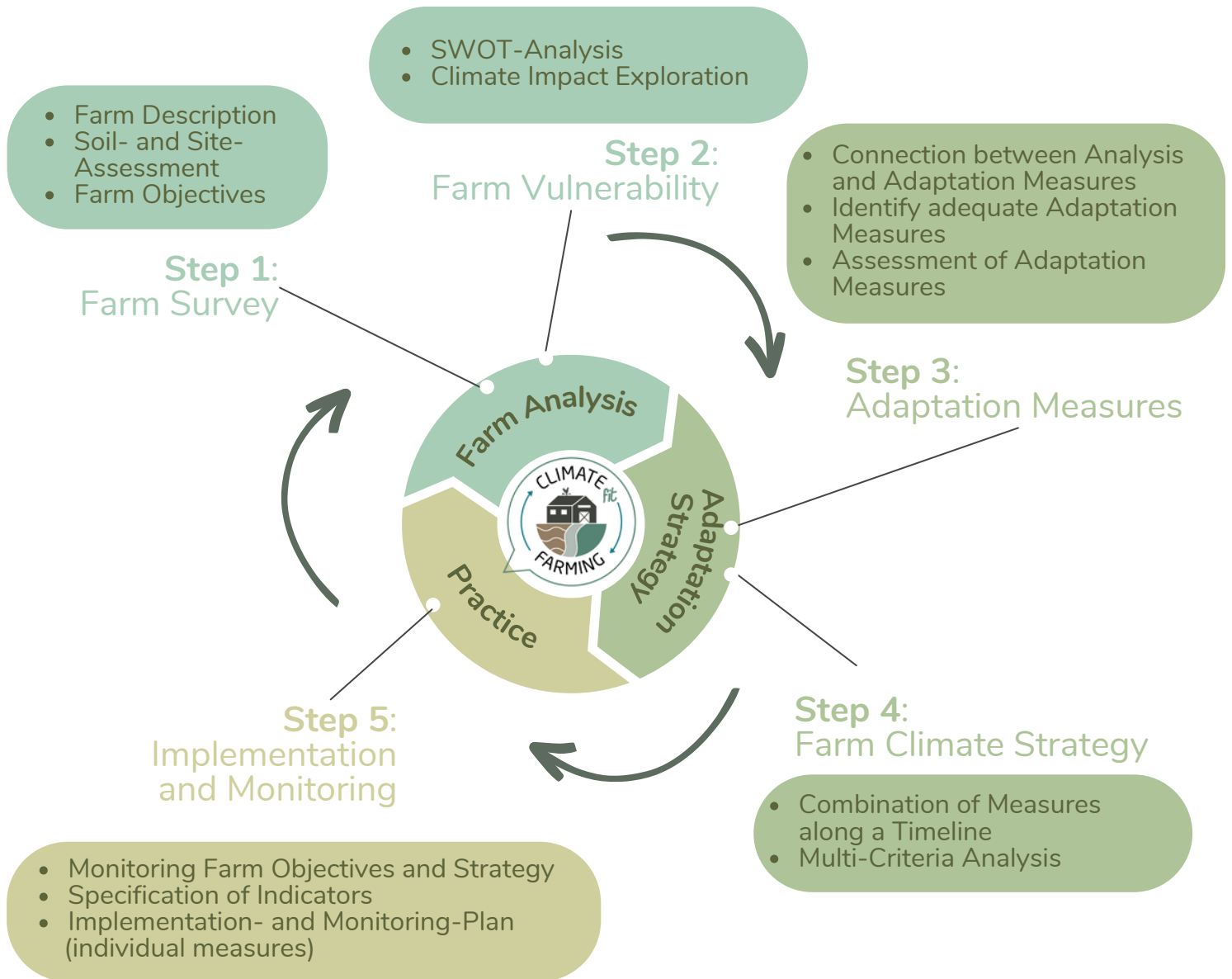
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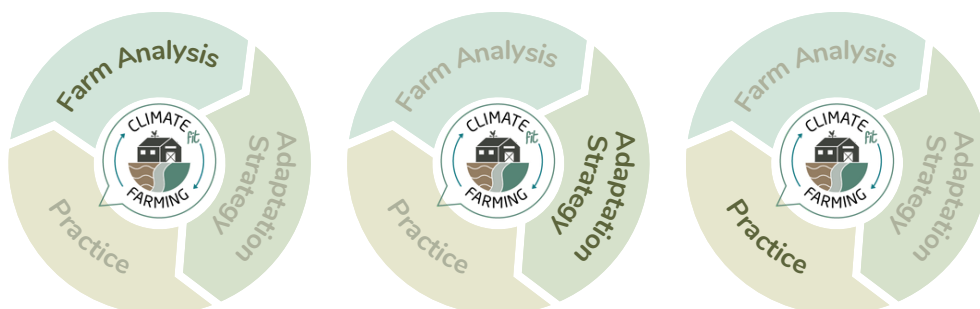
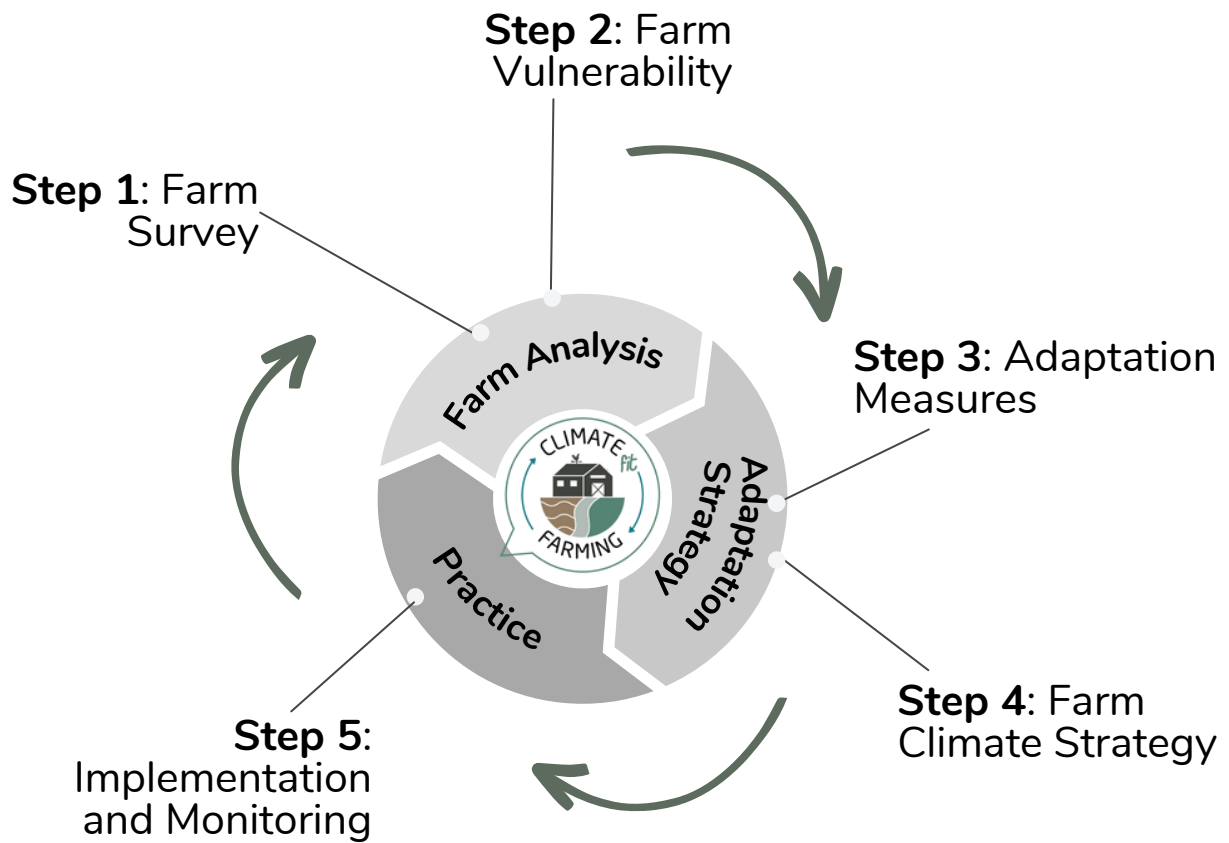


# ClimateFarming-Cycle in Practice: Handout for Consultants





# ClimateFarming-Cycle in Practice: Handout for Consultants



# CLIMATE FARMING - CYCLE HANDOUT: CONTENT

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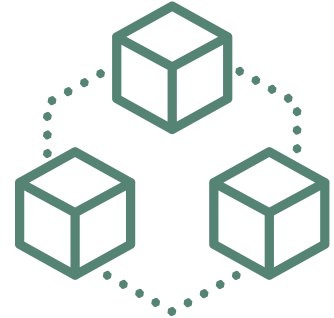
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# CLIMATEFARMING-CYCLE HANDOUT: INTRODUCTION

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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 resources 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 family 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

- 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

### Material and Literature

- 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 discussed 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.



**Optional:** If the CO<sub>2</sub>-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 CO<sub>2</sub>-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-SHEET 1: 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, unforeseen 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.



**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

- Step 1 is conducted and all farm members agree with the farm objectives
- Soil- and Site-Analysis is conducted and all farm members understand the results

### Material and Literature

- 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 point is 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“

<b>S</b> Strengths	<ul style="list-style-type: none"><li>• High degree of mechanization (low dependence on external service)</li></ul>	<b>O</b> Opportunities	<ul style="list-style-type: none"><li>• Many farmers in the area with environmental aspirations: potential for cooperations</li></ul>
<b>W</b> Weaknesses	<ul style="list-style-type: none"><li>• Low soil organic carbon content</li><li>• Erosion risk</li></ul>	<b>T</b> Threats	<ul style="list-style-type: none"><li>• Increasing energy and input prices</li><li>• Lack of qualified employees</li></ul>



**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.

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?

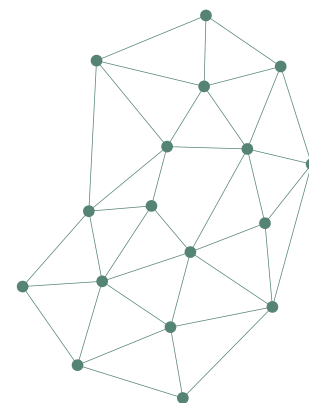
**Pests and diseases:** How could your crops or animals be impacted by upcoming or new pests and diseases?

**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 unexpected challenges might arise when several factors change and aggravate problems. Check the chapter **Farming in a changing climate** in the Training Handbook 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 worthwhile 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.



# 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 impacts, too.

## INFO-SHEET 3: CLIMATE IMPACTS

### 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 calendar
- [https://www.climate-service-center.de/products\\_and\\_publications/fact\\_sheets/climate\\_fact\\_sheets/index.php.de](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 concerning 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 aggravated 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

- 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

### Material and Literature

- 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


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

(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 resources. 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

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

### ADAPTATION MEASURE:

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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

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### 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 effects**. 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 unforeseen 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-contrioned shed is payed off, the farmer is heavily limited in their financial flexibility and will potentially not be able to implement other adaptation measures or switch to other production branches.



## INFO-SHEET 5: MALADAPTATION II

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### 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

- The ClimateFarming-Consultant processes the results of Step 3;
- Farm members are provided with the results from Step 3

### Material and Literature

- 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 - III
- 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

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### 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 discuss 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

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 advisable 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	Does the strategy fulfill most of the categories with minor trade-offs or deficits?	3 Points
	NO		
2. Redundancy: The strategy entails various adaptation measures which respond differently to climate impacts?	YES	Does the strategy fulfill most of the categories with some trade-offs or deficits?	2 Points
	NO		
3. Flexibility: The strategy enables the farm to react quickly in the face of surprising climate impacts, e.g. the occurrence of a new pest or disease?	YES	Does the strategy fulfill most of the categories, but with major trade-offs or deficits?	1 Point
	NO		
4. Adaptiveness: The strategy enables the farm to adjust its goals and methods in the mid- to long-term?	YES	Does the strategy only fulfill some of the categories or feature fundamental trade-offs or deficits?	0 Points
	NO		
5. Comprehensiveness In the development of the strategy, various perspectives and potential climate impacts were included and addressed?	YES		
	NO		

#### 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.

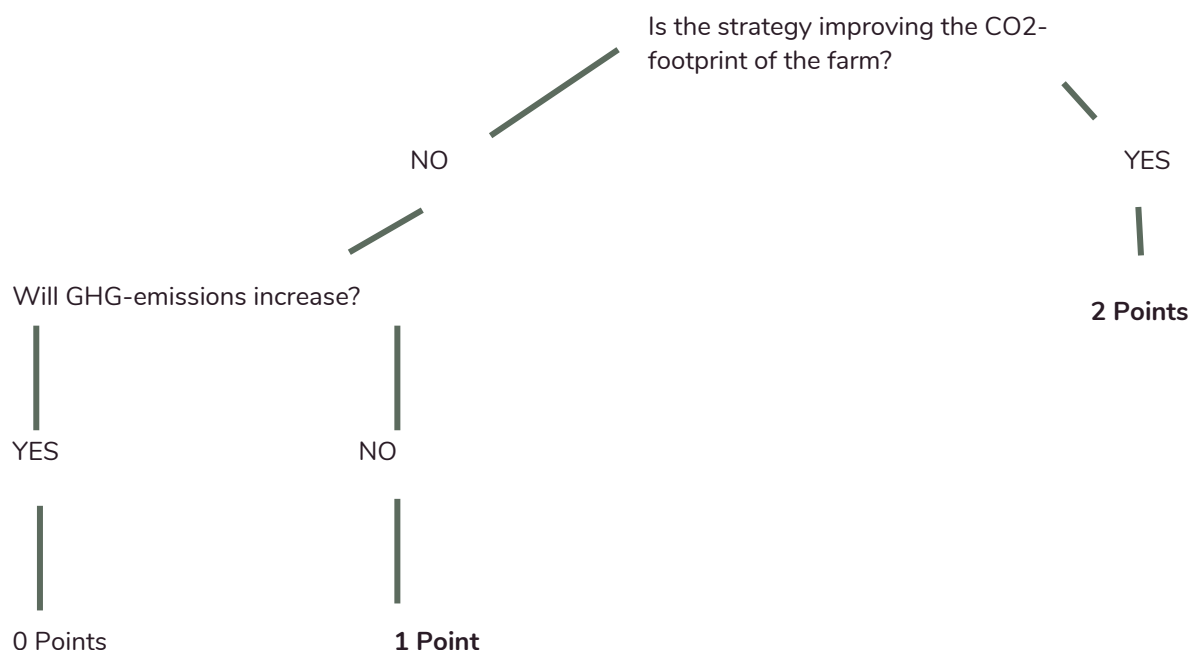
\* Resilience-Proxies are further explained in the Consultation Material:  
Step 4

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

## STEP 4: STRATEGY ASSESSMENT II

## Assessment Farm Climate Strategy | Decision-Tree

## Climate Protection\*



\*Climate protection potential compared to the baseline CO<sub>2</sub>-footprint of the farm, if available



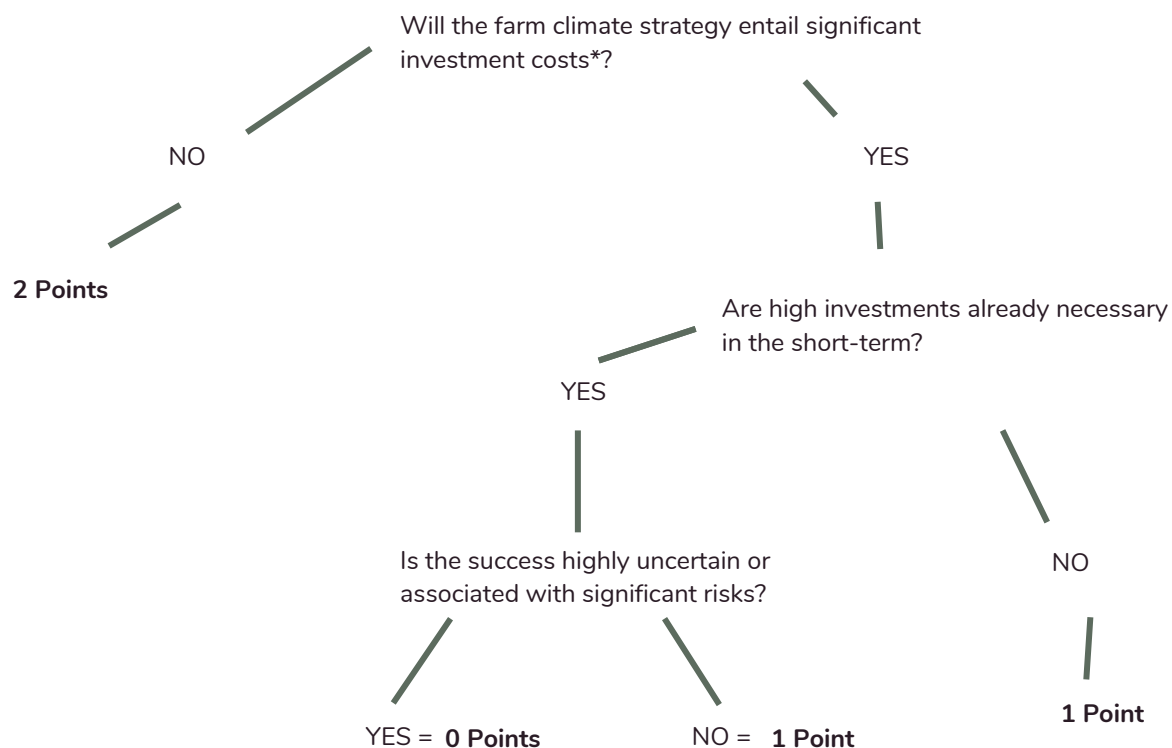
### Application Notes

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 advisable, 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.

## STEP 4: STRATEGY ASSESSMENT III

## 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 dryer.

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:





SWOT

Contingency-Measures



# 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



## 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 - IMPLEMENTATION AND MONITORING

## 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

- All farm members agree with the developed farm climate strategy and its assessment

## Material and Literature

- 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 monitoring 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. unforeseen 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 an 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 - IMPLEMENTATION AND 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.

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 - IMPLEMENTATION AND MONITORING

## 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



Engage external (expert) consultants for specific adaptation measures

### Material und Literature

- 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-resources 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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## The Farm Survey

### Process



#### Preparation

- meet online or have a call: introduce the farm survey and agree on sites to be worked with
- consultant sends out the survey
- farmer fills in the survey as much as possible
- agree on a soil laboratory in accordance to needs and budget
- **define goals for the farm to understand what to look out for when assessing the farm**

#### General Farm Information, Site & Soil Assessment

- at the farm
- takes max 2-3h for the farmer
- farmer & consultant discuss and complete General Farm Information and Site & Soil Assessment
- ideally, farmer and consultant go to the field together  
→ **the farmer learns how to apply the methods/ assess their site and soil themselves in the future**

#### Compilation

- consultant checks if all information is there, checks for additional information with farmer if necessary
- consultant compiles information from the farm survey and writes a report

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**



**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 processors
- 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](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.

📘 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



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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.

**i** 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

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



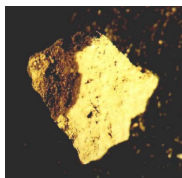
Term	Diameter	Surface	Shape	Emergence
fine crumb	few millimetres	rough surface	round	mainly biologically built structure
polyhedron	few millimetres	smooth surface	angular	swelling-shrinking cycles, mechanical cultivation
<b>fragments</b>	<b>general term for aggregates in centimeter and decimetre range</b>			
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).

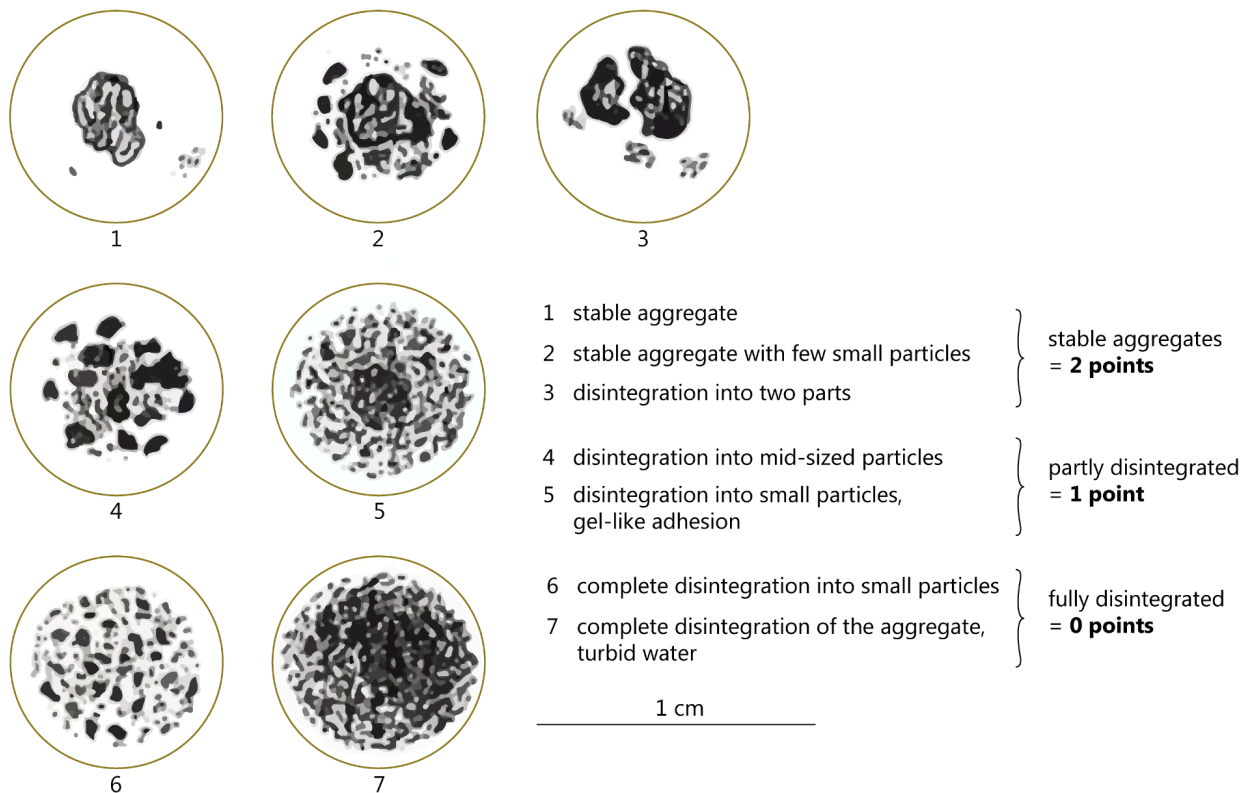
### 3.1.6. Aggregate stability test / Slaking test

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

$$\text{Soil structure index} = \left( \frac{\text{soil score}_{\text{topsoil}} \times \text{aggregate stability}_{\text{topsoil}}}{2} \right) + \left( \frac{\text{soil score}_{\text{subsoil}} \times \text{aggregate stability}_{\text{subsoil}}}{2} \right)$$

- 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?

**i** 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?

**i** 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.

**i** 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?

**i** 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?

**i** 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.

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**★** 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.

**i** If you see foaming or bubbling, there 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?

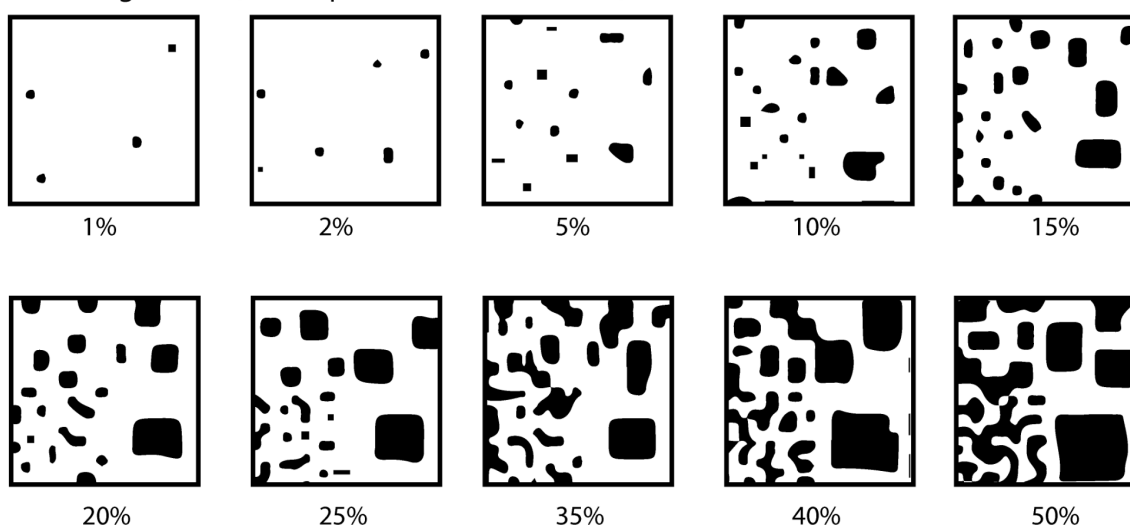
**Color, color gradient:** Note: dark/ light brown, gray, greenish, white, other (describe). You can also compare your sample with a handful of soil from an undisturbed area (e.g. grass strip next to the field). Do you see any difference in color, is it paler/ darker than the undisturbed soil?

**i** 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).

**i** 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?

**i** 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.








**i** 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).

**i** 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.

**i** 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<sup>2</sup>. Thus, **mm / hour = L / m<sup>2</sup> / hour**. We measure how long it takes for a 10cm (=100mm) water column to infiltrate, thus we can calculate the infiltration rate:

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

### 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.

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

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



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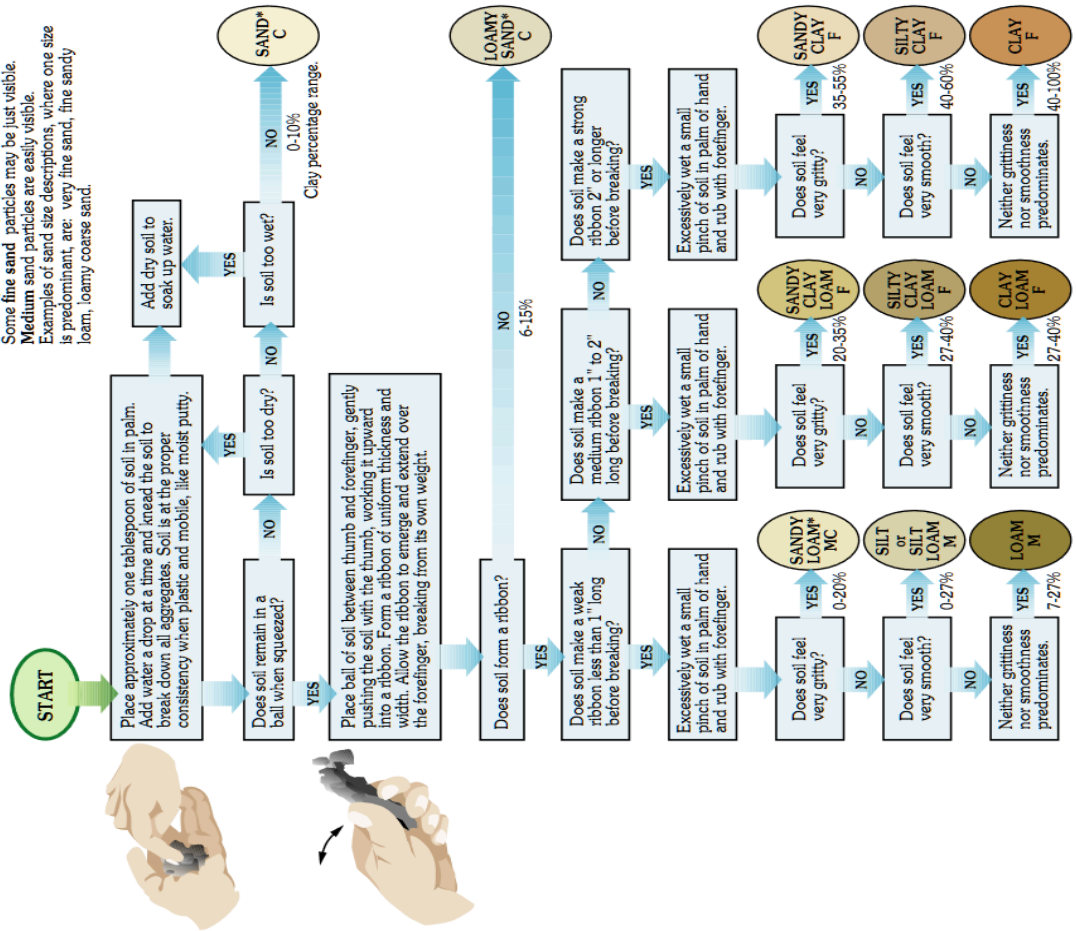


# Determining Soil Texture By the Feel Method

## 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.

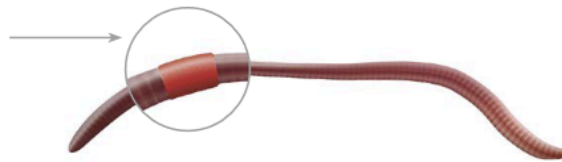


## Identifying adults and juveniles

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](http://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.

<b>1</b>	Dig out a soil pit (20cm x 20cm x 20cm) and place soil on mat	<b>3</b>	Count and record the total number of earthworms
<b>2</b>	Hand-sort the soil, placing each whole earthworm into the pot	<b>4</b>	Separate earthworms into adults and juveniles (see above)
<b>5</b>	Return juveniles to the soil pit	<b>7</b>	Return earthworms to the soil pit and backfill with soil
<b>6</b>	Count and record the number of each type of adult earthworm (see overleaf)	<b>8</b>	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



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## Farm Survey

Documentation form

Alena Holzknecht<sup>1</sup>, Nils Tolle<sup>1</sup>, Janos Wack<sup>1</sup>

---

### Contact

Name	
Address	
E-Mail	
Telephone	

### 1. General farm information

Total farm area [ha]	
Production branches	
Certifications (EU-organic, other organic, etc.)	<input type="checkbox"/> yes <input type="checkbox"/> 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)	

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<sup>1</sup> [kontakt@triebwerk-landwirtschaft.de](mailto: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	<input type="checkbox"/> yes <input type="checkbox"/> 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	<input type="checkbox"/> available <input type="checkbox"/> planned <input type="checkbox"/> 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	<input type="checkbox"/> yes <input type="checkbox"/> 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: <ul style="list-style-type: none"> <li>- nitrogen</li> <li>- water</li> <li>- compaction</li> <li>- salt</li> </ul>	

## 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

<input type="checkbox"/> wheel tracks <input type="checkbox"/> wind erosion <input type="checkbox"/> water erosion (rills/gullies) <input type="checkbox"/> surface ponding <input type="checkbox"/> crusting <input type="checkbox"/> cracks

<b>Ground cover:</b> <input type="checkbox"/> <30% <input type="checkbox"/> 30-70% <input type="checkbox"/> >70%



##### 3.1.2. Organic matter, root and harvest residues

<input type="checkbox"/> none <input type="checkbox"/> little <input type="checkbox"/> moderate <input type="checkbox"/> 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

$$\text{Soil structure index} = \left( \frac{\text{soil score}_{\text{topsoil}} \times \text{aggregate stability}_{\text{topsoil}}}{2} \right) + \left( \frac{\text{soil score}_{\text{subsoil}} \times \text{aggregate stability}_{\text{subsoil}}}{2} \right)$$

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:



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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)	??	?		
crop	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
Lower 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)
<b>Economy/Logistics/Transportation</b>					
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
<b>Water &amp; energy supply</b>					
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					
<b>Climate change consequences</b>					
<b>Categories/Indicators</b>	<b>Explanation</b>	<b>Measurement</b>	<b>expressiveness</b>	<b>Measurement frequency</b>	
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	

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 $\varnothing$ , $>30^{\circ}$ , $<0^{\circ}$	How does the temperature change daily/yearly? Is there a change compared to long-term averages? When do temperatures $>30^{\circ}\text{C}$ or $<0^{\circ}\text{C}$ 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	
<b>Economy/Logistics/Transportation</b>					
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	
<b>Water &amp; energy supply</b>					
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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HOLISTIC RESOURCE MANAGEMENT FOR  
CLIMATE RESILIENCE OF FARMING

# Consultation Material - Module 3

## ClimateFarming

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## Module 3: What it means to be a successful consultant

### Tasks of a Consultant

Consultants play a vital role in the success of businesses in common and here in farming by providing expert advice, analysis, and solutions to various problems and challenges. The role of a consultant varies depending on the specific needs of the client, but some of the key responsibilities and tasks include:

1. **Assessing the situation:** A consultant's first task is to understand the client's needs, goals, and challenges. This involves gathering data, analyzing processes, and identifying areas for improvement or growth.
2. **Developing a plan:** Once the consultant has a clear understanding of the client's needs, they develop a strategic plan to achieve the desired outcomes. This may involve recommending changes to operations, policies, or procedures, developing new strategies, or implementing new technology.
3. **Implementing the plan:** Consultants often work with clients to implement the recommendations they have made. This may involve working with internal teams or external partners, such as vendors or contractors, to execute the plan.
4. **Monitoring progress:** Consultants monitor the progress of the plan to ensure that it is achieving the desired outcomes. This involves measuring results, analyzing data, and making adjustments as needed.
5. **Providing ongoing support:** Some consultants provide ongoing support to clients, helping them to maintain and improve their operations over time. This may involve providing training, coaching, and sometimes even mediating.

Following the last point we see, that it is necessary to differentiate training, coaching, and mentoring from consulting.

### Different roles of a consultant

#### Trainer

A trainer deliberately transfers knowledge and skills to groups or individuals in an official setting. In the role of a trainer you are both didactically fit and socially competent. Most of the added value lies in the design, delivery and evaluation of training. You make sure that skill goals are achieved. You can train (almost) everything at all levels of the company.

#### Coach

The main focus of the coach is the further development of individuals and entire teams. In this role, you act as a 'sparring partner' for the client, reflecting together and at eye level on hard and soft challenges in the company. Coaches are connoisseurs of human nature, somewhere between a technical expert and a project psychologist. With their questioning and listening techniques, they help clients achieve organisational and individual goals. Their portfolio consists of the common methods of people diagnosis and personality development.



### **Mediator**

The positive shaping of internal and external company relationships is the mediator's bread and butter business. In business mediation, it is often a matter of resolving a conflict, for example between a superior and an employee or a client and a supplier. As a mediator you are sensitive and know about the people. You usually make sure that the organisation solves internal problems and can help itself in the future.

### **“Scapegoat”**

If the consulting project gets into trouble or the hoped-for success fails to materialise, you sometimes find yourself unintentionally in the role of scapegoat, as the reason for failure & lightning rod. Why not? After all, the client wanted to use the external force to prevent the project from failing. The fact that the final decision was made internally and that the consultant only accompanied it is pushed into the background. In fact, as a consultant, it is difficult to shed this role.

As we can see, the counsellor is in the tension between knowledge transfer (hard skills) and soft skills transfer. He supports his client in what to do and enables him to do it on his own.

### **Skills required for a successful consultant.**

The role of a consultant requires a diverse set of skills and expertise, including:

#### **Analytical skills**

Consultants need to be able to gather and analyze data to identify problems and develop solutions. Analytical skills refer to the ability to collect, analyze, interpret, and draw meaningful conclusions from data and information. Individuals with strong analytical skills are able to break down complex problems or situations into their component parts, understand the relationships between these parts, and develop logical and data-driven solutions. Analytical skills involve critical thinking, problem-solving, and decision-making, and often involve the use of quantitative methods, statistical analysis, and other data-driven techniques to evaluate and interpret information.

#### **Communication skills**

Consultants need to be able to communicate effectively with clients, stakeholders, and team members to build rapport, explain complex ideas, and present recommendations. Communication skills refer to the ability to convey and exchange information and ideas effectively through various modes of communication, including verbal, nonverbal, written, and visual communication. Individuals with strong communication skills are able to express their thoughts clearly, listen actively and attentively to others, and adapt their communication style to different audiences and situations. Effective communication also involves using appropriate tone, body language, and context-specific terminology to ensure that the message is received and understood by the intended audience.

#### **Sector knowledge**

Consultants need to have a deep understanding of the sector, here agriculture and stay up-to-date with the latest trends and best practices.



### **Project management skills**

Consultants often work on complex projects with multiple stakeholders and need to be able to manage timelines, budgets, and resources effectively. Project management skills refer to the ability to plan, organize, execute, and close projects effectively and efficiently. Individuals with strong project management skills are able to define project goals and objectives, develop a detailed project plan with timelines, budgets, and resource allocations, communicate project status and progress to stakeholders, monitor and control project risks and issues, and deliver high-quality results on time and within budget. Effective project management also involves managing project teams, including assigning tasks, managing team dynamics, and providing feedback and support to team members.

### **Problem-solving skills**

Consultants need to be able to think critically and creatively to develop innovative solutions to complex problems. Problem-solving skills refer to the ability to identify, analyze, and develop effective solutions to complex or challenging problems. Individuals with strong problem-solving skills are able to approach problems in a systematic and logical manner, using critical thinking, creativity, and analytical skills to evaluate information, identify root causes, and develop and implement solutions.

## **Toolbox for consultants**

### **Counselling contract**

It is advisable to conclude a counselling contract with the client. This contract contains the status quo before the consultation, the main points, why the client is asking for support. Furthermore, goals should be formulated, and these should be in the form of SMART goals.

Here's what each letter of SMART stands for:

- **Specific:** Objectives should be clearly defined and specific, outlining exactly what you want to achieve. This means being clear about the who, what, where, when, and why of your goal.
- **Measurable:** Objectives should be quantifiable and include specific metrics or measurements to track progress and determine when you have achieved your goal.
- **Achievable:** Objectives should be realistic and feasible, taking into account available resources, skills, and time constraints.
- **Relevant:** Objectives should be relevant to your overall goals and objectives, contributing to a larger purpose or mission.
- **Time-bound:** Objectives should have a clear deadline or timeline for completion, helping you stay focused and accountable.



### Project Management Models and Gantt Chart

The general project management model should be described in the contract, possibly methods like scrum. A roadmap with estimated resource input (time and financial resources) should be agreed upon. And finally, the description of possible risks and how these can be managed. These points can be visualized in a Gantt chart.

A Gantt chart is a visual tool used in project management to represent a project schedule. Gantt charts typically consist of horizontal bars representing individual tasks that are arranged along a horizontal time axis. The bars are color-coded to indicate their status (e.g., completed, in progress, not started) and show the duration of each task. The chart also shows the dependencies between tasks, with arrows connecting tasks that are dependent on each other.

Sample of a Gantt Chart: (M = month)

ACTIVITIES	Who	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12
Initial inquiry, Soil Analysis		█	█	█									
Vulnerability Analysis				█	█								
Farm Assessment						█	█						
Practical implementation measure 1								█					
Practical implementation measure 2									█				
Practical implementation measure 3										█			
Evaluation											█	█	
Report													█

### Communication

All communication theories assume that the message passes through a channel, a medium, on its way from the sender to the receiver and is thereby changed. This "noise in the channel" is the cause of misunderstandings that can only be mitigated by both partners being aware of this fact and both making an effort to understand better by asking questions.

The Four Ears Model or Four Eared Listener Model, was developed by Friedemann Schulz von Thun, a German psychologist and expert in communication. This model is designed to help individuals understand the various levels of communication that occur during interpersonal interactions.

The Four Ears Model or Four Eared Listener Model suggests that there are four levels of listening that take place in communication. These levels are:

- The factual level (content): This level is concerned with the literal meaning of what is being said. It includes the facts, data, and information being communicated.
- The self-revealing level (self-disclosure): This level is concerned with what the speaker is revealing about themselves through their communication. It includes their thoughts, feelings, and emotions.
- The relationship level (relationship): This level is concerned with the nature of the relationship between the speaker and listener. It includes the emotional tone of the communication, the level of trust and respect between the individuals, and the power dynamic at play.
- The appeal level (action): This level is concerned with what the speaker is asking the listener to do or not to do. It includes requests, commands, suggestions, and advice.



According to the model, effective communication requires that all four levels are addressed by the speaker and understood by the listener. It also suggests that each level of communication can be perceived and responded to differently by different individuals, depending on their own background, experiences, and preferences.

### **Conflict Management**

Friedrich Glasl is an Austrian conflict researcher who developed a model for conflict escalation. The Glasl's model of conflict escalation provides a useful framework for understanding the different stages of conflict and for developing effective conflict management strategies. It emphasizes the importance of de-escalation and dialogue in resolving conflicts and highlights the need for ongoing efforts to build trust and cooperation between the parties involved.

Stage 1: Latent conflict. In this stage, there are underlying tensions or issues that have not yet surfaced, but which may become a source of conflict in the future.

Stage 2: Manifest conflict. In this stage, the conflict becomes evident and is openly expressed. The parties involved begin to take sides and positions become more entrenched.

Stage 3: Conflict escalation. In this stage, the conflict intensifies and emotions become more heated. Communication becomes more difficult, and the parties involved become more aggressive and defensive.

Stage 4: Stalemate. In this stage, the conflict becomes deadlocked and progress towards resolution becomes difficult. The parties involved may become more entrenched in their positions and are less willing to listen to each other.

Stage 5: De-escalation. In this stage, the parties involved start to look for ways to reduce tensions and to move towards a more constructive dialogue.

Stage 6: Settlement/agreement. In this stage, the parties involved reach a resolution or agreement that is acceptable to all parties.

Stage 7: Consolidation. In this stage, the parties involved work to maintain the agreement and to build trust and cooperation.

Stage 8: Reconciliation. In this stage, the parties involved work to repair relationships and restore mutual respect and trust.

Stage 9: Peacebuilding. In this stage, the parties involved work to address the underlying causes of the conflict and to prevent future conflicts from arising.

In order to avoid conflicts, Marshall B. Rosenberg developed non-violent communication. The approach is based on the principle of empathy and focuses on creating understanding, mutual respect, and compassionate relationships. NVC is widely used in conflict resolution, personal growth, and organizational development.

According to NVC, communication involves four basic components: observation, feeling, need, and request. The approach encourages individuals to communicate these four elements in a way that promotes understanding and connection with others.

- Observation: The first step in NVC is to describe the situation or behavior in a neutral and objective manner, without judgment or interpretation.
- Feeling: The second step is to express how the situation or behavior makes you feel, using a vocabulary of emotions that accurately reflects your experience.
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- Need: The third step is to identify the underlying need or desire that is driving your feelings. Needs are seen as universal and fundamental to human nature, and are distinct from specific strategies or actions.
- Request: The fourth step is to make a request for action or change that is concrete, specific, and respectful of the other person's autonomy.

The aim of NVC is to foster empathy and mutual understanding by encouraging individuals to express themselves honestly and empathetically, and to listen with empathy and respect.

### **Creativity methods**

The Six Hats tool is a creativity tool developed by Edward de Bono that is designed to help individuals think more effectively and creatively by exploring multiple perspectives on a given problem or issue. There are six different colored "hats" in the Six Hats tool, each representing a different type of thinking:

- White Hat: This hat represents the collection of objective information and facts. In this mode, the focus is on analyzing data and information that is available and making logical deductions.
- Red Hat: This hat represents emotions and feelings. In this mode, the focus is on understanding and expressing the feelings, hunches, and intuitions that arise when considering a problem.
- Black Hat: This hat represents the critical and cautious thinking. In this mode, the focus is on identifying the potential problems, drawbacks, and obstacles to a given solution.
- Yellow Hat: This hat represents the optimistic and positive thinking. In this mode, the focus is on identifying the potential benefits, opportunities, and advantages of a given solution.
- Green Hat: This hat represents the creative and imaginative thinking. In this mode, the focus is on generating new and innovative ideas, and on considering alternative approaches to the problem.
- Blue Hat: This hat represents the reflective and procedural thinking. In this mode, the focus is on reviewing and evaluating the thinking process and deciding on the next steps.

The Six Hats tool encourages individuals to wear different hats at different times during the problem-solving process, in order to explore different perspectives and generate more creative solutions. By switching hats, individuals can break free from their habitual ways of thinking and consider new and different approaches to the problem at hand.

### **Visualizing causes of problems**

An Ishikawa diagram, also known as a fishbone diagram or cause-and-effect diagram, is a tool used for identifying and organizing the possible causes of a problem or issue. It was developed by Kaoru Ishikawa, a Japanese quality control expert.

The Ishikawa diagram is based on the idea that there are several possible causes of a problem, and that these causes can be grouped into several major categories. The diagram is constructed as follows:



- Start by defining the problem or issue you want to investigate and write it at the head of the diagram.
- Draw a horizontal arrow pointing to the right from the head of the diagram.
- Draw a vertical arrow pointing downwards from the horizontal arrow to create the spine of the fishbone.
- Identify the major categories of possible causes for the problem, such as people, process, equipment, materials, and environment, and draw diagonal arrows from the spine to these categories.
- Identify the specific causes within each category and draw diagonal arrows from the major categories to the specific causes.
- Identify the root cause(s) of the problem by analyzing the specific causes.

The Ishikawa diagram is a visual tool that helps to identify the different factors that may be contributing to a problem. By breaking down the problem into different categories and specific causes, it becomes easier to understand the root cause of the problem and to develop a solution.

### **Methods for creating new businesses**

Design thinking is an approach that puts human needs and experiences at the center of the design process. It is a methodology that is used to create innovative and effective solutions, especially very useful, when creating new business ideas. The design thinking process is often broken down into five stages: empathy, definition, ideation, prototyping, and testing.

- **Empathy:** The first stage of the design thinking process is to develop empathy for the people who are affected by the idea. This involves observing and understanding their needs, wants, and behaviors, and developing insights into their experiences.
- **Definition:** The next stage is to define the problem or business idea that needs to be addressed. This involves synthesizing the insights gathered during the empathy stage and defining the idea in a way that is meaningful and actionable.
- **Ideation:** In this stage, designers brainstorm and generate a wide range of ideas for possible business. The emphasis is on quantity rather than quality, and designers are encouraged to think creatively and unconventionally.
- **Prototyping:** The fourth stage involves building rough, low-fidelity prototypes / product of the most promising ideas. These prototypes can take many forms, from sketches and diagrams to physical models and mockups.
- **Testing:** In the final stage, designers test the prototypes with the target audience to gain feedback and insights into the effectiveness of the solutions. Based on the feedback, designers refine and iterate their ideas until they arrive at a solution that meets the needs of the users.



## Risk management

As a first step for risk management, it is important to know the risks that could happen. For that a SWOT analysis is a useful tool to identify the strengths, weaknesses, opportunities, and threats of a project. The goal of a SWOT analysis is to help organizations make better decisions by identifying factors that may affect their success or failure.

The acronym SWOT stands for the following:

- **Strengths:** Internal factors of the farm that give an advantage concerning a special project
- **Weaknesses:** Internal factors of the farm that give a disadvantage concerning a special project
- **Opportunities:** External factors that can be leveraged to benefit the organization, such as market trends, changes in regulations, or emerging technologies.
- **Threats:** External factors that can negatively impact the organization, such as increased competition, economic downturns, or changing customer preferences.

The SWOT analysis process typically involves the following steps:

- **Identify the objective:** The first step in a SWOT analysis is to define the objective, such as evaluating a new product or assessing the performance of an existing business.
- **Conduct internal analysis:** Identify the strengths and weaknesses of the organization by analyzing its resources, capabilities, and internal processes.
- **Conduct external analysis:** Identify the opportunities and threats by analyzing the external environment, including competitors, customers, and market trends.
- **Develop an action plan:** Based on the analysis, develop an action plan that leverages the organization's strengths and opportunities while addressing weaknesses and threats.

## What this means for consultants in agriculture

Climate change has a significant impact on agriculture, and consultants in agriculture must be able to assess the situation of a farm considering the effects of climate change. Here are some ways a consultant in agriculture can assess the situation of a farm in light of climate change:

**Analyze historical climate data:** The consultant can analyze historical climate data for the region and farm to determine if there have been any trends in temperature, precipitation, or other climate variables that could impact the farm.

**Identify risks:** The consultant can identify the specific risks that climate change poses to the farm. These could include changes in water availability, increased frequency or severity of extreme weather events, or changes in pest or disease pressure.

**Evaluate soil quality:** Climate change can impact soil quality, and a consultant can assess the health of the soil and determine if any remediation is needed.

**Assess crop and livestock performance:** The consultant can evaluate the performance of crops and livestock on the farm to determine if any changes are needed to adapt to the changing climate.

**Develop a climate adaptation plan:** Based on the assessment, the consultant can develop a climate adaptation plan that identifies specific actions the farm can take to reduce risks and adapt to the changing climate. This may include changes to cropping practices, changes to irrigation systems, or other adjustments.

**Provide ongoing support:** The consultant can provide ongoing support to the farm to ensure the climate adaptation plan is implemented successfully and adapted as needed over time.





### Reading list:

#### Coaching

- Starr, *The Coaching Manual*.

#### Communication

- [https://en.wikipedia.org/wiki/Four-sides\\_model](https://en.wikipedia.org/wiki/Four-sides_model). Download: 26.02.2023
- Friedemann Schulz von Thun: *Miteinander reden*. Bd. 1-3. Rowohlt 2008
- [What Is Nonviolent Communication developed by Marshall Rosenberg? \(insightfulcounselling.com\)](https://insightfulcounselling.com) Download: 26.02.2023
- Marshall B. Rosenberg: *Nonviolent Communication: A Language of Life (Nonviolent Communication Guides)*. PuddleDancer Press; 3rd ed. Edition (2015)

#### Conflict Management

- [9 Stages of Conflict Escalation according to Friedrich Glasl | projectmanagement.guide](https://projectmanagement.guide). Download 26.02.2023

#### Leading groups

- Lawson, *The Trainer's Handbook*.

#### Problem Solving

- 35 problem-solving techniques and methods for solving complex problems. <https://www.sessionlab.com/blog/problem-solving-techniques/#problem-solving-techniques-for-developing-solutions>. Download 26.02.2023

#### Project Management

- [Scrum - what it is, how it works, and why it's awesome \(atlassian.com\)](https://atlassian.com). Download 27.02.2023
- [Free Gantt Chart Maker - Create a Gantt Chart Online | Canva](https://canva.com). Download 27.02.2023

#### Starting a new business

- <https://mitsloan.mit.edu/ideas-made-to-matter/design-thinking-explained>. Download 26.02.2023