Swiss Farmers' Views on the Role of Soil Management to Mitigate Impacts of Droughts and Extreme Precipitation

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Abstract

Extreme weather events like severe summer droughts and less frequent but more intense rainfalls will become more common in many parts of Europe in the future, posing serious risks to crop production, soil health and the environment. Droughts and heavy precipitation events significantly affect soil functions relevant for agricultural production. To reduce impacts due to heavy precipitation or droughts, preserving soil functions is highly relevant. Integrating sustainable soil management practices can help to increase the resilience of farms and enhance soil health. A main finding from studies analysing what drives farmers to change soil management practices is that there are a few factors relevant in each and every context; among them environmental values and economic considerations. In this thesis, I analyse farmers' context-specific factors (i.e. factors that are relevant in specific cases) and their opinions of what constitutes a 'Good Farmer' that are influencing their choice of soil management practices across the Swiss Plateau. I identified three distinguished viewpoints among Swiss crop farmers; the 'Sustainable Farmer', the 'Pragmatic Farmer' and the 'Market-Focused Traditionalist'. When deciding on their soil management, the 'Sustainable Farmer' thinks about the long-term effects of their actions and their impacts on the future generations. The 'Pragmatic Farmer' decides based on his scientific knowledge and takes legal restrictions, nature, effort and enjoyment of the soil management practice into account. Neat and tidy fields as well as economic considerations characterise the 'Market-Focused Traditionalist'. Additionally, what constitutes a 'Good Farmer' in Switzerland was explored. Being open-minded, having the right timing, having traditional values and having an affinity for nature represent the characteristics that were mentioned most frequently by the farmers. The results suggest a policy mix that incorporates farmers context-specific factors. Supporting farmers in the implementation of conservation practices and encouraging them to share their knowledge and viewpoints, could further increase their acceptance.

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1. Introduction

Agricultural production is the foundation of our health and well-being. Increasing human population and limited productive land requires agricultural production to expand or intensify to meet the increasing demand for food, risking the soils to become depleted and thus less resilient (Hobbs, 2007; Lehmann et al., 2015). Agriculture is among the sectors that are most sensitive to climatic changes, and, thus, is in need to take adaptation and mitigation measures to decrease the negative impacts on agricultural productivity (Klein et al. 2014; Faye, 2022). Projections under the intermediate climate change scenario RCP4.5 for 2060 describe a change in summer precipitation from 0 to -20 % and a temperature increase from +1.5 to +2.8 °C (National Centre for Climate Services, 2018). Increasing temperature, seasonal deficits in rainfall and enhanced evaporation may increase risks for droughts and heavy precipitation events like thunderstorms (Calanca, 2007). Both precipitation extremes increase risks of erosion. Erosion is currently considered as one of the greatest threats to agricultural soils (Montgomery, 2007). The vulnerability of soil erosion is determined by slope, soil type and farming practice (Montgomery, 2007; Altieri, 2015). Enhancing soil resilience is an important factor in mitigating risks related to climate change (Altieri, 2015).

In current research, biophysical models are being used to identify the impacts of climate change on different crops and to explore possible adaptation measures. A large proportion of recent research in agricultural climate change adaptation and mitigation focuses on crops and soil management (e.g. Sørensen et al., 2014; Holzkämper, 2020; Altieri, 2015). This body of literature found several conservation practices, such as enhancing soil organic carbon and reducing tillage, with whom farmers could increase their soil's resilience towards risks related to climate change. However, the farmer itself as decision maker and implementor of adaptation and mitigation measures is central to systematic evaluations.

Farmer's decision-making is crucial to the adoption of agricultural practices. Past studies have found several different factors that drive farmers to adopt practices with climate-related benefits (for recent reviews, see Bartkowski and Bartke, 2018; Dessart et al., 2019; Prokopy et al., 2019; Cullen et al., 2020). Economic considerations and environmental awareness are two factors that are found critical for adaptation across contexts. Similarly, past studies have found different factors that are hindering the adoption of practices (for a recent review, see Ranjan et al., 2019). Critical factors across contexts are for example mismatches between production systems and new practices as well as economic considerations. Generally, only a few factors have been found to be important in each and every context (Bartkowski and Bartke, 2018). However, there are many different context-specific factors like social, cultural, behavioural, and institutional factors (e.g. Ranjan et al., 2019). In their study on the adaptation

of European agricultural environmental schemes, Wittstock et al. (2022) found several context-specific factors, e.g. farm type, geographic factors, routine-related factors, economic factors or land use decisions. For this reason, it is relevant for researchers to focus on context-specific factors that are supporting or hindering farmers' decisions on soil management practices.

In this thesis, I focused on farmers' decisions on the adoption of soil management practices, with the aim to identify the factors that are context-specific in decision-making of farmers located in the Swiss Plateau. In this thesis, context-specific refers to economic, institutional, social, or biophysical circumstances or, in other words, farmers' specific environment (similar to Wittstock et al., 2022). I investigated individual farmers' views on the relevance of soil management practices, as well as their challenging and enabling elements. To analyse those individual factors of each farmer in a broader context, I applied Q-methodology. Q-methodology combines qualitative and quantitative elements to identify types of farmers who share similar views on an issue (Stenner and Watts, 2012). Understanding farmer typologies can help to tailor policy more effectively to farmers (Burton and Wilson, 2006; Cullen et al., 2020). In addition, I conducted qualitative interviews to elicit farmers' understanding of what constitutes a 'Good Farmer' (Burton et al. 2008). The combination of those methods allows not only to focus on sociocultural influences like values and norms that are often missed out by policies (Bartkowski and Bartke, 2018), but also to analyse the relative importance of many other factors that may influence farmers' decision-making. Therefore, this thesis addresses this knowledge gap by exploring the following two research hypotheses:

1) Various farmer-related challenges limit the widespread uptake of improved soil management practices and these challenges vary in importance depending on context and type of practice.
2) How farmers view their soil management practice depends on their perception of and identification as a 'Good Farmer'.

Four research questions derive from these two hypotheses:

1) What considerations are central for farmers in Switzerland when choosing their soil management?
2) What constitutes a 'Good Farmer' for Swiss farmers?
3) To what extent does the perception of what a 'Good Farmer' is, differ from the farmers' own values?
4) What challenges prevent farmers from adopting practices that promote soil health?

The following chapter provides a definition of extreme events and an introduction of two of the most relevant weather extremes in agricultural production: droughts and heavy precipitation. In addition, soil management practices that have climate-related benefits are briefly summarised. Subsequently, in Chapter 3, agricultural soil management, soil health, and current policies for mitigating extreme events will be described. In Chapter 4, Q-methodology and the method of the 'Good Farmer' (GF) are presented. The results from the study are shown in Chapter 5. Finally, Chapter 6 provides a discussion of the results. The final conclusion answers the four research questions.

2. State of Research: Precipitation Extremes and Soil Management Practices

In many areas of Europe, extreme weather events like severe summer droughts and less frequent, but more intense rainfalls are almost certain to become more frequent (Keller and Fuhrer, 2004; Scherrer et al., 2016; Seneviratne, 2021). Extreme events are defined by the Intergovernmental Panel on Climate Change (IPCC, 2012: 116) as *"the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends ('tails') of the range of observed values of the variable"*. They describe, in other words, the occurrence of anomalous weather. Extreme weather events can be very short-term, like heavy precipitation during a thunderstorm, or last up to ten consecutive days, like weather anomalies (e.g. heat waves), that are typically associated with droughts. Extreme weather events that last several days result from changes in the atmospheric conditions that last for two to ten days and cover large areas (McGregor, 2005), whereas short-time extreme events can be very concentrated, small-scale events. As for the National Centre for Climate Services (2018: 104), extremes *"[…] encompass rare weather and climate events with potentially serious implications for humans, infrastructure, and the environment."* Implications from extreme events can pose serious challenges to farmers, as Cogato et al. (2019) found in their review of consequences of extreme weather events related to agriculture. Negative effects include drought stress in plants, especially during flowering and grain filling, reduction or loss in yields, and erosion.

Projected temperature changes under climate change scenarios are relevant to the agricultural sector, as droughts can not only be caused by a lack of rainfall, but also by increased potential evaporation resulting from increased radiation, i.e. increased temperatures (IPCC, 2012: 167). According to the recent IPCC report's projections, Europe will most likely experience periods of warmer temperatures (IPCC, 2022). Within the projections of a global

warming of 2 degrees Celsius, which is the goal currently pursued under the Paris Agreement (United Nations Framework Convention on Climate Change, 2016), an increase of heat days is to be expected. There is a similar outlook for heavy precipitation events: It is likely to very likely that heavy precipitation events over Europe will increase in frequency and intensity. In the future, as the IPCC (2022) reports, extreme events may occur in a larger magnitude, as compound events, i.e. several events at the same time or shortly after one another, with increased frequency or at new locations and different timings (e.g. earlier or later in the year).

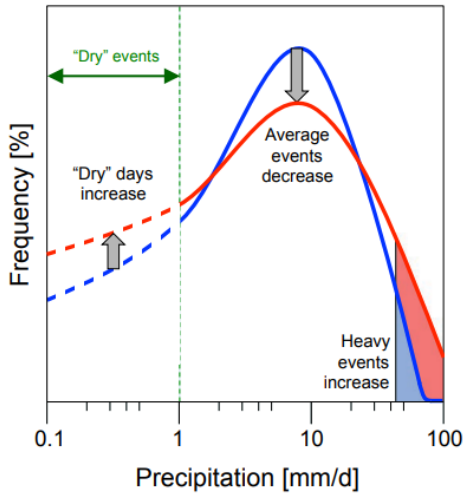

Figure 1: Expected shift in precipitation extremes for a location in the Swiss Plateau (Zurich). A change in distribution of precipitation increases the probability of droughts as well as heavy precipitation to occur, whereas average precipitation is more likely to decrease. Source: National Centre for Climate Services (2018) CH2018 – Climate Scenarios for Switzerland, Technical Report, p. 105.

2.1 Precipitation Extreme: Droughts

In research, different types of droughts are described (e.g. meteorological, hydrological, socioeconomic, and agricultural droughts). The World Meteorological Organisation (1992: 784) defines drought as *"period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance"*. Droughts from a meteorological point of view are in principle about changes in net water availability, determined by the amount of precipitation and evapotranspiration (Hanel et al., 2018). According to Brunner et al. (2019), agricultural droughts are specified by meteorological droughts causing a lack of surface water and soil moisture, which can lead to crop yield losses. Definitions of agricultural droughts take crop physiology and phenology into account (Mishra and Singh, 2010). A reoccurring theme in drought research is that not only the complex characteristics of drought events but also that

various definitions and quantifications lead to discrepancies and uncertainties in findings (Petrovic et al., 2022). In the remainder of this thesis, I refer to the definition of agricultural droughts by Brunner et al. (2019).

There is a large body of studies in Europe giving evidence for droughts to increase in the future (e.g. Mishra and Singh, 2010; Dai, 2011; Grillakis, 2019; Trnka et al., 2016). But there are also studies suggesting a decreasing trend (e.g. Spinoni et al., 2018) and no trend (e.g. Vicente-Serrano et al., 2021). Drought events do, despite their high damage potential, not yet have a simple explanation since they are region- and context-specific (Hlavinka, 2009). In any case, the occurrence of droughts can have serious impacts on soil structure and crop production. Soil structure can be damaged by cracked soils, surface water runoff and erosion (Schorer, 1992). Crops that lack available soil water may, depending on the vegetation phase and cultivar, begin to senesce or be restricted in their growth.

2.2 Precipitation Extreme: Heavy Precipitation

The previous chapter established that there is no single definition for droughts. Similarly, there is no single definition for heavy precipitation. Generally, heavy precipitation can be described as high-magnitude rainfall (Tichavský, 2019). In some studies, a fixed daily precipitation threshold to assess extreme events is used. Absolute thresholds for heavy precipitation are region-specific and therefore not always useful for comparisons: For example, the threshold is defined with ≥ 50 mm d^{-1} precipitation in a study in China (Chen et al., 2011) or ≥ 20 mm d^{-1} in a study in Germany (Lupikasza et al., 2011). From a statistical point of view, heavy precipitation events on a daily scale can be defined by percentile-based indices; rainfall exceeding the 90th percentile (Yin et al., 2022) or exceeding the 99th percentile (Alexander et al., 2006).

In the recent IPCC report AR6, Seneviratne et al. (2021) conclude that there is robust evidence that the intensity and magnitude of heavy precipitation have increased since the 1950s, especially in winter and summer seasons (Madsen et al., 2014). This trend may occur since rising global air temperatures due to climate change increase the amount of water vapor that can be held by the atmosphere (Allen and Ingram, 2002; Westra et al., 2014). According to the Clausius-Clapeyron relationship, the water vapor in the atmosphere increases by 6-7 % per degree of warming (e.g., Held and Soden, 2000). More water vapor in the atmosphere intensifies the hydrological cycle and increases the risk of heavy precipitation, its frequency, intensity, or duration at more or less the same rate as the humidity increases per degree of warming (Frei et al., 1998; Knutson and Tuleya, 2004; Huntington, 2010).

In crop production, extreme precipitation can represent a serious risk for water erosion (Schorer, 1992). Water erosion can cause the first layer of soil to be washed off, especially in soils that are inclined and not covered by vegetation, or soils that are dried up (Federal Office for the Environment, 2017). By losing the top layer, the soil loses its most fertile and nutrient-rich soil and its overall thickness (Schorer, 1992). The risk and intensity of erosion are especially high if droughts and heavy precipitation occur subsequently, as dry soil has a lower water absorption capacity (Tichavský et al., 2019).

As the last two subchapters have shown, droughts and heavy precipitation could become even more frequent in the future. Both precipitation extremes can have serious negative effects on soils, among them reduced soil quality and crop productivity losses. The intensity of those negative effects does not only depend on physical soil characteristics, but also on soil management; both of which will be summarised in the next two subchapters.

2.3 Physical Soil Characteristics

The soil's texture is one of the most important soil characteristics and is directly related to nutrient retention and drainage capacity (Jaja, 2016). Drainage capacity is an important factor in soil erodibility. Physical soil characteristics, like the size of soil particles, can influence their drainage capacity and erodibility. Following O'geen et al., erodibility is a *"detachment of soil particles, continues with the transport of those particles, and ends with the deposition of soil particles in a new location"* (2006: 1). Soil erodibility depends on the soil type, topography as well as land use and land cover (McCool and Williams, 2008). Additionally, when rainfall is scarce, the soil's ability for water retention becomes relevant. Soil water retention measures how much water a type of soil can retain and is similar to erosion risk factors influenced by the type and texture of the soil (Lal et al. 2012). Soils having a larger proportion of sand or silty soils, i.e. larger particles, are more at risk for soil erosion (Ulén et al., 2012). Additionally, they lose their water content the fastest (Finch et al., 2014). Crops grown on sandy soils therefore can experience drought stress more quickly. Clay soils, in contrast, are less prone to soil erosion, since their particles bond better. Heavy soils that are rich in clay content also have a higher water retention capacity (Artiola et al., 2019). Nevertheless, heavy soils are at risk to shrink during droughts and develop cracked surfaces that dry out the plant and roots even more. Shrinkage also leads to soil compaction, which leads rainfall to run off without reaching the deeper soil layers, according to Artiola et al. (2019). Soils that have both properties, medium heavy soils like sandy loam, can retain more water than sandy soil and are not as

likely to become compacted when dried out. Also, their structure allows roots to grow deeper and reach water resources better than dense clay soils (Artiola et al., 2019).

Soil management practices are largely influenced by physical soil characteristics (Jaja, 2016). How farmers work with their soils can both harm and enhance soil resilience to extreme precipitation events. Since in the Swiss Plateau both clay and sandy loam soils are prevalent, farmers' management practices to mitigate extreme precipitation and enhance soil resilience become even more context-specific. In the next chapter, I elaborate on how soil management practices influence the soils' resilience.

2.4 Soil Resilience

In general, healthy soil is resilient soil. A resilient soil is one that can adapt to or recover from stress, for example extreme events, and that has a good soil biota (Lehmann et al., 2015). Soil health can be defined as "*the capacity of a soil to function within ecosystem and land-use boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health"* (Doran and Parkin, 1994 in Bünemann, 2018: 105). With respect to agriculture, a healthy soil has five key functions: Provision of nutrients, protection from diseases, production of growth factors, availability of water, and reduction of risk of soil erosion (Lehmann et al., 2015).

Erosion already affects around 20 percent of Switzerland's cultivated lands and is both a result of poor soil management and extreme weather events (Ledermann et al., 2008). Since soil erosion due to heavy precipitation is expected to increase with climate change, it poses an increasing risk to soil health and soil functions, for example by decreasing soil fertility and productivity. Risks arising from extreme weather events can be reduced by keeping the soil healthy and implementing appropriate mitigation and adaptation measures (IPCC, 2012). Several factors are relevant to sustainably using the soil in agricultural production and increase the soil's resilience. Resource intense production, as it is common in many areas of Europe, damages the soil: Intense use of soil can not only lead to a loss of soil biodiversity, including earthworms (Tsiafouli et al., 2015; Feijoo et al., 2011), but also to poor soil health (Cárceles et al., 2022). Intensive soil management practices (e.g. heavy machinery) could lead to soil compaction and physical, chemical, and biological degradations like erosion or loss of organic matter (Bolinder et al., 2020). Decreasing soil health leads to increased use of high inputs, like fertilisers and pesticides, to maintain production levels. The intense use of inputs is costly and not sustainable long-term (Panagos et al., 2012). Long-term sustainable soil health can be achieved through sustainable management practices.

The use of sustainable management practices could break the negative spiral of poor quality, increased inputs, and further damage to soil's health (Sørensen et al., 2014). Enhancing soil health and structure through optimal soil management is found to be important to enhance agricultural resilience towards extreme weather events (Godfray et al., 2010) and therefore reduce risks in crop production (Garré et al., 2022). In the following, soil management practices influencing the soil's resilience are summarised. The presented soil management practices do not represent an exhaustive review but an introduction to those practices that were included in the qualitative analysis of this thesis. Other valuable sustainable soil management practices, like intercropping or agroforestry, were not part of the farmers' survey and, hence, are not further elaborated on this point.

Cover Crops, Undersowing and Living Mulch

Plants grown after the harvest of a primary crop are called cover crops, whereas undersowings or mulches are either planted before or with a main crop (Hartwig and Ammon, 2002; Abdalla et al, 2019). Cover crops are used to avoid periods of bare soil, for example during winter, and therefore reduce risks of erosion, as well as soil and nutrient loss. In addition, cover crops can help to improve water holding capacity, fixate nitrogen and reduce weed pressure and evaporation (Harunaa and Nkongolo, 2019). Non-legumes and legumes, crops like canola and clover are suitable cover crops or undersowings (Abdalla et al., 2019). While cover crops and undersowings are at some point incorporated into the soil or killed, mechanically or chemically, living mulches grow for longer periods with the main crop and can even be perennial, i.e. they do not require another sowing. Crop residues from living mulch or cover crops have the effect of reducing evaporation and helping the soil to keep moisture during dry periods (Kingra and Kaur, 2017). All three management practices also share some disadvantages, like negative impacts on soil structure due to eventual additional tillage and nutrient competition with the main crop (Harunaa and Nkongolo, 2019).

Reduced Soil Management and No-Tillage

Tillage is a simple soil inversion practice that has been used for a long time in agricultural production (Hobbs, 2007; Forschungsinstitut für biologischen Landbau, 2014). By using a plough, farmers can mechanically break up soil and turn it over, preparing the seed bed for planting crops. It reduces weed density, incorporates crop residues into soils, and increases nutrient availability (Weber et al., 2017). However, ploughing can increase soil erosion and compaction, disrupt soil ecosystems, and increases soil organic matter loss (Key et al., 2016).

In a review of tillage erosion studies, Van Oost et al. (2006) found that tillage depth is, regardless of the soil type, the most important factor affecting erosion. Traditional ploughing, where soil as deep as 25-30 cm can be turned up to the surface, can be replaced by alternative tillage practices that are less invasive. Among them are the chisel plough, disc harrow, or cultivator (Mäder and Berner, 2012). A reduced tillage practice can for instance include shallow soil cultivation (e.g. 5 cm depth) by a cultivator. In no-tillage, the seeds are planted directly into the undisturbed soil. No-till systems (e.g. tine coulter, disc harrow) are non-invasive systems that can have various positive influences on crop production, such as lower evaporation, more net carbon uptake, more available water content, and higher yields (Kingra and Kaur, 2017).

As for the disadvantages, no-till systems can lead to increased herbicide pressure and less available plant nutrients, requiring both herbicides and fertilisers (e.g. mineral nitrogen) (Mäder and Berner, 2012). Not only have these negative effects on the biodiversity and the environment but also have they been banned from organic agriculture in Switzerland (see Fedlex, 1997). For this reason, organic agriculture still relies on tillage practices. However, many farmers nowadays prefer to use reduced tillage practices, like the chisel plough.

Biochar, Mineral and Organic Fertilizers

Mineral fertilisers are inorganic fertilisers containing large amounts of specific nutrients, particularly phosphorus (P) and nitrogen (N). They provide relevant nutrients to crops and increase crop growth (Yang et al., 2022). However, their production requires large amounts of energy, and their usage can not only lead to soil degradation but also the emission of potent greenhouse gasses like NO_x, making them not sustainable long-term (Yang et al., 2022). When overusing mineral fertilisers, nutrients can run off or leach and harm surrounding ecosystems (e.g eutrophication of lakes).

Some of those adverse effects can be reduced by using organic instead of inorganic fertilisers. Organic fertilisers are based on natural resources of plant or animal origin and can increase soil quality (Shi et al., 2023). Slurry, dung, and compost are often used as a substitute for mineral fertilisers. According to Shi et al. (2023), the application of organic matter to soil can increase crop yield through nutrient provision, and increase soil organic carbon and soil porosity, which supports the water capacity of soils. Since organic fertilisers do not provide nutrients in their raw form, they may not meet the nutrient demand for some crops (Liu et al., 2022).

Another example of organic matter is the biochar. Biochar is organic matter that has been pyrolyzed in an oxygen-limited environment (Joseph et al., 2021). Biochar has many advantages besides its effect on soil coverage: It decreases the leaking of minerals and emissions of NO_x and increases nutrients like organic carbon as well as water retention and aggregate stability. Nevertheless, biochar will not be able to replace fertilisers but rather complement them, especially with its capacity to enhance soil's resilience to droughts (Edeh et al., 2020).

Soil Investigations and Crop Rotation

Crop rotation is the growing of different types of crops on the same soil during different seasons (Shah et al., 2021). According to Shah et al. (2021), diversified crop rotations can increase overall soil health, make the soil more resistant to diseases, and increase physical properties. Crop rotations can include cover crops, including their benefits. Even though a diverse crop rotation benefits the soil, some farmers may be restricted in expanding their crop rotation. Limited knowledge and machinery, as well as short-term contracts for lands and investments, can hinder farmers' uptake of specific crops into their normal rotations (Shah et al. 2021).

Farmers participating in Switzerland's direct payment scheme have to test their soils at least every decade in order to optimize fertiliser usage. It is even recommended to do soil testing in cropland every four to six years (Flisch et al., 2017). Flisch et al. (2017) recommend soil testing not only to optimize fertiliser use but also to gain knowledge on soil parameters like organic content and physical properties that can be influenced by the application of fertilisers and other soil management practices. Soil testing is a relevant measure for climate change adaptation.

Whilst these brief introductions on management practices point out the positive and negative effects of individual measures, it is yet important to mention that there is still an existing knowledge gap regarding interactions of different soil management practices (see Techen et al., 2020). Elaborating on those complex interactions of soil management practices would go beyond the scope of this thesis.

2.5 Swiss Farmers' Context

As Ledermann et al. (2008) stated, today about 20 % of cultivated land in Switzerland is to some degree affected by erosion, some of it caused by the practice of plough and other soil management practices. Around 30 years ago, Switzerland's agricultural policy recognized the

problems arising from erosion and started promoting regulations for soil protection. Since the early 1990s, Switzerland has undertaken many agricultural policy reforms (OECD, 2017). The direct payments were first production-oriented and led to intensified farming. They have later been restructured by the demand of the public to include the protection of agro-ecosystems, while still maintaining the economic security of the production sector (Cretegny, 2001). The embedding of the protection of agro-ecosystems in Swiss Agricultural Policy included farmer training and education, as well as a direct payment system (Karali et al., 2014; Federal Office for Agriculture, 2023). Direct payment systems created economic incentives for farmers to implement management practices enhancing soil quality. The Swiss Climate Strategy for Agriculture includes both general direct payments as well as ecological direct payments (Federal Office for Agriculture, 2011). In order to receive direct payments, farmers have to fulfill the 'proof of ecological performance' (PEP). The PEP is an integrated production principle and comparable to cross-compliance under the 'Common Agricultural Policy' (CAP) by the EU (OECD, 2017). Compared to the CAP, the PEP is a stricter system, strongly limiting farmers' leeway (Jarrett and Moeser, 2013). To this day, many farm managers joined the direct payment program[1]. Measures that are advised by the PEP include a balanced use of fertilisers, limited use of pesticides, crop rotations, soil conservation (e.g. protection from erosion), and ecological compensation areas (e.g. extensive pasture) (Jarrett and Moeser, 2013). Financial incentives led to an increase in some conservation practices, however, others, like no-tillage, have failed to be widely adopted (Ledermann et al., 2008). No-tillage is applied on no more than about 4 % of farmland in Switzerland (Federal Office for Agriculture, 2020).

Agricultural production contributed around 0.6 % of Switzerland's GDP in 2020 and, therefore, is only a small part of the Swiss economy (Federal Department of Foreign Affairs, 2021). In 2022, 1'042'000 hectares of farmland have been managed by around 48'000 farms (Federal Statistical Office, 2022). A typical Swiss farm has an agricultural area of 22 hectares, which is relatively small compared to neighbouring countries (Federal Statistics Office, 2022). Even though agricultural land area is continuing to decline, land used by agriculture (without alpine farming) made up almost one fourth of Switzerland's area in 2018. Agriculture did not only shape the Swiss landscape but also cultural values. Most of the Swiss farms are family-run and passed on to a successor in the family, forming the values of Swiss farmers (Mann, 2007). Cultural values can influence farmers' decision-making (Celio et al., 2014, see Chapter 3).

The Swiss Plateau or midlands is the region with the highest proportion of agricultural land (48.5 %) (Federal Statistics Office, 2018). The Swiss Plateau is a central arch reaching from Lake Geneva in the southwest up to Lake Constance in the northeast of Switzerland. The

[1] All farmers who participated in this study participated to some degree in the PEP.

climate of the Swiss Plateau is typically influenced by the Atlantic and is therefore rather damp and mild with annual rainfall of 800-1'400 mm, depending on the specific location (National Centre for Climate Services, 2022). In the southern area close to the Jura, there is rather less rainfall compared to the regions close to the Alps, where the annual rainfall is the highest. The projected increase in heavy precipitation events will also affect the Swiss Plateau (Scherrer et al., 2016). In Switzerland, additional factors like structural change in agriculture (e.g. larger plots, more intense farming, and heavy machinery), and the displacement of agricultural land towards hillside locations due to the spreading of residential areas can increase the soil's risk of erosion (Federal Office for the Environment, 2017).

3. State of Research: Farmers' Views on Soil Management

As the previous chapter exemplified, farmers' decisions for or against soil management practices can change the soil's resilience towards weather extremes. Even though Switzerland's agricultural policy promotes the adoption of sustainable management practices, monetary incentives alone may not be reason enough for farmers to adopt measures, as studies have shown (e.g. Vatn, 2010; Greiner and Gregg, 2011; Karali et al., 2014; Bartkowski and Bartke, 2018; Dessart et al., 2019).

Intrinsic motivation for adoption and farmers' own values are often not reflected by policies (Braito et al., 2020). Knowledge gaps between policies and farmers' normative models could explain secondary policy effects, like rebound and crowding-out effects, and disentangling those decision-making determinants can be relevant to the design of soil governance instruments (Dessart et al., 2019). There is a large body of literature that investigates hindering or driving factors of farmers' uptake of sustainable soil management practices (e.g. Vanclay, 2006; Knowler and Bradshaw, 2007; Prokopy et al., 2008; Reimer et al., 2012; Prokopy et al., 2019; Cullen et al., 2020; Foguesatto et al., 2020; Serebrennikov et al., 2020; Happel et al., 2022). In a review of publications on behavioural factors in farmers' decision-making, Dessart et al. (2019) provided a categorization of existing variables into an integrated framework in a policy-oriented context. They distinguished three types of behavioural factors found in European studies on farmers' decision-making: 1) Dispositional factors (personality, resistance to change, risk tolerance, concerns, farming objectives), 2) social factors (descriptive norms, injunctive norms, signalling motives), 3) cognitive factors (knowledge, perceived control, perceived risks). Bartkowski and Bartke (2018) found an especially strong influence of past experiences, pro-environmental attitudes, and the goodness of fit in farmers' decision-making on sustainable management practices. They distinguished six primary factors

that influence farmers' decision-making: 1) Objective characteristics of both the farm (size, technology, local environment) and 2) the farmer (demographic factors); 3) economic constraints (costs of measures, financial incentives, compensation payments); 4) behavioural characteristics (e.g. attitudes, beliefs, values, knowledge); 5) social-institutional environment (legal and institutional framework), and 6) decision characteristics. The latter category can be described as the goodness of fit with farmers' activities and legal restriction; how well the adoption of new soil management practices fits into pre-existing management systems and legal circumstances or, in other words, how severe the required change in farm management would be (Wilson, 1997).

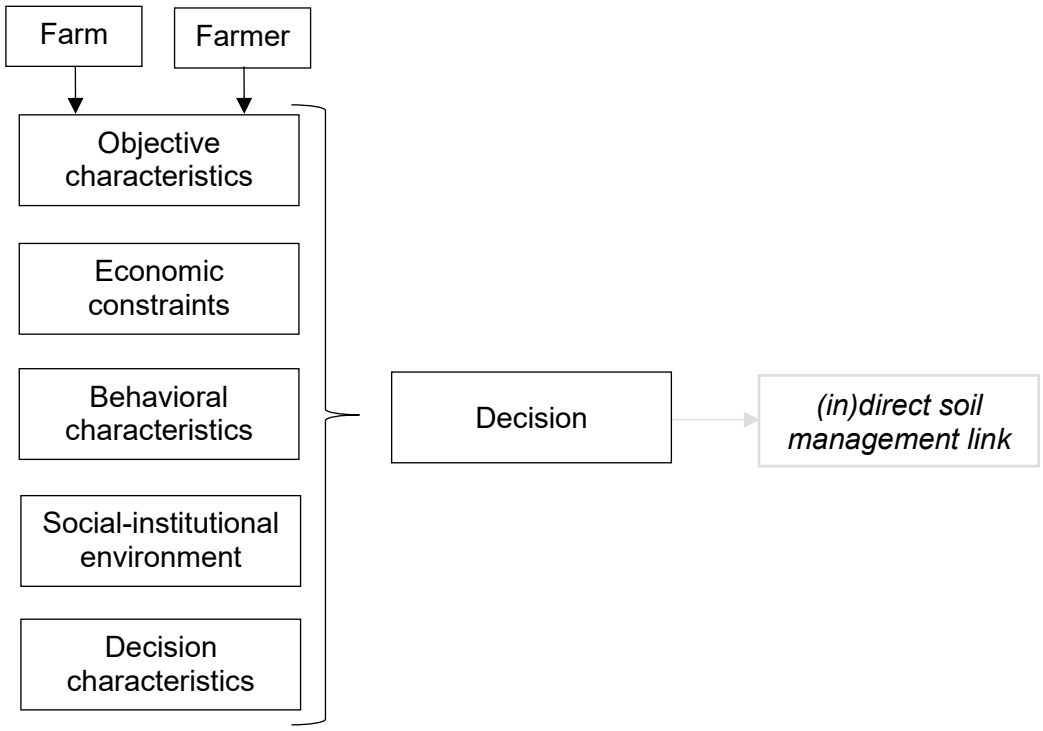

Figure 2: Conceptual framework of farmers' decision-making, based on Bartkowsk and Bartke (2018), showing their concept of the five main factors influencing farmers' decision-making.

Another review done by Ranjan et al. (2019) on qualitative studies in the United States found also several main variables influencing farmers' decision-making. Within the economic factors, they found costs and yield to be a dominant theme. Similar to Bartkowski and Bartke (2018), the studies conducted in the United States often discussed compatibility as an important factor in farmers' decision-making on farm and soil management. Furthermore, their analysis of social norms included different studies on subjective norms, trust in communities, neighbours, leadership, and blame shifting. Within farm characteristics, they found that especially objective

farm characteristics like the vulnerability of the farm and farmland (e.g. erodibility) showed to be an important variable in farmers' decision-making in several studies. Additionally, farmers' characteristics, practices, and perceptions of conservation practices, environmental awareness, trust and distrust in information sources, risks, land tenure, and benefits of conservation practices were found to be factors relevant in qualitative studies within the last 25 years.

Whereas many studies on farmers' decision-making have a broad geographical scope, the survey part of this thesis has been limited to crop farmers' decision-making in one specific Swiss region with a similar cultural and legal context. However, even if some geographic and social-institutional contexts can be controlled, farmers remain a very heterogenous group with a plurality of different viewpoints and farm management practices. Swiss farmers' decision-making in the context of agricultural policies has been subject to several studies (Schenk et al., 2007; Schneider et al., 2009; Karali et al., 2014, Celio et al., 2014). Schneider et al. (2009) analysed the reason for the scarcely implemented soil protection measures that had been already introduced in the early 1990ies in Switzerland. As they argue, the main reasons for limited adoption were that soil protection has been perceived as a technical task that is transferred from experts to farmers as adopters and that policies emphasize ecological and economic dimensions whilst missing out on sociocultural elements like values and norms. A few years later, this knowledge gap was addressed by Karali et al. (2014). In addition, they highlight the importance of context-specific information in farmers' decision-making as a consequence of studies identifying and generalising numerous factors.

Creating types of farmers having similar viewpoints or even self-identities may be helpful to adjust policies for farmers (e.g. Cullen et al., 2020; Braito et al. 2020). To explore the complexity of subjectivity and identify the shared viewpoints of participants, Q-methodology has been proven to be a successful method (see Braito et al., 2020). In the course of this research, it has been observed that in the area of the Swiss Plateau, crop farmers' decision-making has not been extensively explored in the existing literature. To the best of my knowledge, neither has Q-methodology been used in the context of farmers' decision-making nor have farmer typologies or archetypes of farmers with regard to the adoption of soil management practices in the area of the Swiss Plateau been identified. This gap offers an opportunity to investigate and contribute new insights to the field of farmers' decision-making. To identify farmers' archetypes and how they describe ideal management practices and farmer personality traits, Q-methodology, complemented by the concept of GF, has been applied. The next section provides an introduction to the concept of GF.

To answer the second and third research questions about Swiss farmers' descriptions of a GF and the relation of the GF to the viewpoints arising from the Q-analysis, this chapter introduces the concept of the GF. The GF-concept is a holistic way to capture the social evaluation of farmers. Social evaluation is defined, according to Cusworth and Dodsworth (2021), as farmers learning about themselves by comparing themselves with others. Social evaluation is influencing farmers' decision-making, and therefore relevant for farmers' decision-making on soil management practices. The GF-concept is based on Bourdieu's social theory on capital (Bourdieu, 1983). His theory of social capital (e.g. networks, mutual obligations), economic capital (material property), and cultural capital is well known in sociological research. Cultural capital is especially interesting when building the GF-concept, and it can be further distinguished into three forms; institutionalized (e.g. education, social status), objectified (e.g. possession of highly valued cultural goods), and embodied (e.g. knowledge and skills from habitus) capital. Embodied capital of farmers can be accumulated through everyday activities, individual skill development, and the heritage of skills through family (Burton et al., 2008). Embodied capital plays an important role in agricultural communities. Farmers develop their own set of embodied capital, e.g. established agricultural practices that shape the culture of farmers and therefore their understanding of the GF.

Apart from these three types of capital, a fourth superordinate form of capital called symbolic capital has been identified by Bourdieu. Symbolic capital is according to Bourdieu *"[…] the acquisition of a reputation for competence and an image of respectability and honorability […]"* (1984: 291). All of the three forms of capital can become symbolic capital, but cultural capital, in particular embodied capital, are the most predisposed to function as symbolic capital. According to Bourdieu, reproduction of symbolic capital is a way to achieve favorable social standing in a social group like farmers (Bourdieu, 1986).

The concept of the GF has already been applied in several studies on farmers' decision-making. According to Burton et al. (2021), the characteristics of a GF, so-called GF-symbols, are symbols that cannot be changed suddenly. A conventional farmer's GF-symbols could be tidy fields, high yields, and farming machinery (Burton, 2021; Tiselius, 2022). By implementing new farming practices that are not established as cultural capital within the group of farmers, individual farmers risk losing symbolic capital, e.g. their reputation. If, for example, a conservation practice leads to untidy fields, the conventional farmer may experience cognitive dissonance due to their desire to have fields that look neat and tidy. They may weigh their costs to deviate from the symbolic values to which they are accustomed. Even if a farmer gets a financial incentive to adopt the conservation measure, they lose the capability to reproduce their cultural capital (Burton et al., 2008). As Haggerty et al. (2009: 769) write: *"If Bourdieu is correct, and the pursuit of social status is fundamental to social life, farmers will strive to be*

'good farmers' not 'bad farmers', to accrue 'good farmer' capital, and this drive will inform their farming strategies.' Schenk et al. (2007) interviewed Swiss farmers about the factors that influence the acceptance of adopting conservation measures. In their study, they did not only find that economic factors' influence on acceptance is limited but also that farmers have different types of symbolic capital that have to be accounted for. Another study done by Karali et al. (2014) had similar findings; economic incentives matter, but also cultural and other factors determine the GF. For some farmers, changing their soil management could not only imply economic losses but also losses in social and cultural capital (Burton et al., 2008).

4. Methods

In the following, both research methods are introduced. Subchapter 4.1 summarises Q-methodological research, whereas Subchapters 4.2 to 4.5. describe the actual process of designing, testing, applying, and analysing Q in an empirical survey. Subchapter 4.6 presents the implementation of the GF-concept.

4.1 Introducing Q-Method

Q-methodology, here referred to as 'Q-method', has its origins in psychology (Stephenson, 1935). Q-method constitutes a useful tool to study subjective attitudes and opinions. So far, Q-method has been successfully applied in several empirical studies, particularly within socio-environmental research (e.g. Brown, 1980; Exel and de Graaf, 2005; Cairns, 2012). Its main advantage is its holistic approach that supports the reflection of whole viewpoints of participants while limiting the bias from the conducting researcher (Watts and Stenner, 2012; Stephenson, 2014). In Q-method, participants rank statements that cover a broad range of opinions or perspectives (the Q-set) into a quasi-normal shape (the Q-sort), depending on the degree of agreement or disagreement. Stenner et al. (2003: 2163) describe the Q-sort as *"a collection of items […] which are sorted by a participant according to a subjective dimension such as 'agreement / disagreement' or 'most like me / least like me'. Through sorting the items, the participant provides […] a model of their viewpoint on the issue under study"*. The Q-set is usually developed by literature review, qualitative interviews, or expert consultations and has the aim to represent a proxy for the respective concourse (Zabala et al., 2018). The pre-prepared Q-set is then presented to several participants, who sort the statements into a pre-design pattern, resulting in the respective Q-sorts that are later digitalized by the researcher for further analysis.

According to Watts and Stenner (2015), after the digitalization of Q-sorts, they are analysed by means of Q-pattern by-person factor analysis using generic software packages or, as used in this thesis, an open-source desktop application called Ken-Q/KADE (Banasick, 2019). The application extracts unrotated factors by applying a Principal Component Analysis (PCA). Depending on several criteria, the number of factors for the following factor rotation needs to be chosen, with respect to the Kaiser-Guttman criterion (Guttman, 1954), as well as the total explained variance of the study (Watts and Stenner, 2015), the number of significant loadings on one factor and the interpretability of the factors (Brown, 1980). After choosing the number of factors to continue the analysis, a factor rotation is performed. By using a mathematical rotation method like Varimax or rotating the factors manually, the explained variance can be maximized. The extracted factors describe shared subjective perspectives or viewpoints of farmers. Therefore, the researcher should also consider his or her own knowledge to further identify patterns and confirm shared viewpoints. In the next step, factor loadings are analysed. Most representative Q-sorts show a loading that is significantly high in one factor, which means that it approximates the perspective represented in this factor (Watts and Stenner, 2015: 130). In a final step, score ranks guide the development of descriptive accounts of those typical factors (see Chapter 4.5). The descriptive accounts are based on a combination of the typical Q-sorts and their explanations from the associated interviews (Braito et al., 2020).

In short, the Q-analysis comprises a by-person factor analysis and identification of correlations between participants' Q-sorts to identify groups of participants that sorted the Q-statements, the Q-set, in a similar way (Fairweather and Klonsky, 2009).

4.2 The Q-set and Interview Documents

The first step in Q-methodology is to create a set of statements that all refer to a discourse or subject matter of interest (Watts and Stenner, 2012). According to Watts and Stenner (2012), a typical Q-set usually ranges between 40 and 60 statements. In my case, the set of statements, the Q-set, contains perspectives on soil management practices in the broader context of the implementation of sustainable management practices. To be an effective Q-set, it should be as representative of all possible opinions and as balanced as possible, minimizing the bias towards some particular opinion (Watts and Stenner, 2015). Sampling items largely depends on the type of study and the research question. In my case, the Q-set has been developed by consulting relevant literature, project reports, and experts. The Q-set covered statements from different categories including economic considerations, environmental awareness, farm and farmer's context, natural context, institutional and social environment.

By categorization and subcategorization of items from the literature review, a balanced number of viewpoints, beliefs, attitudes or experiences has been chosen.

Next, ensuring that the Q-set, representing the core of the Q-method, is comprehensible to farmers, versatile, and representative of the issue under investigation, the initial statements were discussed, adapted, specified, and clarified in a multi-step process. In order for the method to work, the statements need to be unique, and written in consistent wording (Watts and Stenner, 2012). Following this criterion, the number of words of each statement was reduced by creating a superordinate sentence that initiated all of the following statements (see Figure 5). This decreased the load of information per statement, making the Q-set more comprehensible. In addition, all statements that were too specific were reformulated. For example, the statement *"The economic viability of my farm is 'top priority' for me"* was rewritten as *"(When I work with my soil, it is important to me) …to ensure the economic viability of my farm"*. The term in brackets represents the superordinate part of the statements. While some of the statements were removed or merged due to overlapping with others, some additional statements were included after the review in order to complement the Q-set. Since Q-method does not prescribe the number of statements to include in a Q-set, it is reasonable to include a sufficient number to capture all associated viewpoints, whilst also considering that too many statements decrease the motivation and concentration of the participants (Watts and Stenner, 2012). Considering all these factors, the final Q-set contained 45 statements, shown in table 1, that were later translated into German.

Table 1: The Q-set consisting of 45 statements. Statements are numbered and ordered according to their category. All statements refer to the introductory sentence.

No.	Statement	Source
	When I work with my soil, it is important for me…	
1	… that my plots look tidy and neat.	Ryan et al. (2003), Schneider et al. (2010), Braito et al. (2020)
2	… to preserve the soil for future generations.	Ryan et al. (2003), Braito et al. (2020)
3	… to consider the costs involved.	Charlisle (2016), Braito et al. (2020)
4	… to ensure the long-term economic viability of my farm.	Charlisle (2016), Braito et al. (2020)
5	… to prioritize short-term profit.	Charlisle (2016), Dessart et al. (2014)
6	… to receive subsidies for what I do.	Braito et al. (2020)
7	… to maximize crop yields in this year.	Walder and Kantelhardt (2018)

8	… how far a plot is away from the farm house.	Barbayjannis et al. (2009), Lahmar (2010), Braito et al. (2020)
9	… to hand it over to my successors in a good condition.	Cullen et al. (2020)
10	… that it is possible to work with the machines I have access to.	Bartkowski and Bartke (2018
11	… whether I own the plot.	Foguesatto et al. (2020)
12	… to rely on what I learned in my training or education.	Braito et al. (2020)
13	… to rely on the experiences of colleagues.	Bartkowski and Bartke (2018)
14	… to rely on my own experiences.	Braito et al. (2020)
15	… to do what I believe in.	Happel et al. (2022)
16	… to consider how neighboring plots are farmed.	Braito et al. (2020)
17	… to consider how my actions impact my neighbors.	Ryan et al. (2003), Braito et al. (2020)
18	… to minimize working time.	Dwyer et al. (2007), Braito et al. (2020)
19	… to rely on traditional, handed-down knowledge.	Karali et a. (2014), Braito et al. (2020)
20	… to rely on the advice from advisory services.	Dessart et al. (2019)
21	… how long I will continue to farm.	Karali et al. (2014), Leonhardt et al. (2019), Charlisle (2016), Braito et al. (2020)
22	… that I don’t have to deal with more paperwork than necessary.	Walder and Kantelhardt (2018)
23	… to rely on the latest research results or recommendations.	Serebrennikov et al. (2020)
24	… not to come in conflict with legal regulations.	Karali et al. (2014), Braito et al. (2020)
25	… to mitigate negative effects from extreme weather events.	Mitter (2018), Braito et al. (2020)
26	… to reduce soil erosion.	Mitter (2018), Braito et al. (2020)
27	… to prevent pests.	Mitter (2018), Braito et al. (2020)
28	… to know the plot’s soil quality data.	Prokopy et al. (2008), Happel et al (2022)
29	… to meet the requirements of my buyers.	Karali et al. (2014), Braito et al. (2020)
30	… to meet the expectations of society.	Karali et al. (2014), Braito et al. (2020)
31	… to produce food for society.	Burton (2004), Burton and Wilson (2006), Braito et al. (2020)
32	… how my actions impact the environment.	Delaroche (2020), Prokopy et al. (2008)
33	… that I work together with nature.	Braito et al. (2020)
34	… how my actions impact soil organisms such as earthworms.	Walder and Kantelhardt (2018)
35	… how others perceive my actions.	Karali et al. (2014), Braito et al. (2020)
36	… that the work gives me pleasure.	Braito et al. (2020)
37	… to avoid economic risks.	Karali et al. (2015), Braito et al. (2020)
38	… to ensure a stable yield in long term.	Bartkowski and Bartke (2018)

39	… that I try new practices.	Kowler and Bradshaw (2007), Prager and Posthumus (2010), Braito et al. (2020)
40	… to increase organic matter.	Serebrennikov et al. (2020)
41	… to prevent nutrient losses.	Serebrennikov et al. (2020)
42	… to minimize machinery use.	Bartkowski and Bartke (2018)
43	… to protect water resources.	Delaroche (2020)
44	… to consider climatic changes.	Bartkowski and Bartke (2018)
45	… to increase the soil's water retention capacity.	Bartkowski and Bartke (2018)

To include farmers' information on age, education level, farm characteristics, and current soil management practices, a short questionnaire was developed in addition to the Q-set (see Appendix D). Both the questionnaire and the final Q-set, containing 45 statements, were pre-tested with two people before the beginning of the data collection method. By pre-testing, the comprehensibility and integrity of the Q-set were evaluated. The pre-tests were not included in the factor analysis. Both pre-testers, one of them being a farmer, and the other being an agricultural scientist, were able to complete the Q-set and the questionnaire. In the subsequent discussion, no additional opinions or statements were raised.

Due to the sensitivity of the information from recruitment and those that were collected during the study itself (in particular the recordings of the subsequent interviews), ethical considerations are important. The consent form for this study was is based on the EU's General Data Protection Regulation (GDPR) and was approved by the Ethics Board of the University of Natural Resources and Life Sciences, Vienna (see Appendix E). Especially the requirements of Article 13 GDPR on the collection of personal data from data subjects had to be fulfilled. Farmers had to consent to the data collection. To be as transparent as possible, I followed the GDPR and informed the farmers about the consent form before the interviews and made sure that they understood the data collection method and how their data will be stored and used. Before the interviews could start, all of the participants had to read and sign the consent form on-site.

4.3 The P-set

The data collection begins with the sampling of farmers willing to participate in the survey. To get reliable results with Q-method, the participants, also called the P-set, should have clear and distinct viewpoints with regard to the issue (Exel and de Graaf, 2005). The P-set does not

necessarily need to be large but rather include distinct opinions (Brown, 1980; Zabala et al., 2016). Therefore, several different channels were used to find participants within different contexts having as diverse opinions as possible. As this thesis is part of a project associated with Agroscope, the Swiss centre of excellence for agricultural research, some of their channels and networks could be used to reach potential participants. To participate, the study-specific requirements for farmers were 1) to farm at least some cropland, 2) to be located in the Swiss Plateau, and 3) to be the primary farm manager making decisions about the soil management practices. A participant information sheet, describing the study purpose, the interview process, and the ethical aspects of the data collection, was prepared. This participant information sheet has then been distributed in multiple channels with the request to forward the invitation message. The channels used for communication included associations (e.g. SWISS NO-TILL), experts and advisors, scientists, Social Media (e.g. Facebook page of Agroscope), and a farmers' newspaper (Schweizer Bauer). Simultaneously with the sampling process, the first interviews were conducted. In the end of each interview, the farmers were asked to recommend neighbouring farmers or colleagues that could also be interested in participating in the study. With these convenience and snowball sampling methods combined, slightly more than 30 farmers reached out or were directly contacted. Out of all interested farmers, 26 met the requirements to participate and were requested to schedule an appointment for the interview.

Figure 3 shows a map of Switzerland, the area of the Swiss Plateau is shaded in dark grey. Each black dot marks a location of a farm that has been visited, respectively an interview that has been conducted at this location. Within the vicinity to Lake Geneva in the southwestern part, no interviews were conducted due to the increased proportion of French-speaking farmers and the fact that the Q-set and questionnaire were being set up in German.

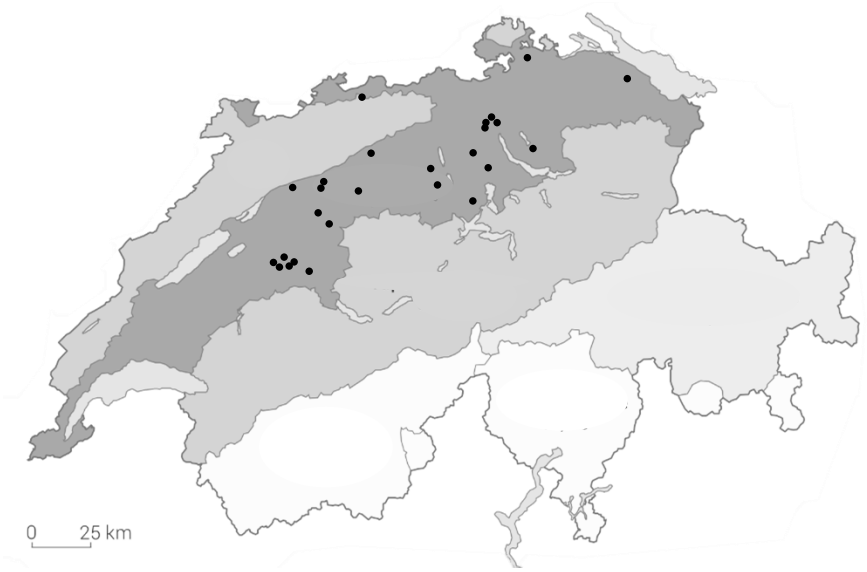

Figure 3: Map of Switzerland's biogeographic regions. Dark grey represents the Swiss Plateau. Each black dot represents one interviewed farmer. Modified from source: Federal Statistics Office (2018) Agricultural areas.

The sample consisted of 26 farmers from different parts of the Swiss Plateau. All except one participant identified as male. The farm manager's age reached from 31 to 69 years (Ø 49 years), around one third of them is working full-time and a second third of them is working part-time at their farm (last third: n/a). Farm sizes varied between 12 and 60 hectares (Ø 28.75 ha), of which at least 2 hectares and a maximum of 45 hectares were used for crop production (see Figure 4). 12 farms were certified organic, 10 farms were conventional, and 4 farmers said to be transitioning or to be at least partly, but not yet certified, organic. Eight farmers completed an apprenticeship, 12 visited an agricultural secondary school, four have a university degree, and one farmer did not have an agricultural education at all. 19 ran a mixed farm while the other 7 exclusively grew field crops. 21 out of 26 farmers kept some sort of livestock, mostly cows and sometimes chickens or pigs. The number of livestock has been measured in livestock units (LSU), a well-known method to compare and aggregate stocks of different farm animals (1 LSU is equal to one dairy cow). The participants indicated on average a LSU of 24, with a range from 0 to 135 LSU. When comparing the sample to the overall population of Swiss farmers, the participants managing organic farms were slightly overrepresented. Only 15 % of farms in Switzerland are certified organic, compared to around 50 % organic farmers in the sample. According to Zorn (2020) and the Federal Statistics Office (2020), the average farm size in Switzerland is around 22 hectares. Swiss farms have on average around 28 LSU.

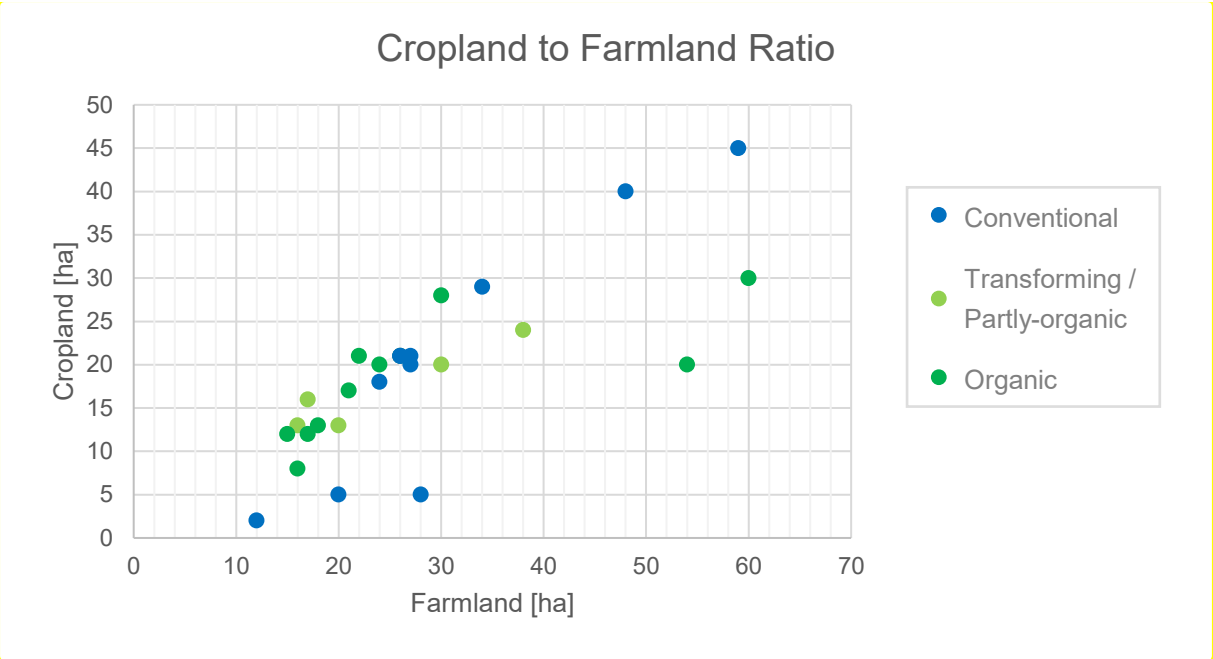

Figure 4: Ratio of cropland to farmland. Each dot represents one of the 26 farms.

4.4 The Q-sort

The semi-structured interviews were conducted from March 2023 to early May 2023. Within those weeks, I visited 26 farm managers at their farms. By visiting the farmers at home, I could not only offer the farmers the least effort option, which was quite important during the time of the year, when they begin to work in the field. With this, the interview also took place in an environment that is familiar to them. On average, the interviews lasted one hour, depending on the depth of the discussion. The shortest interview took 40 minutes and the longest took around 3 hours. The interviews did not require any information that the farmers would not know by heart, i.e. they were not required to prepare for the interview. The interviews were conducted in Swiss German. Even though German and Swiss German are closely related, some questions were formulated slightly differently but as far as possible, the formulation was kept as close to German as possible. All of the interviews were recorded under the consent of the farmers and later transcribed and anonymized.

During the interviews, I followed a semi-structured interview guideline that was previously constructed (see

Appendix C: Interview Guideline (English + German)). This guideline included some opening questions about the farm, their current management practices, and perceived climatic change, followed by the Q-sort and the questions about the GF. At the end of each interview, data on the farmer's management practices, the farmer's viewpoint of factors describing a good or bad farmer, and some sociodemographic questions about themselves were collected.

Typically, the interviews proceeded as follows: On average, the first ten to 20 minutes consisted of open questions about the farm, the farmer, and the production conditions. Those questions were intentionally easy to answer and motivated the farmer to talk freely. In the first introductory part, one question about soil management practices and perceived climate change was included. I asked them about how they typically prepare their soil and if they have changed their soil management in some way since the beginning of their work as farm managers. With this question, we introduced the Q-sort.

In the second part of the interview, the farmers sorted the Q-statements and further discussed the Q-sort with the interviewer. Generally, most of the farmers were very talkative and revealed a lot of information about their viewpoints. The part in which the Q-sort was discussed, was the core part of the interview and took between 20 to 90 minutes. In the sorting procedure, each participant sorted the Q-set of 45 statements in a forced quasi-normal shape according to their level of agreement or disagreement (see Table 2). The statements were printed on separate cards (see Figure 5). I followed the approach suggested by Watts and Stenner (2015). In the first step, the farmers were asked to sort the items into three piles; 1) do not agree, 2) neutral, and 3) do agree. All statements were only referring to their soil management practices. I asked them to decide spontaneously about the importance of each statement. In the second step, I laid out the sorting aids for the forced choice distribution of the Q-sort. Numbered from -4 to +4, the aids showed the participants how many items they can sort under each number according to their perceived importance. Generally, the pile with the statements they agreed upon was bigger than the other two. Therefore, I asked them to take the pile of the 'do not agree'-statements first and let them decide which two statements of this pile they agree upon the least. Those two items were put at -4. Next, I asked them to decide which four of the remaining statements they now agree upon the least. Those items were put at -3, and so on until the last item of this pile has been sorted. Then they were asked to move on to the pile of the 'do agree'-statements. I first let them decide which two statements they agree upon the most. Those were the statements that they found to be the most important for their soil management and were therefore ranked at +4. Then they were asked to decide which four statements of the remaining items they found to be the most important for them. These statements were put at +3, and so on until the last card was sorted. The remaining cards, the neutral pile, were then put in the middle, either beginning with the most important or the least

important statements. After they finished sorting all of the statements, I asked them to look closely at the final sort and to switch items if they were not satisfied with their position in the sort. Only a few farmers made some additional changes at this point.

Table 2: Forced choice distribution of the Q-sort

Ranking value	-4	-3	-2	-1	0	+1	+2	+3	+4
Number of statements	2	4	5	7	9	7	5	4	2

In the third step, after they finished the Q-sort, I asked them some questions about how they decided on where to put the statements and what they found to be difficult during the sorting procedure. I also used the opportunity to ask about statements, where I had the impression that the participants took longer to decide about their placement than usual, or where I was not sure how they personally interpreted the statement. In addition, they were asked if they wanted to add something to ensure that no viewpoint was missing. Some of the participants already discussed the statements during the sorting process, so that the subsequent discussion turned out to be shorter compared to other participants. After this discussion, the Q was finished and the questions on the GF were asked.

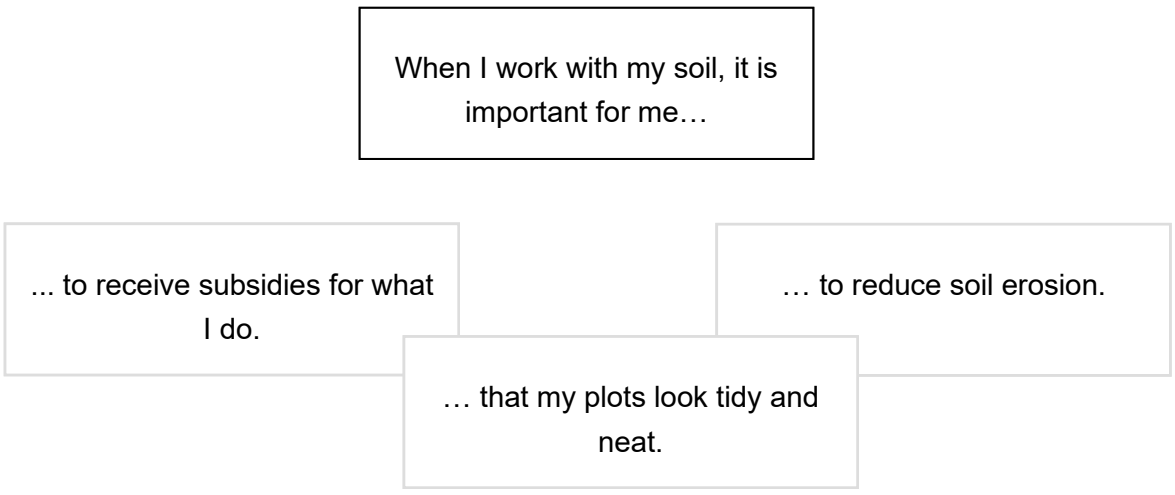

Figure 5: Superordinate sentence and exemplary statements, as presented to the participants.

4.5 The Q-analysis

In Q-analysis, a factor analysis is performed to uncover the structure of a set of variables (Kline, 1994). In other words, the Q-analysis uncovers commonalities and distinguishing viewpoints of farmers. The important part of Q-analysis is its shift in analytical focus; instead of a regular by-item factor analysis, the factor analysis in Q is inverted, meaning that participants turn into variables resulting in a by-person factor analysis (Brown, 1980; Watts and Stenner, 2015).

The factor analysis for this project was carried out using a desktop software called KADE (Banasick, 2019). Outputs from KADE are similar to those generated by PQMethod which is the software most commonly used in recent Q-studies (Dieteren et al., 2023). KADE additionally displays relative rankings of statements between factors and visualizations of composite factors, both of which are useful for the interpretation of results. Since the Q-sorts were done by sorting printed statements, the photographs of the final Q-sorts of each participant had to be digitalized, coded and merged into one file to be loaded into KADE. The analysis with KADE consists of several steps, with three main decisions: The number of factors (viewpoints), the method for extraction of factors (principal component analysis or centroid factor analysis), and the method for the rotation of factors (varimax or judgemental). The process of the analysis can be described as follows.

First, the data is loaded into the software and the correlations (-1 to +1) between the Q-sorts of all participants are displayed in a correlation matrix. At this point, three participants' Q-sorts had to be excluded from further analysis. One participant did not properly follow the instructions and was not focused during the sorting procedure. Two other participants did not sort the statements exclusively by themselves and therefore their Q-sorts did not reflect their own viewpoints, but rather a mix of two different viewpoints. One farmer sorted the Q together with his wife, and the other farmer together with his son. Even though the subsequent interviews were valuable, especially the latter two, all three rankings could not be trusted, and therefore had to be excluded from the factor analysis.

Second, the number of factors to be extracted has to be chosen. Factor extraction can either be done by centroid factors or the PCA method. Even though Watts and Stenner (2012) prefer centroid factor analysis, here, PCA was applied because it resolves itself into one best mathematical solution making the interpretation straightforward.

Third, after factor extraction, the respective eigenvalues and explained variances were calculated. Based on these statistical benchmarks, the number of factors to keep for rotation is chosen. In this case, with respect to the Kaiser-Guttman criterion (Kaiser, 1960), and the scree test (Cattell, 1966), three factors were chosen based on their eigenvalues (length > 1.00). Eigenvalues that are lower than 1.00 explain less variance than one single Q-sort, and therefore should be excluded (Kaiser, 1960). Rotation can either be done by applying varimax rotation or judgemental, i.e. by hand rotation. Both rotations are orthogonal, meaning that the axes remain perpendicular to each other (Watts and Stenner, 2012). Varimax rotation maximizes the explained variance and finds the solution that explains the most variance in the sample by ensuring that each Q-sort has a high loading on only one of the factors (Watts and Stenner, 2012). Because I found that one Q sort had been associated with a factor that did not represent this farmer's values when applying only varimax rotation, I additionally applied a by-hand rotation. This method is suggested by Watts and Stenner (2021), especially if sufficient knowledge of participants is available. Therefore, I rotated the axes of factors 2 and 3 by -20° to associate participant F. 12 to factor 3 instead of factor 2.

In the final step, the factors, representing viewpoints, as well as the loadings of each participant's Q-sort on the factors are displayed. The factor loadings are the correlation of a variable (Q-sort) with a factor (Kline, 1994). KADE allows for automatic flagging of the Q-sorts that are most representative of a given factor. The level of significance for factor loadings can be manually set. Here, a significance level of $p > 0.01$ has been chosen. Finally, KADE produces the outputs in the form of tables showing the factor loadings, factor score ranks (z-scores), and the distinguishing and consensus statements. The z-score is a standardized measure of the distance between one participant's ranking and the mean ranking or, in other words, how a factor or archetype agrees with a statement (Watts and Stenner, 2012; Zabala and Pascual, 2016). According to Zabala et al. (2018), z-scores show not only how a hypothetical person would order the Q-set, but also whether an item is a consensus or a distinguishing statement over all factors (see Appendix A: Composite Q-Sort). Similar z-scores across all factors show consensus statements, whereas different z-scores show distinguishing statements. Z-scores and the according rank of statements guide the interpretation of viewpoints. To create narratives for each viewpoint, generating crib sheets as explained in Watts and Stenner (2012) can help to identify those items or statements that define a factor in itself and in relation to the other factors. The narrative of each factor is a result of the factor score interpretations and the content of the interviews conducted after the Q-sorts.

4.6 Applying the 'Good Farmer'-Concept

In the interviews, the GF-concept was introduced after the discussion on the Q-sort, by asking the farmers five short questions:

1) When you think about this region (*the Swiss Plateau)*, how would you describe someone who is a good farmer?

2) How do you recognize a good farmer (e.g. by their fields / by their farm)?

3) When you think about this region (*the Swiss Plateau)*, how would you describe someone who is a bad farmer?

4) How do you recognize a bad farmer (e.g. by their fields / by their farm)?

5) Has your attitude about what is a good farmer and what is a bad farmer changed since you started as a farm manager?

The first two questions build the foundation of the analysis of the definition of the GF in this study. Questions three and four helped to further distinguish their opinions and were mostly the ones that farmers found to be easier to answer. By identifying the opposite of a GF, the definition of the GF can be further outlined. The last question introduced a retrospective question to the GF concept: by asking the farmers how their perception of what is a good and a bad farmer changed since they started as farm managers, the underlying process of the formation of their opinions could be further analysed.

The transcripts of the GF concept were analysed by using a qualitative content analysis tool called QCAmap. I applied a version of qualitative content analysis for text analysis and to identify emerging themes and narratives (Mayring, 2015). The goal of qualitative content analysis is to reduce the amount of information to a condensed image of the whole data set or text transcripts (Mayring, 1990: 54). In qualitative content analysis, I followed Mayring's analysis steps. In the first step, I extracted the parts of the interview transcripts that were explicitly about the GF. I then decided on the coding unit (single word) and the context unit, namely all the parts of the interviews where they talked about the GF. Hence, I split the parts into 1) when they talk about the GF and 2) when they talk about the 'bad farmer', in order to get both perspectives distinctively. Having already decided on the research question, I chose the analysis technique that suits the research question the most; the so-called inductive category formation. Inductively defined categories reflect the topics that are mentioned. Thus, it represents a useful method in research in which many subjective opinions may be present (Thomas, 2003). It is a method not guided by theory but rather guided by the researcher identifying patterns and themes alongside the analysis process. In the first step, each farmer's

answer to the question about how they describe and recognize a GF was analysed. Each time they mentioned a new characteristic, a new category was formed. If one farmer mentioned a characteristic or a topic several times, it was categorised only once, so that the number of entries in one category equals the number of farmers who have mentioned it. By using this method, between 27 and 31 categories were formed over all 26 text transcripts. In the second step, the categories were summarised into main categories to form as distinct categories as possible.

Since the inductive category building is not theory-guided, it is criticized of being too dependent on the researcher's evaluation. One important measure to ensure reliability and objectivity is to prove intercoder validity (Mayring, 2015). Not knowing the categories of the first coder, a second coder categorizes the same content. The two categorization schemes then are compared and discussed. This step was not included in this study, as it would have been beyond the scope of this thesis to include this step. Hence, I was the only person analysing the data. However, to achieve a higher level of reliability and objectivity, I chose to perform the content analysis twice – once directly after the interviews and once one month later. I then tested the reliability of the results. With this approach, the categories were reduced to 13 main categories in the GF and 11 main categories in the 'bad farmer' text analysis (see Appendix B: GF-Codes).

5. Results: Farmers' Viewpoints

In a Q-methodological study, the final output is narratives that describe shared viewpoints (e.g. Braito et al., 2020). The descriptions are a combination of qualitative interpretations of the results from Q-analysis and the subsequent discussions with participants about the Q-set. This chapter is structured as follows: In the first part, the main points of the statistical analysis of the Q are outlined, followed by the narratives describing farmers' viewpoints, their similarities and differences. In the second part, the results of the content analysis of the questions on GF are summarised.

5.1 Farmers' Soil Management Practices

Before continuing with the Q-analysis, this section offers a summarised description of the participants and their soil management practices. Comparing education levels of farmers to their choice of soil management, I found that higher education is correlated to the use of less

mineral fertilisers and the implementation of more conservation measures, especially the use of cover crops. Age, farm size and LSU on the other hand did not explain any differences in the use of soil management practices. Even when farmers are separated into organic and conventional, there is no noticeable difference in the tillage methods implemented.

Not only does the region of the Swiss Plateau show variations in meteorological parameters but also does soil texture, soil depth, and slopes vary. Therefore, farmers apply different soil management practices adjusted to their specific context. As part of the questionnaire, common soil management practices were queried. Farmers then indicated whether they apply the practice on their whole farmland, part of their farmland, or not at all. Table 3 shows that especially those practices that are part of the direct payment system are often implemented at farms. The PEP, which must be applied to receive direct payments, includes the use of cover crops, a balanced nutrient use that promotes having an accurate number of livestock animals to use their manure for soil fertilization. Soil testing at least every tenth year is mandatory when participating in PEP. Cover crops and the use of animal manure, as well as soil testing, are common practices among all participants. Although some do not have livestock, all farmers apply animal manure or slurry. As expected, the plough is still used by the majority of the farmers. However, as the interviews revealed, almost all of them aim to reduce tillage to some degree. As other types of soil management, the use of silage effluent (‘Gärsaft’), compost tea, and especially the use of effective microorganisms (EM) have been mentioned by several farmers. The use of effective microorganisms is a common practice in regenerative agriculture.

Table 3: Types of soil management practices applied by participants, grouped in archetypes resulting from Q-analysis. Type 1 represents the ‘Sustainable Farmer’, Type 2 the ‘Pragmatic Farmer’ and Type 3 the ‘Market-Focused Traditionalist’.

	No	Partly		Entirely	No	Partly	Entirely
Cover crops	**0**	**6**	**16**	**Mineral fertiliser**	**10**	**9**	**3**
Type 1	0	4	13	Type 1	7	7	3
Type 2	0	1	1	Type 2	1	1	0
Type 3	0	1	2	Type 3	2	1	0
Undersown crops	**10**	**6**	**5**	**Animal manure/slurry**	**0**	**8**	**14**
Type 1	8	3	5	Type 1	0	5	12
Type 2	1	1	0	Type 2	0	1	1
Type 3	1	2	0	Type 3	0	2	1
Ploughing	**7**	**14**	**0**	**Compost**	**8**	**8**	**6**
Type 1	6	11	0	Type 1	5	6	6
Type 2	0	2	0	Type 2	2	0	0
Type 3	1	2	0	Type 3	1	2	0

Reduced tillage	**1**	**14**	**7**	**Biochar**	**14**	**3**	**5**
Type 1	0	11	6	Type 1	9	3	5
Type 2	1	1	0	Type 2	2	0	0
Type 3	0	2	1	Type 3	3	0	0
No-till / direct seeding	**5**	**13**	**4**	**Soil testing**	**0**	**1**	**21**
Type 1	3	10	4	Type 1	0	0	17
Type 2	1	1	0	Type 2	0	1	1
Type 3	1	2	0	Type 3	0	0	3

5.2 Statistical Analysis

As described in Chapter 4.5, it was proven to be the best possible solution to extract three factors to represent the viewpoints among Swiss crop farmers. Together, these three factors explain 67 % of the study variance. Table 4 shows the correlations between the factors. The correlations are a measure of how similar viewpoints are after rotation. The correlation values indicate that the viewpoints share some, but not too many, similarities. Yet, they have many differences, which later become visible in the detailed analysis of the individual factors.

Table 4: Correlation matrix of the three rotated factors.

Factors	**1**	**2**	**3**
1	1	0.4387	0.3687
2		1	0.3568
3			1

As previously mentioned, three participants' Q-sorts were not considered for the factor analysis. Out of the remaining 23 Q-sorts, one Q-sort (F. 01) did not load significantly onto a single factor, which means that the Q-sort was not representative for any factor. To maximise difference between factors, the Q-sort of farmer 1 was not flagged (Zabala and Pascual, 2016). Factor 1 is composed of 17 Q-sorts, factor 3 of 3 Q-sorts, and factor 2 of only 2 Q-sorts. According to Brown (1980), a factor should at least be composed of two factors, which is fulfilled here. Table 5 shows the loadings of all Q sorts, the significant or flagged values in bold ($p > 0.01$). The loadings on the factors can be interpreted similarly to the z-scores but instead of the correlation between statements and factors, loadings represent the correlation between

a whole Q-sort and a factor. Hence, factor loadings show the individual farmer's association with the different viewpoints.

Table 5: Factor loadings of Q-sorts with bold numbers showing the sorts that define the factors (p > 0.01), as well as the factors' eigenvalues and the number of defining variables. The loadings of Q-sort 1 in cursive, as it does not significantly define any factor.

Q-sort	Factor 1	Factor 2	Factor 3
13	**0.864**	0.2306	0.022
19	**0.8523**	-0.0423	0.2037
11	**0.8247**	-0.0269	0.084
08	**0.8226**	0.2954	0.0354
18	**0.8202**	0.2094	0.229
25	**0.7876**	0.1901	0.2303
20	**0.7731**	0.1043	0.3526
02	**0.7656**	0.108	0.399
07	**0.7654**	0.2844	0.286
09	**0.7611**	0.3294	0.1605
16	**0.7353**	0.1742	0.0142
05	**0.7222**	-0.0436	0.0844
15	**0.722**	-0.1783	0.3005
04	**0.6977**	0.2861	0.3223
21	**0.6904**	0.2774	0.2687
24	**0.6385**	0.2529	0.2486
23	**0.6318**	0.2204	0.2938
17	-0.0977	**0.6539**	0.263
26	0.4573	**0.6187**	0.3402
01	*0.5236*	*0.5402*	*0.2612*
06	-0.051	-0.2484	**0.8405**
12	0.2926	0.4398	**0.6926**
14	0.4157	0.0142	**0.5921**
Eigenvalues	**12.58**	**1.66**	**1.22**
Flagged Q-sorts	**17**	**2**	**3**

Based on the z-scores that indicate the strength of a statement within a factor or how much an archetype agrees with a statement (e.g. Leonhardt et al., 2022), factor scores were converted back into the form of a typical Q-sort (Brown, 1993). Hence, they show how an archetype would have hypothetically sorted the Q-statements. Additionally, the converted z-scores enable a visual interpretation of the agreement or disagreement of statements in each factor and between the factors, as shown in table 6.

Table 6: List of statements and factor scores. Consensus statements that do not differ significantly between any pair of factors, are marked with an asterisk

No.	Statement	Fact. 1	Fact. 2	Fact. 3
	When I work with my soil, it is important for me…			
1	… that my plots look tidy and neat.	-3	0	+4
2	… to preserve the soil for future generations.	+4	+1	0
3	… to consider the costs involved.	0	-1	+2
4*	… to ensure the long-term economic viability of my farm.	+2	+1	+2
5*	… to prioritize short-term profit.	-4	-3	-3
6	… to receive subsidies for what I do.	-2	0	+3
7	… to maximize crop yields in this year.	-3	-2	-2
8	… how far a plot is away from the farm house.	-3	0	-3
9	… to hand it over to my successors in a good condition.	+3	-1	+1
10	… that it is possible to work with the machines I have access to.	0	0	+3
11	… whether I own the plot.	-4	-4	-4
12	… to rely on what I learned in my training or education.	0	-1	+1
13	… to rely on the experiences of colleagues.	0	-2	-1
14	… to rely on my own experiences.	+1	-1	+3
15*	… to do what I believe in.	+1	+2	0
16*	… to consider how neighboring plots are farmed.	-2	-3	-2
17	… to consider how my actions impact my neighbors.	-1	-3	-2
18*	… to minimize working time.	-1	-1	0
19	… to rely on traditional, handed-down knowledge.	0	+1	-3
20	… to rely on the advice from advisory services.	-1	+1	-2
21	… how long I will continue to farm.	-3	-1	-1
22	… that I don’t have to deal with more paperwork than necessary.	-2	+3	-3
23	… to rely on the latest research results or recommendations.	-1	+4	+1
24	… not to come in conflict with legal regulations.	-1	+4	+2
25	… to mitigate negative effects from extreme weather events.	+1	-2	+1
26*	… to reduce soil erosion.	+2	+1	+1
27	… to prevent pests.	0	-2	+1
28*	… to know the plot’s soil quality data.	0	+2	0

29	… to meet the requirements of my buyers.	-1	-2	+4
30*	… to meet the expectations of society.	-2	-3	-2
31*	… to produce food for society.	0	+2	0
32	… how my actions impact the environment.	+2	0	0
33	… that I work together with nature.	+3	+3	0
34	… how my actions impact soil organisms such as earthworms.	+3	+1	-1
35	… how others perceive my actions.	-2	-4	-4
36	… that the work gives me pleasure.	+1	+3	-1
37	… to avoid economic risks.	-1	+3	+3
38	… to ensure a stable yield in long term.	+2	0	+1
39	… that I try new practices.	+1	-1	+2
40	… to increase organic matter.	+4	+1	-1
41	… to prevent nutrient losses.	+3	0	0
42	… to minimize machinery use.	0	0	+2
43	… to protect water resources.	+2	+2	-1
44*	… to consider climatic changes.	+1	+2	0
45	… to increase the soil's water retention capacity.	+1	0	-1

In the next step, statements that distinguish factors and statements that are a consensus among factors were identified. A statement is a distinguishing statement if its z-score is significantly different from the z-scores across the other factors (Zabala and Pascual, 2016). The threshold is given by the standard error for differences in z-scores for each pair of factors, multiplied by 1.96 for a significance level of $p < 0.05$ (Zabala and Pascual, 2016). Consensus statements do not exceed the threshold between any pair of factors and are characterised by having similar z-scores across factors (Zabala et al., 2018). A consensus statement is a thus commonly agreed-upon (Brown, 1980; Zabala and Pascual, 2016). Consensus statements are shown shown in table 6 by the asterisks, and table 7 sorted by the factors.

Table 7: Consensus statements that are at least not distinguishing between two factors at p < 0.05

Factor	No.	Statement	Factor score	Z-score
1	4	… to ensure the long-term economic viability of my farm.	+2	1.168
	26	… to reduce soil erosion.	+2	1.052
	45	… to increase the soil's water retention capacity.	0	1.029
	25	… to mitigate negative effects from extreme weather events.	0	0.588
	31	… to produce food for society.	-1	0.024
	5	… to prioritize short-term profit.	-4	-1.646
2	15	… to do what I believe in.	+2	0.996
	44	… to consider climatic changes.	+2	0.878
	28	… to know the plot's soil quality data.	+2	0.84
	31	… to produce food for society.	+2	0.84
	18	… to minimize working time.	-1	-0.319
	30	… to meet the expectations of society.	-3	-1.237
	16	… to consider how neighboring plots are farmed.	-3	-1.516
3	4	… to ensure the long-term economic viability of my farm.	+2	0.658
	15	… to do what I believe in.	0	0.317
	31	… to produce food for society.	0	0.294
	28	… to know the plot's soil quality data.	0	0.159
	18	… to minimize working time.	0	0.094

If the difference in z-scores is higher than the threshold value, the statement is a distinguishing statement. Distinguishing statements for all factors are presented in table 8. In the following chapter, each factor or archetype is presented in a narrative way. Relevant rankings are indicated by the numbers in brackets. For example (13: +1) means that the archetype would have hypothetically ranked statement 13 in the +1 position. The description of archetypes is complemented by comments made by the participants that are indicated in italics.

Table 8: Distinguishing statements at p < 0.05 (p < 0.01).*

Factor	No.	Statement	Factor score	Z-score
1	2*	… to preserve the soil for future generations.	+4	1.94
	40*	… to increase organic matter.	+4	1.44
	9*	… to hand it over to my successors in a good condition.	+3	1.34
	34	… how my actions impact soil organisms such as earthworms.	+3	1.31
	41*	… to prevent nutrient losses.	+3	1.28
	38	… to ensure a stable yield in long term.	+2	1.2
	32	… how my actions impact the environment.	+2	1.14
	45	… to increase the soil's water retention capacity.	+2	1.03
	19	… to rely on traditional, handed-down knowledge.	0	-0.21
	29	… to meet the requirements of my buyers.	-1	-0.44
	24*	… not to come in conflict with legal regulations.	-1	-0.51
	37*	… to avoid economic risks.	-1	-0.51
	23*	… to rely on the latest research results or recommendations.	-1	-0.7
	22*	… that I don't have to deal with more paperwork than necessary.	-2	-0.95
	35*	… how others perceive my actions.	-2	-0.96
	6	… to receive subsidies for what I do.	-2	-1.03
	1*	… that my plots look tidy and neat.	-3	-1.39
	21*	… how long I will continue to farm.	-3	-1.42
2	23	… to rely on the latest research results or recommendations.	+4	1.56
	22*	… that I don't have to deal with more paperwork than necessary.	+3	1.2
	20*	… to rely on the advice from advisory services.	+1	0.68
	19	… to rely on traditional, handed-down knowledge.	+1	0.64
	34	… how my actions impact soil organisms such as earthworms.	+1	0.6
	8*	… how far a plot is away from the farm house.	0	0.12
	1*	… that my plots look tidy and neat.	0	0.08
	6	… to receive subsidies for what I do.	0	-0.2
	14*	… to rely on my own experiences.	-1	-0.28
	39	… that I try new practices.	-1	-0.32
	25*	… to mitigate negative effects from extreme weather events.	-2	-0.64
	27*	… to prevent pests.	-2	-0.92
	13	… to rely on the experiences of colleagues.	-2	-1.2
	29	… to meet the requirements of my buyers.	-2	-1.24
	17	… to consider how my actions impact my neighbors.	-3	-1.84

3	29*	… to meet the requirements of my buyers.	+4	1.68
	1*	… that my plots look tidy and neat.	+4	1.28
	6*	… to receive subsidies for what I do.	+3	1.08
	10	… that it is possible to work with the machines I have access to.	+3	1.07
	3*	… to consider the costs involved.	+2	1.01
	12	… to rely on what I learned in my training or education.	+1	0.65
	23	… to rely on the latest research results or recommendations.	+1	0.57
	33	… that I work together with nature.	0	0.38
	44	… to consider climatic changes.	0	-0.05
	36*	… that the work gives me pleasure.	-1	-0.17
	43	… to protect water resources.	-1	-0.26
	34*	… how my actions impact soil organisms such as earthworms.	-1	-0.57
	19*	… to rely on traditional, handed-down knowledge.	-3	-1.33
	22*	… that I don't have to deal with more paperwork than necessary.	-3	-1.79

5.3 Farmer's Archetype 1: The 'Sustainable Farmer'

The first factor of the Q-analysis describes an archetype that thinks about sustainability when deciding about their soil management. The first factor has an eigenvalue of 12.58 and explains 55 % of the study variance. 17 participants are associated with this viewpoint, of which six farmers were certified organic farmers. They were on average 50 years old and managed farms of 12 to 60 ha. Factor 1 is characterized by farmers that consider the preservation of soil functions for future generations as very important, therefore I named this archetype the 'Sustainable Farmer'.

Farmers sharing this viewpoint think about the soil as a production resource that can become depleted and has to be taken care of to ensure that future generations have soil that they can work with (2: +4). The Q-sorts of participants mentioning that they support and implement the principle of regenerative agriculture all load significantly on this factor. Being part of this community has probably shaped this archetype. A typical statement on regenerative farming by farmer 9: *"I am actually in the field of regenerative agriculture; I was also involved in the co-founding of the association [in Switzerland]. And there, the soil is the most important thing. There is nothing more important. Everything builds on it and if it is depleted, then you can add as much fertiliser as you want, it doesn't help. And I think this is what is very important. That one is aware of the fact that the children should also be able to farm reasonably. And of course, it's also good for the environment."*

One statement that distinguishes this archetype from the other two archetypes is their interpretation of clean and tidy fields (1: -3). For most of the loading participants, this is a value they would probably also share with the other archetypes. However, they stated that neat and tidy fields are in conflict with their aim to work together with nature (3: +3): *"Because clean and neat means you are doing something against nature. This is completely wrong and the more you work against nature, the more nature resists."* (F. 05) Most participants limit ploughing and they use cover crops, as it is most important to them to increase the organic content of soil (40: +4) and to reduce nutrient loss (41: +3).

Farmers of this archetype often mention the conflict between organic farming and reduced tillage: *"It is still difficult. The plough still works relatively well. It's just a proven tool. It just always works. And also, weed suppression in organic farming should also work with less ploughing. And yes, according to the principle of disturbing as little as possible, […]. But yes, in organic [farming], it's double-edged. Sometimes you have to go out into the field more often."* (F. 15) With this, Farmer 15, who is an organic farmer, explains, why he still uses the plough. Organic farmers explain that due to the restrictions on pesticides and fertilisers, they often feel like they have no other option than to use the plough for certain crops. With *"[…] you make a lot more passes"*, he refers to the issue of soil compaction that arises when farmers have to drive their fields more often and with heavy machinery.

'Sustainable Farmer's' think not only about their successors (9: +3) but more importantly about future generations in general (2: +4). They do not care how long they still manage the farm (21: -3). As a consequence of thinking long-term, ensuring that the soil is able to produce a persistent and stable yield is ranked as important (38: +2). They are aware that their actions have an impact on the environment (32: +2): *"The most important thing is that we make our soils sustainable over several generations. We just have to be honest, the 20cm layer of humus we have around the globe is our livelihood. So, in general, the basis of life. […] My actions... there is an impact on the environment. Yes, there is. It's about keeping the impact as positive as possible."* (F. 12)

Some of these farmers identified themselves as innovative during the subsequent interviews. They rank statements like not getting into conflict with the law (24: -1), avoiding financial risks (37: -1), and how others perceive their work (35: -2) significantly lower than the other farmers. While they like to test new things, they are aware that this implies some additional effort. Similarly, they do not limit their soil management practices depending on how much paperwork they would have to do (22: -2).

One thing that became apparent during the discussions on the Q-sorts is that even though the participants seem to be motivated to keep their soils healthy (e.g. 34: +3; 45: +1), not all of

them do it based on having strong environmental values only, as Farmer 9 explains to Statement 41 on the prevention of nutrient loss:

> *"If you do not do that, you give away money […]. So, you also ruin the environment but primarily you are a farmer... so, yield and wallet. You can't say that doesn't matter at all, that's a lie. In the end, we all have to be able to pay our bills at the end of the month."*

Nevertheless, the low rank of statement 6 on receiving subsidies (-2) indicates that their decision-making on soil management practices is not necessarily guided by financial policy incentives. There was also a shared perspective that some subsidies could harm the soil because they do not fit the natural circumstances of some farms. Consequently, some do not participate in certain subsidised measures, because they do not consider them reasonable.

The 'Sustainable Farmer's' highest value is to conserve the soil for future generations (2: +4), which indicates that their decision-making on soil management practices depends on several conservation thoughts. They take the short-time economic risk of innovative measures while still ensuring financial stability to manage their farm as sustainably as they can, depending on their circumstances.

5.4 Farmer's Archetype 2: The 'Pragmatic Farmer'

The second factor has an eigenvalue of 1.66 and explains 7 % of the study variance. Two participants, one male, and one female, are associated with this viewpoint (F. 17; F. 26). They are both around 50 years old and have mixed farms. One farmer was certified organic, the other conventional. They both chose agricultural careers later in life and have no successor within their families. Their decision on management practices does depend on ecological, personal, and economic values. Because these farmershave a mixed set of values, I named this second archetype The 'Pragmatic Farmer'.

The farmers of this archetype have, until now, not been significantly affected by climatic changes or heavy precipitation events, as Farmer 26 explains:

> *"Of course, we have heard about it, but I have the feeling that we have had quite feudal conditions until now. I never had a loss or not been able to work something on the fields because of the weather, certainly not. No."*

Farmer 17 added that he never had erosion issues and that he simply adapted his crop rotation to adapt to dryer summer conditions. Mitigating the effects of extreme events for them is rather

not relevant (35: -3). Consequently, organizing their farm management as pragmatically as possible is more important. For example, they ranked the statement on minimizing paperwork significantly higher than the others (22: +3). It's more important to do what they believe in (15: +3) and to have fun when working with their soils (36: +3). The impact they have on their neighbours while doing so is unimportant to them:

> *"That really doesn't mean a thing to me. I have my clear line that I determinedly implement."* (F. 17) and *"I think, the neighbour must not care […] You should listen to others and hear their tips and experiences, but in the end, it has to be right for you and the farm."* (F. 26)

Their decision on soil management depends on advisory services (20: +1) and handed-down knowledge (19: +1) rather than on their practical experiences (39: -1) or the experiences of their colleagues (13: -2). Doing their own thing also reflects in how they perceive their buyers. To comply with their standards is not important in these farmers' viewpoint (29: -2). Nevertheless, they see themselves as food producers for society and ranked this statement higher than the other two archetypes (31: +2).

Their decisions on farm management mostly depend on recommendations from science and research (23: +4). One of the farmers of this archetype is strongly engaged with research projects on modern agricultural technologies, whereas the other farmer tries to manage the soil as close as possible to the recommendations given by advisors.

Relying on their knowledge from science, they manage problems in a pragmatic way (23: +4). Farmer 17 describes that in his region, they once had issues with pests. According to him, he was the only farmer that did not have any issues with the yield because he decided earlier on not to use pesticides to kill weeds, therefore, the pest did attack the weeds instead of his crops. Because of that, the farmer said that he would not consider the prevention of weeds as an important factor for the decision about soil management practices as did the other farmer that shares this viewpoint (27: -2).

The 'Pragmatic Farmer' is not only influenced by science but also by the market. They talk about themselves as food producers and see their soils and nature as the basis of their income:

> *"For me, the soil, […] is the capital that I have. With the soil, I can make money – dollar signs – and that's... I just drive the soil when it's ok and when it's not, then we say 'it doesn't work anymore' or when we're harrowing 'stop, it doesn't work', because you do too much harm [to the soil]. That's really the asset that I have."* (F. 17)

In summary, the ‘Pragmatic Farmer’ tries to do what works for them and strongly relies on their knowledge. This type of farmer is aware of their influence on nature and how nature influences their farm management but producing food and having fun in doing so is still important in their daily work. They present an archetype that is not as long-term oriented as the first archetype but is less traditional as the third archetype. They share values with both other archetypes, but cannot be related to either one of them.

5.5 Farmer’s Archetype 3: ‘Market-Focused Traditionalist’

The third extracted factor describes the third archetype. The factor has an eigenvalue of 1.22 and explains 5% of the study variance. Three participants are associated with this viewpoint. They were 31, 44, and 51 years old and had medium-sized farms. Two out of the three farms were certified organic. As these farmers represent traditional values and highlight the importance of economic considerations, I named this archetype the ‘Market-Focused Traditionalist’.

The three farmers that loaded onto this factor are farmers that do not primarily think about preserving nature in their decisions on how they manage their soils. They valued the statements to work together with nature (33: 0), to protect waters (43: -1) and soil organisms (34: -1) lower compared to the other archetypes. Considering climate change is not one of their top priorities (44: 0). However, if soil management measures are subsidized and give farmers additional income, then they consider them (6: +3).

They think about the long-term health of their soils, but they think about it as optimization of their production and not to protect the environment. Farmer 6 said he wants to work on his soil health for the long-term, and specified:

> *“If I didn't take care of it, whether it's mine or not, I have [costs] with all the means of production that I go to the field with... It costs me, whether I take care of it beforehand or not, if something is not right with the soil, then I can use the most expensive means of production but it won’t help.”*

They get their knowledge on soil rather from their own experiences (14: +3), from their education (12: +1), or from research (23: +1) than from traditional knowledge (19: -3).

This archetype is budgeting, they try to weigh the costs (3: +2) and implement measures that bring them added value. Farmer 14 explained that he applied mulching *“because it is cheaper and it is better for the soil and tolerates more”,* and that reducing machinery use *“actually also means I have to pass fewer times, less labor input.”* When using machines, they use what is

available and what leads to the best result with the least input (10: +3; 42: +2). The use of machinery probably also serves them to make their plots look neat and tidy (29: +4). Neat and tidy fields, representing a rather traditional value, are valued significantly higher among the farmers associated with this archetype compared to the other archetypes.

Among this archetype, the decision on soil management is guided by subsidies. In order to receive financial payments from the Swiss government, they do not shy away from paperwork (22: -3) and they take into account legal regulations (24: +2). Farmer 6 explains that paperwork *"is not exactly the favorite thing",* but he argues that *"you have to document something. At the end of the day, we get money, we get a lot of money in the form of direct payments and I think you have to be able to document why we get them. So, for me, it's actually also a means of justifying why we're doing this and why we're getting the money."* In the end, they see themselves as producers that want to fulfill the requirements of their buyers (29: +4). As Farmer 12 said: *"I see myself as a food producer. That's what I want with my profession. Although I am organic, I want to produce."*

The 'Market-Focused Traditionalist' is highly motivated to make their fields look neat and tidy. This archetype makes economic considerations while working with their soils while considering their works' impact on the environment is less relevant.

5.6 Differences and Similarities Between Archetypes

As has already been pointed out briefly, the factor correlation matrix (Table 4) indicates that there are certain similarities between the archetypes. The rather large number of consensus statements, i.e. the statements that are not significantly different from at least one other factor, as shown in Table 8, indicates that the extracted archetypes have similarities.

First, Archetypes 1 and 2 show a common theme of some environmental values. As already mentioned in Chapter 5.3, Archetype 2 is to some degree similar to both Archetype 1 and 3. Shared values with Archetype 1 include that they want to work together with nature (33: +3), protect water resources (43: +2), and also to some degree consider climate change (44: +1/+2). Both farmer types are not dependent on their access to machinery when choosing soil management practices.

Second, Archetypes 2 and 3 especially show their agreement in their risk avoidance (37: +3), and their indifference to how others perceive their work (35: -4). Even though they agree upon the avoidance of financial risks, they do not agree upon the uptake of new practices (39: -1 /+2) or the costs involved (3: -1/+2). This difference may occur because the 'Pragmatic Famer'

values handed-down knowledge more than the ‘Market-Focused Traditionalist’ (19: +1/-3). While the ‘Market-Focused Traditionalist’ does not shy away from paperwork (22: -3), The ‘Pragmatic Farmer’s’ are ‘doers’ and rely on what they believe in (22: +3; 15: +1). In short, the similarities indicate their shared preference for stability and security, as well as their tendency to prioritize their own standards and objectives over seeking external validation for their work.

Third, the first and third Archetypes share their view on advisory services (20: -1/-2), their preference for limiting paperwork (22: -2/-3), and mitigating effects from weather extremes (25: +1). Both value the food production for society lower than Archetype 2. However, according to the information from the subsequent interviews, this is not a shared opinion. Famers associated with Archetype 1 rank this statement lower because of their perception of the tension between agricultural production and societal claims as Farmer 11 explained: *“Meeting the expectation of society is simply not possible. They would prefer organic products at a ridiculous price and that is simply not possible.”* On the other hand, farmers associated with Factor 3 are more buyer- than society-oriented in their decisions on soil management. As Farmer 6 added: *“And finally, this is in line with the requirements of the buyer. If I don't deliver the quality, then I don't get the price I would like.”*. Similarly, their shared perspective on the long-term viability of their farm may be interpreted differently: Whereas The ‘Sustainable Farmer’s emphasized ‘long-term’, the ‘Market-Focused Traditionalists’ emphasized ‘economic viability’. Thus, overall, the similarities in their rankings may be due to different interpretations of the statements.

This highlights the importance of the interview part of Q-method and also the advantage of the GF concept that is not dependent on pre-formulated statements, and therefore allows the farmers to express their opinions themselves. In the next chapter, the results from the content analysis of the GF concept are presented, showing that the most commonly shared characteristic of a GF is being open-minded and flexible.

5.7 ‘Good Farmer’-Analysis

For the descriptions of the qualities or traits that a GF has, the answers to all four questions of the good and bad farmer’s characteristics and how they recognize them at their farm and fields, were consolidated. In this section, the farmers that were excluded in the Q-analysis (F. 03, F. 10, F.22), were reincorporated in the content analysis. This decision was made because the farmers’ testimonies added value to the content analysis by contributing substantial descriptions their perceptions of a GF. After performing a content analysis of the interview transcripts, four qualities of a GF commonly referred to were identified. In this subchapter,

these four qualities are summarised and illustrated by quotes taken from the interviews. Additionally, figure 6 shows farmer's answers to the question "What do you consider a 'good farmer'?" that was part of the questionnaire after the interview. High values correspond to agreement, and low values to disagreement. Similar to their own applied practices (see Table 3), farmers rated diversified crop rotation and cover crops high. Traditional values like having tidy fields and minimum weeds are qualities of a GF to some, but not to all farmers. Driving big machines and ploughing their fields tend not to be practices of a GF.

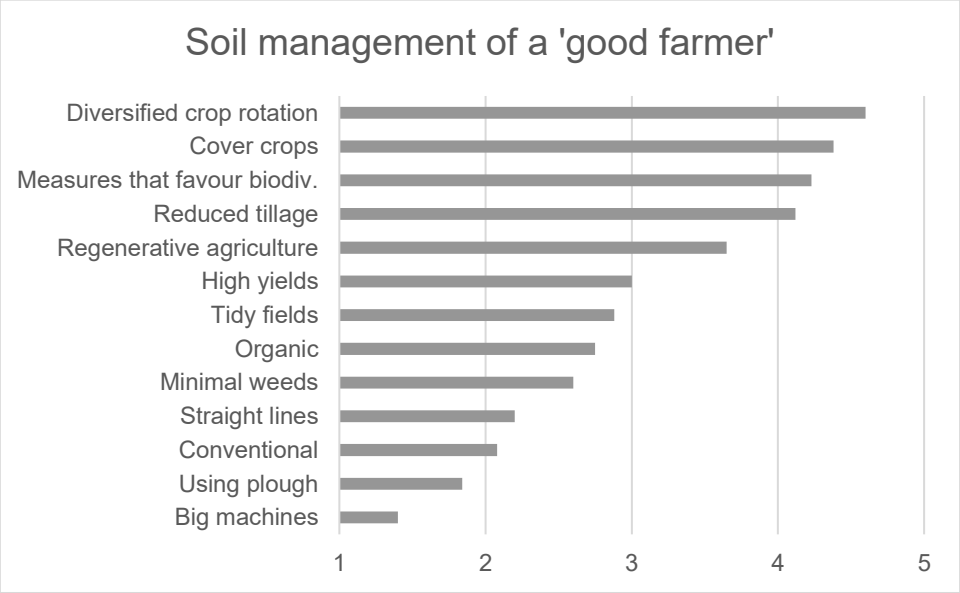

Figure 6: A 'Good Farmers' soil management practices. 1 = "do not agree", 5 "do fully agree"

When talking about good and bad farming practices, most of the farmers emphasize that this distinction can only be done when taking a holistic approach. They prefer to discuss with other farmers about their management practices before deciding whether what they do is good or bad. Also, they do not unanimously specify whether a GF has to be organic or has to cultivate the soil in a certain way. Most of them do not have an idealistic vision of how the farm and fields of a GF should look like because, according to them, it is about the big picture, the 'gut feeling' they have about a farmer or a farm. Some farmers expressed strong opinions that were not shared by many others and therefore did not end up as distinct values in this analysis. Among them are, for example, certain factors related to their attitudes and mental health like work-life balance, not losing the joy and passion of farming, and taking time to reflect about oneself. Nonetheless, there are a few values of what constitutes a GF that are shared between a larger number of farmers.

Open-Minded and Flexible – Innovative Values

After the content analysis of farmers describing what characterises a GF for them, being open-minded was revealed as one of the most important characteristics of a GF. This factor is separated into two aspects: Openness to change and innovation, and openness to engage in discussions.

The first aspect is being open about innovation and adapting to changes or in other words *"not [being] stuck in his or her thinking and doing"* (F. 26). Farmer 2 working part-time on a conventional farm explained:

> *"Well, for me it's actually someone who is open to change, to innovations, who is innovative, who can respond to changes. And then makes the best of it. I can't qualify whether he does it right or wrong. I don't know that either. For me, a good farmer is one who takes care of the resources. That is still easier said than done. But for that, you have to be open to innovations. And otherwise, in my eyes, you're not necessarily great."*

The farmer refers with his statement to adaptations that a farmer has to undertake due to climatic changes. He emphasizes the importance to reconsider one's existing opinions, what has been previously heard or learned and being open to innovations. As an example, he mentioned the heavy machinery that farmers drive onto their fields and that these have different effects on the soils than the smaller machinery used in the past.

Farmer 2 is very conscious about the soil and for him, a balance between food production and conservation is needed. Similarly to Farmer 2, Farmer 4 said:

> *"A good farmer is one who adapts, who adapts to the new needs of the customer and the environment. One who goes with the time. One who informs himself, who also gets involved. Be it within agriculture or in cooperatives. Simply someone who gets involved, who is motivated to move agriculture forward and does not shut himself down."*

What he highlighted is the need for farmers to understand that they are in the field of tension between nature, politics, and consumers, and therefore have to be able to interpret and react to changes. For him, education is one of the most important factors and the foundation for innovations. He and others (F. 05, F. 07, F. 10, F. 11) criticized the agricultural education system of Switzerland. According to them, the education does not provide enough knowledge on climate change mitigation (F. 07), is too short (F. 04) or too focused on economics and

productivity (F. 11). Farmer 4 explained that *"The market is getting faster, you have to be more flexible, you have to adapt more."*.

The second aspect is being open in the sense of being open for discussions. Or as Farmer 20, working part-time on his organic farm, explained:

> *"Who is willing to have discussions with all different people. And out of all that, out of the openness and the discussions, makes changes and learns something and thus changes his farm. In whatever direction and whatever he produces and so. But just with this openness and a bit of flexibility."*

As Farmer 8 explained, his children 'opened his eyes' by questioning his farming practices. For him, not to condemn what others do is an important trait of a GF. The descriptions of other farmers (F. 01, F. 17, F. 18. F. 20, F. 26) also show that it is important to them that they can have conversations with their colleagues. A GF should be able to discuss things openly. Farmer 17, who has over 30 years of experience as a farm manager even said that *"some [farmers] don't tell you anything at all, because you can't say too much."* By that, he refers to farmers' reservedness.

Farmer 26, who has the smallest share of cropland and a mixed farm, described the GF as one who is open-minded towards neighbors and colleagues:

> *"With whom you can talk about things that others can do better than you and you would work together, be more flexible and less narrow-minded. Be a little more cooperative […]."*

Working together, sharing experiences, and being open to discussions and innovations are characteristics that make a GF; a perspective that has been shared by around half of the participants.

Neat and Tidy Fields and Farms – Traditional Values

A GF in Switzerland is also one who represents cultural or traditional values. A trait that also Karali et al. (2014) found in their study on Swiss farmers' attitudes and objectives. Even though innovations, sustainability, and working together with nature are shared values among farmers, the traditionalist values of cleanliness and order are still common. Having a mess around the farm (F. 04, F. 07, F. 10, F. 17, F. 22, F. 24, F. 26), driving in and out of fields without cleaning up the roads (F. 01, F. 10, F. 13) and having too many weeds (F. 01, F. 07, F. 26) were mentioned as values that are not desirable. Participant 10, a 50-year-old conventional farmer said:

“In the field, when there's disorder in the field. Also, [a GF is] one who cleans the corners of the field. For some, it is not so important. It is still something that we value. Or if he has a field where only dandelions grow. If he would take the plough and do something. [A bad farmer is] indifferent. A lot of weed and he does nothing about it.”

Some other traditionalist traits of a GF were mentioned: To be mainly food producers (F. 12, F. 16), to have heavy machinery (F. 07), to have a successor (F. 01), and to have livestock (F. 01, F. 03, F. 07, F. 15, F. 16, F. 22, F. 25):

“A cow farmer is just still the image people have of a farmer, isn't it. It's still... Either that or someone with big machines. Those are the two typical images that you have.” (F. 07)

Nevertheless, some farmers reconsidered their values of neat and tidy fields. Some of them are today more open-minded towards management practices that could support soil health but can increase weed pressure or lead to less uniform yields than they were when they started farming. Farmer 11 represents this position accurately. When asked if he can recognize a GF by his farm or fields, he answered:

“I have been convinced of that for a long time. Meanwhile, I must say, I do not think so. I can't tell now by the cleanliness whether he is a good farmer or not. I can say, he is an orderly farmer or rather a chaotic farmer. But whether it is good for the soil or not, you can't say from that. Under certain circumstances, the chaotic can be better for the soil than the orderly. […] Nature needs disorder, then it can spread. Nature is not orderly, it just isn’t.”

Furthermore, Farmer 10 who made a clear statement on his preference for cleanliness later in the discussion expressed that his opinion on neat and tidy fields changed when he became an organic farmer and that he prefers to have bumblebees and some weeds instead of using pesticides. Some discussions with farmers also leave the impression that they feel conflicted between their traditionalist values and their environmental values. In the next section, the environmental values are summarised.

Affinity for Nature – Environmental Values

This trait describes how a GF should be able to have a systemic view of the nutrient cycle of their farm and their broader environment, resources, and nature. Karali et al. (2014) describe this type of farmers as those who recognize the benefits of eco-friendly decisions both on the farm but also in their surroundings and the wider environment.

A similar picture emerged from my sample, describing many different facets of environmental values a GF shares. A GF takes care of the production factors, as they are *"concerned with the basis of production. Be it animals, soil, whatever, environment."* (F. 12) According to Farmer 4, who is in the process of becoming an organic farmer, a GF works together with nature. *"A GF is one, who interprets the signs of nature correctly and accordingly steers the cultivation in a direction that is also sustainable or future-oriented."*

Many different traits of a farmer who is concerned about the environment emerged. Farmer 15 describes a GF with the following traits:

> *"An organic [farmer] with a few animals, rather extensive, uses his farm fertiliser, animal husbandry rather extensive, perhaps also milk."* (Farmer 15)

For Farmer 5, not only does a GF work together with nature, but he also has a diverse farm:

> *"[It is a GF] if he is diverse. All those who have specialized have a limited point of view. But nature is diverse."*

And the GF thinks about future generations, as Farmer 23 explained:

> *"Not only minimizing the working time is important, but that the soil for the future generation... That he takes care of the soil and does not only maximize profit, that is for me already still... That makes it for me. That you don't just look at working hours and profit, but that you think in the long term."*

In short, farmers describe having an affinity for nature by different traits: diversity, sustainability and having an overall feeling for nature. Nature as the foundation of production is something that a GF considers their farm management.

Organized – Management Values

Some traits of a GF are only revealed when farmers are asked about what a bad farmer is. The trait that farmers mentioned the most is that a bad farmer has wrong timing in his soil management. Be it wrong timing because he works according to an agenda (e.g. cultivation plan, subsidies, contractors), goes into the fields too early in the year or after rainfall, or simply goes when his neighbor goes (follower-personality). The opposite has been referred to as 'having a sense for farming', a trait that probably is based on experience. It includes having a sense of what is appropriate according to the meteorological circumstances. This value is closely related to the nature value and open mindset. It is again the holistic perspective that they require a GF to have, to be able to reflect on oneself and to question one's own beliefs.

One common opinion is that a GF does not drive into his fields at the wrong time, e.g. after rainfall. Among several other farmers, Farmer 14 and Farmer 6 explained:

> *"I simply notice that in part, people act too firmly in the old structures, according to the calendar. And what I also notice, especially with the soil now, is that in some cases people are simply driving or working the soil because they have time because they will be working again in the next two days. […] And the farms are not interested in further training, in know-how. Some of them are simply advised by contractors. And then it is partly not done at the time when it would make sense. Because the contractor comes when he has time."* (F. 14)

> *"[A bad farmer is] one who prefers to plough when it's still raining. Then, when I think it's the right time to let the cows out to pasture, you wait another three weeks and don't see the problems where they actually are. But rather tries to correct with expensive measures, although with small adaptions you could not let the problems arise in the first place."* (F. 06)

When asked about how they recognize a bad farmer based on their fields, farmers mentioned tire tracks and visible soil compactions caused by heavy machinery and/or wrong timing of soil management practices. Wrong management practices can lead to increased erodibility (see Chapter 2.3). Soil erosion as visible effect of a bad farmer has also been mentioned by some farmers, e.g. Farmer 21:

> *"Yes, so one indicator is soil erosion. If the soil is poorly managed, there's certainly soil erosion. If it's been managed too intensively, then certainly erosion is higher."*

In summary, a GF is well-organized, and their time management is in line with the prevailing conditions. A GF does neither simply imitate what their neighbors do, nor do they merely work according to a pre-set agenda that is influenced by their time availability or the contractor.

6. Discussion

In this final chapter, I discuss the results, answer the research questions and put them into the context of existing research on farmers' decision-making and into the context of Switzerland's agricultural policy. In the first subchapter, the first research question ('What considerations are central for farmers in Switzerland when choosing their soil management?') is discussed;

farmers' socio-demographics and the identified archetypes are compared to the findings from previous research. Subchapter 6.2 discusses the second and third research questions ('What constitutes a 'Good Farmer' for Swiss farmers?'; 'To what extent does the perception of what a 'Good Farmer' is, differ from the farmers' own values?'). In subchapter 6.3, I discuss the fourth research question on the challenges that prevent farmers from adopting practices that promote soil health. I close the discussion with the study's limitations in subchapter 6.4.

6.1 Farmers' Considerations When Choosing Their Soil Management

The findings of this study provide insights into the context-specific decision-making processes among crop farmers in the Swiss Plateau. The results showed that context-specific farm and farmer characteristics can influence the farmers' decision-making. Following previous studies, higher education among the farmers in my sample is related to the use of less mineral fertilisers and the implementation of more conservation measures, especially the use of cover crops (Fairweather and Klonski, 2009; Wilson and Hart, 2000). In contrast to findings from other research, I did not find a link between the size of a farm and the adoption of conservation practices (Wilson and Hart, 2000; Karali et al., 2014). In addition, contrary to other studies, I did not find an effect of tenure (Wilson and Hart, 2000; Leonhardt et al., 2019), as all farmers ranked the statement on whether they own a plot at the lowest possible rank (11: -4). Except for the use of mineral fertilisers, which is prohibited in certified Swiss organic agriculture anyways, I did not find any substantial differences in the soil management practices of conventional and organic farmers, as found by Wittstock et al. in their study on farmers in Germany (2022).

Decision-making depends on more than just objective characteristics, as subjective norms and values play an important role (Bartkowsi and Bartke, 2019). Performing a Q-methodological study, three archetypes of farmers could be distinguished: The 'Sustainable Farmer', the 'Pragmatic Farmer', and the 'Market-Focused Traditionalist'. Comparing this typology to previous research shows both consistencies and divergences.

The findings on economic considerations in this study support previous empirical research (e.g. Aerni, 2009; Wilson and Hart, 2000; Karali et al., 2012). Similar to recent research, this study shows that economic values play a role in farmers' decision-making. However, farmers' decision-making cannot be reduced merely to financial incentives (Vatn, et al., 2010; Kieninger et al., 2018, Dessart et al. 2019). The 'Market-Focused Traditionalist' represents the type of farmers that show a tendency to implement soil management practices primarily to receive

subsidies (6: +3). Subsidies have been found to be an important part of Swiss farmers' income (Karali et al., 2012). Therefore, it does not surprise that for some farmers, subsidies as a source of their income influence their decision-making. As Burton et al. (2008) argue, subsidies may still be linked to productivity, as they are calculated based on LSU or farm area. This archetype's higher ranks on productivity-related values like minimizing machinery use (42: +2), minimizing working time (18: 0), and the costs involved (3: +2) could support this theory. Similar to what Wittstock et al. (2022) discovered, the 'Market-Focused Traditionalist' do not make their soil management dependent on the amount of paperwork (22: -3), as accurate paperwork is how they remain eligible for subsidies. Economic and financial motivation factors, as found in Greiner et al. (2009), largely account for the farmer type described by the archetype 'Market-Focused Traditionalist', as he is driven by external motivation like the acknowledgment of their tidy fields (1: +4) and the fulfilment of the requirements of their customers (29: +4). Making modifications in their farm management as a response to customer preferences has also been found important in previous research by Karali et al. (2014). Their desire for their fields to look neat and tidy as proof for their good farming practices may be the key reason for why they do not implement certain soil conservation practices (Burton et al., 2008).

Braito et al. (2020) identified four farmer types in Austria, among them the 'profit maximizer' and 'traditional food provider'. When comparing their viewpoints with the viewpoints of the 'Market-Focused Traditionalist', the latter shares values with both the 'profit maximizer' and the 'traditional food provider'. They associate with the 'profit maximizer' in referring to their soil as the *"basis of their production"* (F. 12). Similarly, they disagree upon the value of passed-on knowledge (19: -3) but rather trust their own experience (14: +3). The 'Market-Focused Traditionalist' also associates with the 'Traditional Food Provider' defined by Braito et al. (2020), as the environment is of less importance for them than it is in the other archetypes. Neat and tidy plots as well as fulfilling customer expectations are both shared values; thus, this archetype relies both on 'Market-Focused' and 'traditional' values in their decision-making.

In contrast, the goal of the 'Sustainable Farmer's soil management practices is to keep the soil healthy for future generations (2: +4). Even though all farmers applied some conservation practices regardless of their archetype, farmers of this group were more aware of their impact on the environment (32: +2) and adopted more conservation practices, supporting the findings of Knowler and Brashaw (2007). These farmers consider diverse environmental aspects when working with their soils (25: +1; 33: +3; 34: +3; 41: +3, 43: +2; 45: +1). As Knowler and Bradshaw (2007) summarised in their review, environmental awareness correlates with the adoption of soil conservation practices. One of the conservation measures that is known to require a lot of effort is no-till. Four farmers in this sample applied no-till on their entire farm.

They are all associated with the archetype of the ‘Sustainable Farmer’, supporting the findings from Knowler and Bradshaw (2007). However, Harrison et al. (1998: 311) noted: *“[E]nrolment in the scheme, however, does not necessarily mean that farmers accepted the conservation ethic.”*

Trying new practices that require investments and significant changes in soil management, like no-till, is always linked to some risks. Similar to Karali et al. (2014), this study showed that some farmers are willing to take risks while others are not. Generally, the ‘Sustainable Farmer’ is less risk-averse (37: -1). However, the underlying reasons why they take risks differ. Taking risks can be influenced both by farmers’ values and the institutional setting (Duong et al., 2019). One farmer associated with Archetype 1 stated: *“Maybe do something that you haven't thought about doing before. And if you've taken the entrepreneurial risk, maybe it's a lucky shot.”* Another farmer (F. 16) explained that even his reason for becoming an organic farmer is due to risk aversion, because “w*ith organic you are at more work but tend to have better prices and tend to have less risk because you have more direct payments.”*

Similar to what Burton and Wilson (2006) described, the archetype of the ‘Sustainable Farmer’ is still embedded in the prevalent production-oriented context. Even though this farmer type shares the values of environmental protection by intrinsic motivation, there is still a spectrum of farmers’ values represented. While some are motivated to farm sustainably to ensure the long-term viability of their farm (3: +2), i.e. also motivated by an economic perspective, others show more accentuation on the importance of working with nature (33: +3). Schenk et al. (2007) describe this by different opinions on the purpose of nature conservation. They found two types of nature conservation values: human-oriented and nature-oriented. Within the ‘Sustainable Farmer’, both types of conservation values could be found, but the majority still framed their purpose of nature conservation in the context of ensuring the basis for production for future generations.

Despite sharing values with the ‘profit maximizers’, the archetype of the ‘Sustainable Farmer’ can be compared to the ‘nature participants’ found by Braito et al. (2020). Their Q-sorts reflect their care for sustainability and soil conservation. As this group seems to include different causes for their environmental values, I did not call them nature participants but rather follow the more human-centered approach of the term sustainability, as described by the “Brundtland-Report” (Hauff, 1987).

The third archetype of farmers that has been distinguished in this study is the ‘Pragmatic Farmer’. The farmers corresponding to this archetype exhibit a strong responsibility to follow the latest scientific recommendations (23: +4). This could be a sign that access to information is important to them. Information and access to information has also been found to be an

important factor by Karali et al. (2014) and Schenk et al. (2007). Schenk et al. (2007) name not only the accessibility of information as an important factor in decision-making but also cooperation. They describe that participation in the planning and implementation process influence the farmers' decision-making. The 'Pragmatic Farmer' is the type of farmers that are especially motivated to work together with advisors and researchers in the process of implementing new soil management measures. The other value that strongly defines this archetype of farmers is their consideration of legal standards. Braito et al. (2020) argue that this could be an indicator for these farmers working closer at the minimum requirements and therefore being more critical about legal regulations. This link could also be present here, as Farmer 26 said about non-compliance to legal regulations: *"You get fines, warnings, there is a follow-up inspection. You're just in a hell of a spot, I've experienced that myself."* This type of farmer is not thoroughly committed to conservation practices (2: +1; 40: +1; 41: 0; 45: 0) but shows compared to the other two archetypes stronger commitment to providing food to society (31: +2). In addition, they do not shy away from investments (3: -1) and additional working time (18: -1), what makes them comparable to the 'traditional food providers' identified by Braito et al. (2020). The 'Pragmatic Farmer' was found to be the only farmer type associated with both high values in working together with nature (33: +3) and having fun when working with the soil (36: +3). Therefore, the 'Pragmatic Farmer' shares values of the 'idealistic type' found by Schmitzberger (2005).

Finally, I conclude that the viewpoints of farmers that influence their decision-making are not fully distinct. They are always a mix of personal, sociocultural, economic, institutional, and environmental variables (see Prager and Posthumus, 2010). Their distinctions lie within their very personal context. One common theme that was found in the subsequent interviews indicates that they are on a path to reframe their symbolic values towards sustainability; traditional values like the fields being neat and tidy and maximizing profits are becoming less and less important to many farmers. It is a trend that has also been found in other studies as well. For example, Davies and Hodge (2007) and Walder and Kantelhardt (2017) found similar to this study an environmental focused type and a business-oriented type of farmers. Both showed the most differentiation in their values but shared the need for sustainable farming practices. This change in farmers' values was not only shown in the Q-sorts in this study, but also in their descriptions of a GF.

6.2 ‘Good Farmer’-Values

Even though the farmers were introduced to the questions on the GF without referring specifically to soil management, the commonly shared GF values of being open-minded, having good timing, and having a ‘feeling for nature’ can be related to how a GF’s soil management practices could be defined. Good timing can be more important for farmers that implement soil conservation practices (Tiselius, 2022). Having an affinity for nature could counteract the traditional values of tidy fields and farms without weeds and with intensive farming methods and therefore support the adoption of conservation practices. Being open-minded is not only a value that has been mentioned by many farmers but also a value that they developed in the course of their career as a farmer (F. 15) describes: *“Yes, I tolerate more scrub and weeds. And just new methods, too. With the organic you also have to rethink and you get a lot of inputs from new things.”*

Multiple farmers mentioned in the retrospective question on the GF that they now care more about soils than when they first started as a farmer. They question themselves and their management system and adjust it based on their experiences, knowledge, and recommendations. Farmer 20 explained that not all farmers have adopted the values of being a GF and refers to the principle of symbolic capital: *“We've been through the process and we're in there now that we're constantly questioning and making and trying. And all the more we are convinced that this [conventional practice] is wrong and bad. This is bad agriculture in our opinion. […] it is difficult to identify with a large part of our profession. This in turn makes things more difficult on a human level.”* The farmer refers to the complexity of value-based decision making and the incompatibility of new management practices to traditional values. The incompatibility between conservation practices promoted by the government (e.g. PEP) and traditional values (e.g. having neat and tidy fields) is also discussed by Burton et al. (2008). According to Burton et al., farmers do not implement new practices due to their lack of skill and expertise associated with the practices. Farmers may demonstrate their farming competence through practices they have experience in, rather than trying new practices that are, in addition, highly visible for other farmers and society (Burton et al., 2008).

Burton and Schwarz (2013) describe an agri-environmental scheme that has not the goal to be production-oriented but to change behaviors and therefore symbolic meaning in the long-term. Those schemes would be based on the improvement of farmers’ skills and would be an educational and cooperative policy scheme. It would require a shift from subsidies as ‘compensation payments’ to subsidies as valuation of farmers’ conservation work. Over time, new practices could replace traditional practices (e.g. the plough) and with enough shared cultural value, new practices could even be embedded in farmers’ symbolic values and

therefore be more widely accepted. Most farmers of my sample were already aware of climate change and how their production has been affected by extreme weather events in recent years. Their awareness sometimes was the reason for them to consider the adoption of soil protection practices. *"To care more"*, has been mentioned by several farmers when asked about how their perception has changed in recent years. They care more about the soil while becoming open-minded towards practices that do not fulfill their symbolic values. Changing symbolic values is something that happens slowly. Policies that encourage farmers in their conservation work, support farmers' networks, form discussion groups or establish experimental farms could support farmers to show their conservation skills and discuss their experiences, results, and doubts in order to form a new understanding of what constitutes a GF (Prager and Creaney, 2017; Burton et al., 2021).

The fact that farmers are not all at the same stage in their re-evaluation of practices is also visible when comparing the GF-values with their associated archetypes. The 'Market-Focused Traditionalist' does not see any change in their perception of what a good or bad farmer is. In contrast, 16 out of 19 farmers associated with the 'Sustainable Farmer' and 'Pragmatic Farmer' say that their values changed in some aspects (e.g. more open towards other practices, cares more about nature, more holistic perspective, more self-reflection).

Interestingly, the main qualities of a GF are also reflected in the main characteristics of the archetypes. But it showed, that the qualities of a GF are not shared only with the corresponding archetypes a farmer is associated to. Hence, the 'Sustainable Farmer' has an affinity for nature and is future-oriented. Farmers associated with this viewpoint do describe a GF by multiple environmental values. However, not exclusively farmers associated with the 'Sustainable Farmer' described a GF as one who shares sustainable values. For example did farmer 12 ('Production-Focused Traditionalist') describe a GF as someone who takes care of nature. As mentioned in the previous chapter, basically all three archetypes share sustainability values to some degree. However, the 'Market-Focused Traditionalist' mentioned traditional GF-qualities. For farmer 6, a GF is recognisable by their fields that do look neat and tidy, according to traditional values. But this value is also shared by farmers associated with the 'Sustainable Farmer' (e.g. F. 01, F. 04, F. 07, F. 15) and by the 'Pragmatic Farmer' (F. 17). The 'Pragmatic Farmer' both describe a GF as one who is open-minded. But also, this perspective is not limited to farmers associated to this archetype but is rather shared by several farmers. In short, the descriptions of a good farmer are depicted in the archetypes, but not exclusively. This could be an indicator showing that farmers own values are not necessarily identical to the values or qualities that describe a GF, which, again, could be a gap that supporting policy measures could close (e.g. by raising environmental awareness, supporting experimental farms, networks and information transfers).

6.3 Hindering Factors in Farmers Uptake of Sustainable Practices

In this subchapter, I elaborate on some challenges farmers mentioned during the interviews. This part has not been evaluated by either Q-method or the GF-concept. It offers an insight into the interview parts, which were not statistically analysed but provide interesting insights into farmers' concerns.

Policy Misfits

Some farmers expressed frustration towards measures they have to implement in order to get subsidies. They express their concern about the feasibility of certain measures that are part of the PEP. Farmer 1 explained that with the new regulation, farmers are obliged to plant cover crops at least seven weeks after the last harvest in autumn. The farmer said that with his crop rotation, the fields would be fallow for longer than seven weeks before he sows winter wheat. If he would follow the regulation and plant a cover crop in between in order to not get fined, he would probably have to go into the fields when meteorological conditions are not optimal. He is not sure whether driving into the fields and risking soil damage is worth compared to evading a fine due to non-compliance with the direct payment scheme. Similar concerns were raised by Farmer 19, who said that the current regulations on fertilisers and cover crops are counterproductive to increasing humus content and increasing the soil's resilience. Additionally, Farmer 14 stated: "*What I have noticed now, politics also plays a role in this, if you are now only supposed to leave [the fields] fallow for seven weeks and sow a cover crop, probably no one from the Federal Government has yet considered that we then have biomass that you can no longer remove with minimal tillage afterward. I assume that this will mean that the plough will be used more in the future."* He added that he would prefer to reduce tillage practices but he feels somewhat limited in his freedom. These examples show not only that the implementation of soil management practices is context-specific, but also that some farmers are frustrated or even confused. It may be an indicator of the lack of intrinsic motivations of farmers to change their soil management. Farmer 18 explained that the required adoptions in the management system to change from conventional to organic farming are similar to many of the regulations of the PEP. Therefore, he mentioned, some farmers change to organic farming in order to be able to sell their crops at a higher price and get subsidies. He called those who accuse organic farmers *"the fundamentalists, who feel that those who have converted [to organic] are only doing it for the money anyway."* This frustration may hinder them not only in their uptake of conservation measures but also in their development of intrinsic motivation for soil conservation measures.

Subsidies and Financial Incentives

Subsidies are calculated not based on the output but on the area on which the measure is implemented. To merely accept the subsidies, rely on contractors' machinery to implement the conservation measure, and work part-time at a not-agricultural job seems to be a way that some farmers feel tempted to go. The lack of intrinsic motivation to soil conservation measures represents not only the statement of this farmer but was also found by Aerni (2006) on the principal agent problem in Swiss direct payments. The principal agent problem arises when the agent (the farmer) takes advantage of the situation of asymmetric information and only passes the information required to the principal (the state) to get the maximum amount of money from subsidies. This definition by Aerni (2006) explains why farmers may not develop intrinsic motivation for sustainable soil management. Burton et al. (2008) highlighted the need for policies to provide the farmers with a value other than an economic incentive for their environmental conservation. Instead of it being something that challenges their traditional values (e.g. using the plough) and identities as farmers, policies should be designed to add value to the farmers' work (Burgess et al., 2000, Burton et al., 2008, Schneider et al., 2010).

The system of Switzerland's agricultural policy is guided by direct payments in a top-down approach. The system has been effective in many ways, e.g. the adoption of integrated management practices, more organic farming, and more ecological restoration areas (Aerni, 2009). In addition to the farmers, researchers criticised Switzerland's agricultural policy by saying that it is vulnerable to the principal agent problem, that it leads farmers to work part-time at another job outside of agriculture, that it was not successful in implementing specific conservation practices (e.g. biodiversity), and that it does not allow for flexibility (Aerni et al., 2009; Cullen et al., 2020; El Benni et al., 2022). Farmer 14 described the political issue as follows: *"It is not against the farmers, but the system has been made in such a way by the policy, with the direct payments, that it is unfortunately too profitable to run the farm as a sideline. With five phone calls, you have the wheat in the gutter. And because of that, you don't even have to look at how your own soils are and how your crops are."* In his description, a mismatch can be recognized. One farmer indicated the underlying issue by simply saying that direct payments do not work. He said that financial incentives do not lead to more environmental awareness and that farmers would have to identify with a sustainable farm system to ensure fundamental changes in farmers' values.

Farmers and Society

Farmers see themselves not only in the area of tension between politics and agriculture but also between society and agriculture. Something that has not been reflected in the Q- and the

GF-analysis but has been addressed in the subsequent interview is that some farmers hold a negative image of society and their expectations. Some expressed that they feel misunderstood and underappreciated by the general public, which led to frustration: *"I just say schizophrenia of the consumer. You can't fulfill their expectations. Simply not."* (F. 11) and *"That was originally my incentive, but it's getting lost because of the way society talks about us."* (F. 13) are only two of many explanations farmer made to the statement on meeting the expectations of society (31). Farmers' perceptions of being unfairly targeted or not properly recognized for their conservation efforts can influence their decision-making on the adoption of new policies negatively. Reconnecting farmers and consumers could have a positive effect on the adoption of policies. The transfer of information and points of contact between farmers and the general society could be highly important and beneficial.

Supportive Policies

Switzerland's agricultural policy has managed to embed environmental protection into soil management practices, mainly through subsidies (Karali et al., 2014). In order to change farmers intrinsic motivations, financial incentives may not be enough (Atari et al., 2009). To strengthen farmers awareness on the importance of environmental protection measures, it is important to provide scientific knowledge that is translated into practice (Guillem et al. 2012). Finding an archetype ('Pragmatic Farmer') that relies on scientific knowledge to make his decisions, highlights the importance of this information transfer. Hence, the information transfer both between science and farmers, and farmers and society are important considerations. Lastly, as the distinction of three archetypes demonstrated, farmers viewpoints on the role of soil management practices are highly context-specific. One-for-all solutions miss the point that in the real world, farmers have very context-specific circumstances, which could lead to frustration and non-participation. Therefore, target-group-specific instruments could increase acceptance. A well-balanced policy mix that includes farmers during the policy formation process can make a difference in farmers intrinsic motivation towards soil management practices. In the light of progressing climate and the resulting consequences for agriculture (droughts and heavy precipitation), it is important that farmers are strengthened in their environmental awareness and thus intrinsically motivated to decide in favour of sustainable practices.

Braito et al. (2019) described that farmers are embedded in unique contexts which shape their reality and daily life. This makes them a heterogenous group, and thus, policies need to reflect farmers' heterogeneity and their contexts. Decisions about the implementation of conservation measures are guided by the attitudes of individual farmers (Guillem et al., 2012). Furthermore,

long-term commitment to sustainable farm management is dependent on intrinsic motivation, which in turn is dependent on symbolic capital (Atari et al., 2009). Even though the participation of farmers in Switzerland's agricultural policy is widespread, the present study found that participation does not necessarily reflect shifts in attitudes (see also Karali et al., 2013). Knowing how farmers decide and how policies encourage or discourage farmers is supportive of agricultural policy design (Defrancesco et al., 2008). If policies fail to address farmers' intrinsic motivation, a withdrawal of financial support through subsidies may cause the farmers to drop conservation measures, as Karali et al. (2014) found in their study.

6.4 Study Limitations

Q-methodology and the concept of the GF have proven to be useful instruments in answering the research questions of this study. As with any study, potential limitations remain and have to be further investigated.

Regarding the Q-set, it is important to remember that even though researchers aim to include all possible statements that can be relevant to someone's decision-making, it is difficult to prove that the Q-set is truly exhaustive. The results therefore might be compromised. In addition, some statements can and will be interpreted differently. The subsequent interviews revealed some of the farmers' individual interpretations of statements. But as Q-methodology is already a time-intensive instrument, discussions on each and every statement are not a feasible endeavor within the scope of this thesis.

With Q-methodology, no conclusions concerning the population of farmers can be drawn. The farmer types can help to identify farmers' viewpoints and what they consider when deciding on their soil management practices but this study cannot make any suggestions on how to recognize those types of farmers (see Braito et al., 2020). In addition, the size of the P-set is rather small and some archetypes are underrepresented, requiring further research in identifying farmer types in Switzerland. The unequal distribution of farmers' association with the viewpoints could be explained by the consensus that the farmers have on the general importance of soil management to reduce the impact of climate change or the overrepresentation of farmers applying regenerative agriculture, due to the participant recruitment method. Contrary to other studies, the P-set in this analysis is limited to crop farmers in a certain geophysical context (see Bartkowski and Bartke, 2018). Which could be the explanation for the subtle differences between the viewpoints. In addition, conducting the interviews in person can also lead to an interviewer effect (Groves, 1989). The cross-sectional nature of Q- and GF analysis also has to be considered. The opinions expressed by the

farmers show only a snapshot. Values are not only context-specific but also subject to change over time (Hoffmann et al., 2020). Although the temporal element could be primarily a limitation, it also allows a comparison at a later point in time and thus, the investigation of how farmers' viewpoints have changed over time.

Regarding the GF concept, some questions might have been challenging to answer for some farmers. It has shown that the answers to the question of what constitutes a 'bad farmer' were more straightforward than the answers to the questions on what constitutes a GF. Additionally, retrospective questions are difficult to answer in general (Van Der Vaart et al., 2005). Hence, the accuracy of the question on how their perception of the GF has changed over time is low.

Finally, the Q-set utilised in this study included several different environmental statements that were not always distinct enough to capture true differences between the viewpoints. Some farmers ranked statements that include others statements higher, because *"these are somewhat the holistic ones"* (F. 25). What they mean by that is that if they, for example, work together with nature, they also take care of soil organisms. Therefore, they rank the statement about nature higher. Ensuring that statements are more distinct could be helpful for further research.

7. Conclusion

Progressive climate change and the associated consequences for agriculture make it important to consider the context-specific factors that are relevant for farmers when making their decisions on their soil management. Gaining an in-depth understanding of farmers' decision-making processes is crucial in developing policy measures that are effective in mitigating effects from heavy precipitation and droughts in long-term. By applying Q-method and the GF-concept, the four research questions of this thesis could be answered:

1) What considerations are central for farmers in Switzerland when choosing their soil management?
2) What constitutes a 'Good Farmer' for Swiss farmers?
3) To what extent does the perception of what a 'Good Farmer' is, differ from the farmers' own values?
4) What challenges prevent farmers from adopting practices that promote soil health?

To answer the first research question, Q-methodology has been applied. Based on the assumption that farmers' decision-making on soil management practices is context-specific, a set of 45 statements on soil management has been developed through an extensive literature review and stakeholder interviews. In this study, several relevant context-specific factors have been found, among them aesthetics and the natural environment. The 'Sustainable Farmer' considers long-term effects of their soil management. The 'Pragmatic Farmer' considers scientific knowledge and his personal preferences to decide on soil management. The 'Market-Focused Traditionalist' is guided by financial incentives. It could be confirmed that indeed, economic considerations are not unimportant in farmers' decision-making these days. However, this study was able to show that economic considerations can not be examined separately from conservation concerns, as all three archetypes that emerged from Q-analysis do share baseline environmental awareness. Regarding the reduction of soil erosion, it is important to mention that for all three archetypes, soil erosion is not at the top of their agenda (26: +2/+1/+1). Farmers fundamental values are certainly context-specific, so an understanding of these factors is important in the process of policy formation. Archetypes can help to get a better understanding of the diversity of context-specific factors. A deeper understanding of the context-specific factors has been provided by the GF-analysis.

The second research question revealed some in-depth insights into how farmers would describe their ideal image of a farmer. What makes a GF is equally a reflection of their

symbolic capital as farmers. By answering what constitutes a good or a bad farmer for them, four main categories were identified from a diverse set of answers: Being open-minded, having the right timing, having traditional values and having an affinity for nature. Being open-minded indicates that farmers are aware of change and the need to adapt to change. Openness is not only important for their decision about farm management but also for their colleagues and society. A good crop farmer in Switzerland is additionally someone, who is organised. For farmers, their field is their business card. Driving the fields at the wrong time leads to visible soil and crop damage, which does not correspond with the GF. A GF drives into the fields, when it's necessary and not when they have time for it. Having the right timing is especially pivotal in conservation soil management. An affinity for nature is the third main category, that describes farmers' relevance to environmental protection. Lastly, a GF still farms according to traditional values; having his farm and fields neat and tidy to contribute to the typical image of the Swiss landscape. Several indicators are suggesting that the symbolic capital of Swiss farmers is transforming. Being open-minded could be an indicator of a change, as well as the decreasing importance of traditional values. Even though traditional values still constitute a GF in Switzerland, there seems to be a shift away from traditional values as some farmers explain that today they tolerate untidy fields and weeds more than when they started as farmers.

This leads to the answer to the third research question. The results suggest that farmers are in a transformation process. On the one hand, there is a dependence on financial incentives for the implementation of measures as well as still well-anchored traditional values. On the other hand, many farmers say about themselves that the soil and the environment have become more and more important to them compared to when they started their careers. This has also been reflected in the foundational agreement with the statements related to climate and environment. What farmers consider a GF does not always correspond to how they sorted the Q. Since they do not correspond to their ideal, facilitating policy measures could be applied where there can be found discrepancies. Those measures could be accepted more easily and sustainably.

Lastly, the fourth question has already been elaborated in the previous chapter. Swiss agricultural policy is very strict and many farmers comply with the regulations to receive financial compensation. To comply with the regulations, farmers will implement measures that do not fully fit their contexts. Financial incentives may be on the one hand the factor of success because they increase participation. But on the other hand, a factor of failure, because of the misfit of policies to the farmers' context which could lead to a lack of intrinsic motivation and unsustainable practices. A policy-mix, feedback mechanisms and continuous monitoring could help to detect undesirable secondary policy effects. Furthermore, a dysfunctional relationship

between farmers and society leads to frustration on both sides. Workshops or open discussions would help to ensure that the demands of both sides could be reconciled.

This study contributes to the understanding of context-specific influences on farmers' decision-making and of what constitutes good farming practices in crop farmers in the Swiss Plateau. By revealing crop farmers' considerations in their soil management choices, new viewpoints emerged that could help build a better understanding of how farmers can be motivated to implement conservation soil management practices. The results of this study show similarities but also differences to previous research, why it would be of great interest to apply the Q-set in an adapted form and a different setting. This could provide further insights for local policymakers and support the effectiveness of soil management measures to reduce the impacts of extreme weather events and sustainably protect the soils in Switzerland.

8. References

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Appendix A: Composite Q-Sort

Figure 7: Hypothetical Q-sort 'Sustainable Farmer'

-4	-3	-2	-1	0	1	2	3	4
(11) … whether I own the plot.	(8) … how far the plot is from the farm house.	(22) … that I don't have to deal with more paperwork than necessary.	(37) … to avoid economic risks.	(3) … to consider the costs involved.	(45) … to increase the soil's water retention capacity.	(4) … to ensure the long-term economic viability of my farm.	(41) … to prevent nutrient losses.	(2) … to preserve the soil for future generations.
(5) … to prioritize short term profit.	(1) … that my plots look tidy and neat.	(6) … to receive subsidies for what I do.	(29) … to meet the requirements of my buyers.	(10) … that it is possible to work with the machines I have access to.	(44) … to consider climatic changes.	(26) … to reduce soil erosion.	(34) … how my actions impact soil organism such as earthworms.	(40) … to increase soil organic matter.
	(21) … how long I will continue to farm.	(16) … to consider how neighboring plots are farmed.	(24) … not to come in conflict with legal regulations.	(12) … to rely on what I learned in my training or education.	(39) … that I try new practices.	(32) … how my actions impact the environment.	(33) … that I work together with nature.	
	(7) … to maximize crop yields in this year.	(30) … to meet the expectations of society.	(23) … to rely on the latest research results or recommendations.	(13) … to rely on the experiences of colleagues.	(36) … that the work gives me pleasure.	(38) … to ensure a stable yield in long term.	(9) … to hand it over to my successors in a good condition.	
		(35) … how others perceive my actions.	(20) … to rely on the advice from advisory services.	(19) … to rely on traditional, handed-down knowledge.	(25) … to mitigate negative effects from extreme weather events.	(43) … to protect water resources.		
			(17) … to consider how my actions impact my neighbors.	(27) … to prevent pests.	(14) … to rely on my own experiences.			
			(18) … to maximize working time.	(28) … to know the plot's soil quality data.	(15) … to do what I believe in.			
				(31) … to produce food for society.				
				(42) … to minimize machinery use.				

Figure 8: Hypothetical Q-sort 'Pragmatic Farmer'

-4	-3	-2	-1	0	1	2	3	4
(11) … whether I own the plot.	(30) … to meet the expectations of society.	(27) … to prevent pests.	(39) … that I try new practices.	(1) … that my plots look tidy and neat.	(40) … to increase soil organic matter.	(28) … to know the plot's soil quality data.	(37) … to avoid economic risks.	(24) … not to come in conflict with legal regulations.
(35) … how others perceive my actions.	(17) … to consider how my actions impact my neighbors.	(7) … to maximize crop yields in this year.	(21) … how long I will continue to farm.	(6) … to receive subsidies for what I do.	(34) … how my actions impact soil organism such as earthworms.	(44) … to consider climatic changes.	(36) … that the work gives me pleasure.	(23) … to rely on the latest research results or recommendations.
	(16) … to consider how neighboring plots are farmed.	(13) … to rely on the experiences of colleagues.	(18) … to maximize working time.	(8) … how far the plot is from the farm house.	(26) … to reduce soil erosion.	(15) … to do what I believe in.	(33) … that I work together with nature.	
	(5) … to prioritize short-term profit.	(25) … to mitigate negative effects from extreme weather events.	(14) … to rely on my own experiences.	(10) … that it is possible to work with the machines I have access to.	(20) … to rely on the advice from advisory services.	(31) … to produce food for society.	(22) … that I don't have to deal with more paperwork than necessary.	
		(29) … to meet the requirements of my buyers.	(12) … to rely on what I learned in my training or education.	(45) … to increase the soil's water retention capacity.	(19) … to rely on traditional, handed-down knowledge.	(43) … to protect water resources.		
			(9) … to hand it over to my successors in a good condition.	(32) … how my actions impact the environment.	(4) … to ensure the long-term economic viability of my farm.			
			(3) … to consider the costs involved.	(38) … to ensure a stable yield in long term.	(2) … to preserve the soil for future generations.			
				(41) … to prevent nutrient losses.				
				(42) … to minimize machinery use.				

Figure 9: Hypothetical Q-sort 'Market-Focused Traditionalist'

-4	-3	-2	-1	0	1	2	3	4
(11) … whether I own the plot.	(22) … that I don't have to deal with more paperwork than necessary.	(7) … to maximize crop yields in this year.	(13) … to rely on the experiences of colleagues.	(2) … to preserve the soil for future generations.	(9) … to hand it over to my successors in a good condition.	(3) … to consider the costs involved.	(6) … to receive subsidies for what I do.	(1) … that my plots look tidy and neat.
(35) … how others perceive my actions.	(19) … to rely on traditional, handed-down knowledge.	(16) … to consider how neighboring plots are farmed.	(21) … how long I will continue to farm.	(15) … to do what I believe in.	(12) … to rely on what I learned in my training or education.	(4) … to ensure the long-term economic viability of my farm.	(10) … that it is possible to work with the machines I have access to.	(29) … to meet the requirements of my buyers.
	(8) … how far the plot is from the farm house.	(17) … to consider how my actions impact my neighbors.	(34) … how my actions impact soil organism such as earthworms.	(18) … to maximize working time.	(23) … to rely on the latest research results or recommendations.	(24) … not to come in conflict with legal regulations.	(14) … to rely on my own experiences.	
	(5) … to prioritize short-term profit.	(20) … to rely on the advice from advisory services.	(36) … that the work gives me pleasure.	(28) … to know the plot's soil quality data.	(25) … to mitigate negative effects from extreme weather events.	(39) … that I try new practices.	(37) … to avoid economic risks.	
		(30) … to meet the expectations of society.	(40) … to increase soil organic matter.	(31) … to produce food for society.	(26) … to reduce soil erosion.	(42) … to minimize machinery use.		
			(43) … to protect water resources.	(32) … how my actions impact the environment.	(21) … how long I will continue to farm.			
			(45) … to increase the soil's water retention capacity.	(33) … that I work together with nature.	(38) … to ensure a stable yield in long term.			
				(41) … to prevent nutrient losses.				
				(44) … to consider climatic changes.				

Appendix B: GF-Codes

Table 9: 'Good Farmer' Codes

'Good Farmer'	Category ID	Category Name	Absolute Count
Openness			14
	RQ1-3	Openness (discussions)	3
	RQ1-5	Openness (to change / innovations)	11
Work together with nature			13
	RQ1-6	Take care of resources	8
	RQ1-8	Works together with nature	3
	RQ1-23	Extensive	2
He lives what he tells			3
	RQ1-27	Not just for the money	1
	RQ1-28	He lives what he tells	2
Traditional values			15
	RQ1-1	Neat and tidy	5
	RQ1-2	Owning livestock	7
	RQ1-21	No weeps	1
	RQ1-24	Nice harvest	2
Food producer			2
	RQ1-19	Produce food	2
Healthy food			2
	RQ1-13	Produce healthy food	1
	RQ1-22	Organic healthy food	1
Machinery			1
	RQ1-12	Having heavy machinery	1
Personal balance			3
	RQ1-11	Self-reflection	3
Knowledge			7
	RQ1-15	Attentive	1
	RQ1-16	Know the market / Society	4
	RQ1-18	Educated	1
	RQ1-20	Know how to manoeuvre machines	1
Organic circle			2
	RQ1-7	Closed organic circle	2
Soil preservation			3
	RQ1-10	Diversity	1
	RQ1-14	Soil cultivation	1
	RQ1-26	Good crop rotation	1
Sustainability			5
	RQ1-9	Sustainability	5
Cooperation with farmers			3
	RQ1-25	Cooperate with farmers	3

Table 10: 'Bad Farmer' Codes

'Bad Farmer'	**Category ID**	**Category Name**	**Absolute Count**
Attitude			10
	RQ2-2	Being fed up	2
	RQ2-7	Being stubborn	4
	RQ2-14	No pride / thrive	3
	RQ2-19	Being gullible	1
Messy			10
	RQ2-12	Having a mess (farm + fields)	7
	RQ2-23	Not nice crops / discontinuous production	2
	RQ2-24	Poorly organized	1
Part time farmers			5
	RQ2-5	Not having enough time	1
	RQ2-15	Casual farmers	4
Family issues			1
	RQ2-1	Not having a successor	1
Not taking care			2
	RQ2-6	Not taking care of animals	2
Poor management			24
	RQ2-3	Wrong timing in soil management	14
	RQ2-9	Short term thinking	4
	RQ2-13	Not thinking about the neighbours	1
	RQ2-18	Bad pesticide and fertilizer management	2
	RQ2-22	Not adjusting the machinery	3
Economic values			9
	RQ2-16	Only working towards subsidies	3
	RQ2-17	Economic pressure / orientation	5
	RQ2-21	Cheating the states system (subsidies, rules)	1
Lack of knowledge			4
	RQ2-10	Lack of knowledge / (further) education	4
Not having a feeling			4
	RQ2-8	Not having a feeling for nature	4
Soil issues			5
	RQ2-4	Not valuing the soil	1
	RQ2-20	Not valuing the soil	1
	RQ2-25	Having erosion	2
	RQ2-26	Bad soil quality	1
Monotonous			1
	RQ2-11	Monotonous fields	1

Appendix C: Interview Guideline (English + German)

SoilX farmer interviews & Q Methodology

INTRODUCTION

- *Welcome*
- *Participant information sheet*
- *GDPR and consent à signature!*
- ***Turn on recorder!***

WARM UP AND PRE-Q QUESTIONS

Topic	Prompt & potential follow-up questions	Potential aspects of interest
Farm	Could you briefly **introduce your farm** to me? • How large is your farm? Which livestock do you hold? • What are the main crops you grow? • How do you mainly sell your produce? • To what extent would you say your farm is typical for this area here? • Who is involved in farm decisions?	Farm type Family farm Main crops Direct marketing / wholesale /… Specificities of the farm
Farmer	Could you tell me about **your role on the farm**? • How did you become a farmer on this farm? • How long have you been farming this farm? • What is your agricultural education?	Decision making Farming experience Ag education
Farming conditions	Could you tell me some basic information about the **farming conditions** on your farm? • How good is your soil? • To what extent is there sloping land on your farm? • What are the weather challenges? Have they changed in the past? • How consolidated/scattered is your land?	Soil productivity Topography Climatic conditions climate change Farmland fragmentation
Soil management	Could you briefly describe your **soil management strategy** on your **cropland** to me? Have you made any **changes** in your soil management during your time as a farmer on this farm? • Why? Were there any specific reasons? • Are any of your practices subsidized?	Adaptation to climate change Specific events Subsidy programs

Q METHODOLOGY: SORTING

We now have a little exercise for you. We brought some cards with us that have statements on them that concern your work with the soil. These are about your **own opinion** and what you **personally** think is important, so there is **no "right" or "wrong"**, just your judgement about **your own situation**.

We are asking you to do the following:

- **Read** each card *(offer to read it out aloud to farmers if trouble reading!)*

- For each card, decide “from your guts” (i.e., **spontaneously**) whether you **agree**, **disagree**, or are **indifferent** about the statement
- Create **three piles** for these agree – disagree – indifferent cards

Next

- Take only the **“agree” pile** and find those statements you agree with the **very most**, i.e., that are most important to you, and sort them into the prepared grid on the **far-right** side
- Find those statements you agree with the **next** most and sort them next to the most important ones, etc.

Next

- Do the same with the **“disagree” pile** of cards and identify those you disagree with **most** and sort them on the **far-left** side of the grid
- Finish by sorting the “**indifferent**” statements in the **middle** of the grid.

Finally

- Take a look at the final sorting: does this seem meaningful to you? Make **changes** if necessary.

Q METHODOLOGY: REFLECTION

- Now when we consider the cards here on the far right, can you explain to me, **how did you decide to put these cards there**?
- When you **first read this** statement, what came to your mind? What does **[topic on card] mean** to you?
- …same for far left…

- Which of the cards were **most difficult** for you to put into the grid? **Why** was that?
- To what extent do you feel like we **missed out on something** important? Is there any statement you think we should have included in addition?
- What did you think about when you read “**work with your soil**”? Which activities, aspects, considerations, feelings?

GOOD FARMING

Now I would like to ask you a few things concerning how you consider yourself and other farmers. Therefore, I would like to ask you some questions regarding what it might mean to be a "good" farmer from your perspective. That is, someone who manages their farm in a good and exemplary way according to you.

Topic	Prompt & follow-up questions
Good farmer	How would you **describe a good farmer** from **your region**? How could you see it on his/her fields and farms? What do you mean by XY (e.g., “tidy”)?
Bad farmer	How would you **describe a bad farmer** from **your region**? How could you **see** it on his/her fields and farms?
Changes	Has your **opinion** concerning what a good farmer is, **changed** since you began as a farmer? If yes, **how**?

QUESTIONNAIRE AND DEBRIEFING

Ask to fill out **form with demographics / general information**

***Thank you**, I think this is all the information we need! Thanks again for taking the time!*

***Issues** you may want to mention or discuss in addition here:*

- Other interview partner suggestions?
- Stakeholder workshops with results presentation next winter: interested in joining?
- Interested in receiving country-specific results of the project (may take some months)?
- Reaffirm that participants can always contact you with questions or concerns.

SoilX Interviews mit Landwirten & Q Methode

BEGINN

- *Willkommen, Dankeschön*
- *Kurze Information zum Forschungsprojekt*
- *Datenschutz und Zustimmung zur Teilnahme à **Unterschrift!***
- ***Aufnahmegerät einschalten!***

WARM UP UND HINTERGRUND

Thema	Erzählaufforderung und mögliche Nachfragen	Mögl. Relevante Aspekte
„ins Reden kommen“, Betrieb	Könnten Sie mir zuerst einmal einen **Überblick** über Ihren **Betrieb** geben? Die Eckdaten beschreiben? • Wie groß ist der Betrieb (gesamt, Acker)? (Welche) Tierhaltung? • Was sind die Hauptkulturen? • Wie verkaufen Sie Ihre Produkte? • Inwiefern würden Sie sagen Ihr Betrieb ist typisch für die Gegend hier? • Wer ist in betriebliche Entscheidungen involviert?	Betriebstyp, Familienbetrieb, Hauptkulturen, Direktvermarktung/ Abnehmer, Spezifika des Betriebs
Person	Könnten Sie mir etwas über sich und **Ihre Rolle am Betrieb** erzählen? • Wie ist es dazu gekommen, dass Sie diesen Betrieb führen? • Wie lange sind Sie hier schon Betriebsleiter:in? • Welche landwirtschaftliche Ausbildung haben Sie?	Erfahrung am Betrieb, Familienbetrieb, Ausbildung

Naturräuml. und strukturelle Gegeben-heiten	Erzählen Sie mir bitte etwas über die **landwirtschaftlichen Produktionsbedingungen** auf Ihrem Betrieb, insbesondere im **Ackerbau**. • Wie (gut) ist der Boden hier? • Inwiefern gibt es auf Ihrem Betrieb hügelige/ erosionsgefährdete Flächen? • Was sind Herausforderungen beim Wetter? Hat sich da etwas verändert in den letzten Jahren? • Inwiefern sind Ihre Flächen verstreut bzw. kommassiert?	Bodenqualität bzw. -art, Topographie, klimatische Verhältnisse, Klimawandel, Fragmentierung der Flächen
Boden-bearbeitung	Könnten Sie mir beschreiben wie Sie Ihren **Ackerboden typischerweise bewirtschaften/bearbeiten**? Inwiefern gab es in Ihrem Bodenbearbeitungssystem **Änderungen** seit Sie den Betrieb führen? • Gab es dafür bestimmte Gründe oder Auslöser? • Bekommen Sie Förderungen für gewisse Maßnahmen?	Klimawandel-anpassung, (Extrem(wetter-)) Ereignisse, Förderungen

Q METHODE: SORTIEREN

Als nächstes haben wir eine kleine Aufgabe für Sie. Wir haben Kärtchen mitgebracht, auf denen Aussagen stehen, die sich darauf beziehen, was Ihnen bei der Arbeit mit dem Boden wichtig ist. Dabei soll es nur um Ihr **Ackerland** gehen, und darum was **Ihnen persönlich** wichtig ist. Es gibt also kein „richtig“ oder „falsch“, sondern Ihre Meinung ist gefragt; zu Ihrer speziellen Situation.

Ich gebe Ihnen jetzt diese Kärtchen und würde Sie als erstes bitten

- **Lesen** sie jedes Kärtchen durch *(Angebot geben vorzulesen!)*
- **Entscheiden** Sie bei jeder Aussage **spontan** („aus dem Bauch heraus“) ob Sie der Aussage **zustimmen**, **nicht zustimmen**, oder Sie **neutral** dazu stehen
- Legen Sie die Kärtchen dementsprechend auf **drei Stapel** ab, „stimme zu“, „stimme nicht zu“ und „neutral“.

Dann

- Nehmen Sie sich nur den **ersten Stapel („stimme zu“)** und überlegen Sie sich, welchen zwei Aussagen Sie am **allermeisten** zustimmen. Sortieren Sie diese dann in der Vorlage ganz nach **rechts**.
- Dann suchen Sie sich die drei Aussagen denen Sie am **nächst-meisten** zustimmen und sortieren Sie sie neben den ersten Kärtchen, usw.

Dann

- Machen Sie als nächstes mit dem **„stimme nicht zu“ Stapel** weiter und suchen Sie die zwei Aussagen, denen Sie am wenigsten zustimmen. Diese kommen ganz nach **links** in der Vorlage. Dann geht’s weiter wie vorhin.
- Als letztes sortieren Sie bitte die **„neutralen“ Aussagen** in die **Mitte** der Vorlage.

Zum Schluss

- Schauen Sie sich das **fertig sortierte Bild** noch einmal in Ruhe an. Haben Sie das Gefühl das passt für Sie? Sie können auch gerne noch etwas **ändern**.

Q METHODE: REFLEXION

- Wenn wir uns hier die Kärtchen ganz rechts anschauen, könnten Sie mir erklären **wie Sie sich entschieden haben** diese Aussagen hierher zu legen?
- Wie Sie diese Karte(n) gelesen haben, was ist Ihnen da **als Erstes dazu eingefallen**? Was **bedeutet das [Thema auf der Karte]** für Sie? *[einzelne Kärtchen durchgehen]*
- …das selbe für ganz links…
- Welche Kärtchen waren für Sie am **schwierigsten einzuordnen**? Inwiefern/Warum?

- Inwiefern haben Sie das Gefühl wir haben **etwas Wichtiges vergessen**? Gäbe es ein Kärtchen das wir noch vorbereiten hätten sollen?
- Woran haben Sie gedacht, wie Sie **„Arbeit mit meinem Boden“** gelesen haben? Welche **Tätigkeiten**, Aspekte, Überlegungen, Gefühle, … verbinden Sie damit?

GUTER LANDWIRT

Jetzt möchten wir Ihnen noch ein paar Fragen dazu stellen, wie Sie sich selbst und andere Landwirt:innen sehen. Wir werden Ihnen ein paar Fragen dazu stellen, was es aus Ihrer Sicht, ein „guter Landwirt“ oder eine „guten Landwirtin“ zu sein. Also jemand der Ihrer Meinung nach seinen/ihren **Betrieb besonders gut** oder **„vorbildlich“ führt**.

Thema	Erzählaufforderung und Nachfragen
Guter Landwirt	Wenn Sie an ihre **Region** hier denken, wie würden Sie jemanden **beschreiben** der ein **„guter Landwirt“** ist? Woran würden Sie **erkennen,** ob jemand ein guter Landwirt ist, z.B. an den **Feldern** oder am **Betrieb**?
Schlechter Landwirt	Und wie würden Sie mir jemanden beschreiben, der ein **schlechter Landwirt** ist? Woran würden Sie einen schlechten Landwirt **erkennen**?
Veränderungen	Hat sich Ihre **Einstellung** oder Meinung dazu, was einen guten Landwirt ausmacht, **verändert** seit Sie als Landwirt begonnen haben? Wenn ja, **inwiefern**?

FRAGEBOGEN UND ABSCHLUSS

Fragebogen *zu Kennzahlen etc. ausfüllen (lassen).*
Vielen Dank, ich denke jetzt haben wir alle Informationen und Einblicke die wir brauchen! Danke nochmals, dass Sie sich diese Zeit genommen haben!

Evtl. Wichtige weitere Dinge
- Vorschläge für weitere InterviewpartnerInnen
- Stakeholder Workshops und Ergebnispräsentation nächsten Winter: Interesse?
- Interesse daran, Ergebnisse zugesendet zu bekommen (kann ein paar Monate dauern)?
- Nochmals erinnern, dass die TeilnehmerInnen sich jederzeit an uns wenden können, wenn sie Fragen oder Bedenken haben.

Appendix D: Questionnaire (English + German)

Figure 10: Questionnaire Interviews (English)

Interview ID: ……, date: ……, time: ……, interviewer: ……					
Year of birth: ……	Gender:	□ male	□ female	□ other	□ n/A
Agricultural education level (highest completed)	□ no ag. eduction	□ Ag. School lower secondary; vocational	□ Ag. School higher secondary; vocational master	□ University degree (Ag.)	□ n/A
Farm manager since:	□ <5 years	□ 5-14 years	□ 15-30 years	□ >30 years	□ n/A
Farm information					
Farmland (ha), without forest: ……	thereof cropland (ha): ……		thereof rented land (ha): ……		
Farm type (main focus):	□ Field crops	□ Horti-culture	□ Permanent crops	□ Grazing livestock	□ Pigs/ poultry	□ Mixed
Livestock (LSU or numbers)	……					
No. of crops in „usual" rotation	……		Organic: □ Yes	□ No	□ Partly	
AES program participation:	……					
Soil management: Which of the following practices do you apply?					
	Entire farm	partly	Not at all	n/A	
Cover crops	□	□	□	□	
Undersown crops	□	□	□	□	
Ploughing	□	□	□	□	
Reduced tillage (ridge-till, mulch-till, etc.)	□	□	□	□	
No-till / direct seeding	□	□	□	□	
Mineral fertilizer	□	□	□	□	
Animal manure/slurry	□	□	□	□	
Compost	□	□	□	□	
Biochar	□	□	□	□	
Soil testing	□	□	□	□	
Others: ……					

In your opinion, what defines a “good farmer” (someone who manages his/her farm in an exemplary way)?						
A **good farmer**…	Fully **disagree** 1	2	3	4	5	Fully **agree** n/A
…has **tidy fields**	□	□	□	□	□	□
…has **minimal weeds** on his/her fields	□	□	□	□	□	□
…has **straight lines** on his/her fields	□	□	□	□	□	□
…produces **high yields**	□	□	□	□	□	□
…has a **diversified crop rotation**	□	□	□	□	□	□
…grows **cover crops**	□	□	□	□	□	□
…uses **measures that favour biodiversity**	□	□	□	□	□	□
…has **big machines**	□	□	□	□	□	□
…**ploughs** his/her fields	□	□	□	□	□	□
…applies **reduced tillage**	□	□	□	□	□	□
…applies **organic** farming	□	□	□	□	□	□
…applies **conventional** farming	□	□	□	□	□	□
…applies **conservation agriculture**	□	□	□	□	□	□
…applies **regenerative** agriculture	□	□	□	□	□	□

Figure 11: Questionnaire Interviews (German)

Interviewdaten: Ort: ……, Datum: ……, Uhrzeit: ……					
Geburtsjahr: ……	Geschlecht	□ männlich	□ weiblich	□ anderes	□ k.A.
Höchste abgeschlossene landwirtschaftliche Ausbildung	□ keine landw. Ausbildung	□ landw. Schule ohne Matura; Lehre	□ landw. Schule mit Matura; Meister	□ landw. Hochschul-abschluss	□ k. A.
Betriebsleiter:in seit:	□ <5 Jahre	□ 5-14 Jahre	□ 15-30 Jahre	□ >30 Jahre	□ k. A.
Betriebsmerkmale					
Betriebsgröße (in ha) (ohne Wald):…… davon Ackerfläche (ha): …… davon gepachtete Fläche (ha): ……	**Bio**: □ Ja □ Nein □ Teilweise **Erwerbsart**: □ Haupterwerb □ Nebenerwerb □ KA				
Betriebsart (hauptsächlich)	□ Feldfrüchte	□ Gartenbau	□ Dauerkultur	□ Weidevieh	□ Schweine / Geflügel	□ Gemischt
Nutzvieh (GVE oder Anzahl): ……					

Anzahl Kulturen in Ihrer typischen Fruchtfolge: ……

Agrarumweltmaßnahmen (wenn ja, welche?):
……

Bodenbearbeitung: Welche der folgenden Praktiken der Bodenbearbeitung wenden Sie an?

	am ganzen Betrieb	teilweise	gar nicht	k. A.
Begrünungen	□	□	□	□
Untersaaten	□	□	□	□
Pflügen	□	□	□	□
Reduzierte Bodenbearbeitung	□	□	□	□
Pfluglose Bodenbearbeitung / Direktsaat	□	□	□	□
Mineraldünger	□	□	□	□
Gülle/Jauche/Mist	□	□	□	□
Kompost	□	□	□	□
Biokohle	□	□	□	□
Bodenuntersuchungen	□	□	□	□
Anderes: ……	□	□	□	□

Was zeichnet Ihrer Meinung nach einen guten Landwirt aus?

	Stimme gar nicht zu				Stimme voll zu	
Ein/eine **gute:r Landwirt:in** …	1	2	3	4	5	k.A.
…hat **saubere** Felder	□	□	□	□	□	□
…hat **kein Unkraut** auf den Feldern	□	□	□	□	□	□
…hat **gerade Zeilen** auf den Feldern	□	□	□	□	□	□
…erwirtschaftet **hohe Erträge**	□	□	□	□	□	□
…hat eine **diversifizierte Fruchtfolge**	□	□	□	□	□	□
…nutzt **Begrünungen**	□	□	□	□	□	□
…achtet auf die **Biodiversität**	□	□	□	□	□	□
…hat **grosse Maschinen**	□	□	□	□	□	□
…**pflügt** ihre/seine Felder	□	□	□	□	□	□
…nutzt **reduzierte Bodenbearbeitung**	□	□	□	□	□	□
…arbeitet **biologisch**	□	□	□	□	□	□
…arbeitet **konventionell**	□	□	□	□	□	□
…nutzt **konservierende Bodenbearbeitung**	□	□	□	□	□	□
…nutzt **regenerative Landwirtschaft**	□	□	□	□	□	□

Appendix E: Consent Form (German)

Universität für Bodenkultur Wien

University of Natural Resources and Life Sciences, Vienna

Einwilligungserklärung Interviews

Die Universität für Bodenkultur Wien nimmt den Schutz personenbezogener Daten ernst. Der Schutz der individuellen Privatsphäre bei der Verarbeitung personenbezogener Daten ist für uns ein wichtiges Anliegen, das wir bei unseren Geschäftsprozessen mit hoher Aufmerksamkeit berücksichtigen.

Die Verarbeitung Ihrer personenbezogenen Daten(-kategorien) gemäß beiliegender „Information über die Verarbeitung personenbezogener Daten im Rahmen eines Interviews“ erfolgt nur mit Ihrer freiwilligen Einwilligung.

Zudem ist uns wichtig, dass alle TeilnehmerInnen an unserem Forschungsprojekt vollständig darüber informiert sind, was ihre Teilnahme an dem Projekt bedeutet und dass sie ihre freiwillige Zustimmung zu ihrer Teilnahme geben.

Bitte lesen Sie die folgenden Informationen sorgfältig durch und bestätigen Sie Ihr Einverständnis:

Einwilligung in Datenerhebung und Datenverarbeitung

Ich, ... ,

1. bestätige, dass ich freiwillig am Forschungsprojekt SoilX teilnehme und dass ich weiß, dass ich jederzeit davon zurücktreten kann (z.B. das Interview abbrechen oder später die Daten löschen lassen).

2. bestätige, dass ich ausreichende Informationen über das Forschungsprojekt erhalten habe und dass ich die Möglichkeit hatte, Fragen dazu zu stellen die ausreichend beantwortet wurden.

3. bin damit einverstanden, dass das Interview zu Analysezwecken aufgezeichnet wird und dass die Tonaufnahmen nach der Transkription in pseudonymisierten Text gelöscht werden.

4. habe die beiliegende „Information über die Verarbeitung personenbezogener Daten im Rahmen eines Interviews“ verstanden, insbesondere die Belehrung über meine Rechte als Betroffene*r

5. bin damit einverstanden, dass die Universität für Bodenkultur Wien als Verantwortliche meine personenbezogenen Daten(-kategorien) gemäß beiliegender „Information über die Verarbeitung personenbezogener Daten im Rahmen eines Interviews“ verarbeitet.

....

Ort, Datum Unterschrift

Information über die Verarbeitung personenbezogener Daten im Rahmen eines Interviews

Mit 25. Mai 2018 ist die Verordnung des Europäischen Parlaments und des Rates vom 27. April 2016 zum Schutz natürlicher Personen bei der Verarbeitung personenbezogener Daten, zum freien Datenverkehr und zur Aufhebung der Richtlinie 95/46/EG (Datenschutz-Grundverordnung, kurz DSGVO) in allen Mitgliedstaaten der Europäischen Union unmittelbar anwendbar.

Die DSGVO sieht unter anderem erweiterte Informationsverpflichtungen betreffend die Verarbeitung von personenbezogenen Daten vor.

In Erfüllung dieser Verpflichtungen (insbesondere Artikel 13 DSGVO) informieren wir Sie hiermit über die von uns durchgeführte(n) Verarbeitung(en) Ihrer personenbezogenen Daten.

Welche personenbezogenen Daten (kurz „Daten“) werden verarbeitet?

Es werden die im Interview abgefragten und von Ihnen freiwillig angegebenen Daten verarbeitet.

Zu welchem Zweck werden die Daten verarbeitet?

Die im Interview erhobenen Daten werden im Rahmen des Forschungsprojektes SoilX ausschließlich zu Forschungszwecken verarbeitet.

Sofern Sie Interesse an einer Teilnahme am Ergebnisdiskussionsworkshop haben und/oder die Forschungsergebnisse zugesandt bekommen möchten, dann werden Ihre Kontaktdaten (Name, Postadresse oder E-Mail Adresse) auch zum Zweck der Einladung zum Workshop bzw. Zusendung der Ergebnisse verarbeitet.

Auf Basis welcher Rechtsgrundlage werden die Daten verarbeitet?

Es besteht Ihrerseits keine Verpflichtung am Interview teilzunehmen. Die Bekanntgabe Ihrer Daten erfolgt freiwillig. Die Verarbeitung Ihrer Daten erfolgt auf Basis Ihrer im Rahmen des Interviews erteilten Einwilligung zu dem oben genannten Zweck.
Die Einwilligung kann jederzeit mit Wirkung für die Zukunft widerrufen werden, hierbei entstehen keine nachteiligen Folgen für Sie. Ein Widerruf hat zur Folge, dass wir Ihre Daten ab diesem Zeitpunkt zu oben genanntem Zweck nicht mehr verarbeiten und insbesondere (noch) gespeicherte Daten löschen.

Werden die Daten gänzlich oder zum Teil an andere Personen/Einrichtungen übermittelt?

☒ Nein
☐ Ja, ihre Daten werden im Zuge der Verarbeitung zu oben genanntem Zweck an folgende Empfänger übermittelt:

Befinden sich die unter Punkt 4 genannten Empfänger außerhalb der EU/des EWR bzw. handelt es sich dabei um eine internationale Organisation?

☒ Nein
☐ Ja, und zwar:

Empfänger	Drittstaat	Internationale Organisation	Schutzniveau (Artikel gemäß DSGVO)
			☐ Angemessenheitsbeschluss der Europäischen Kommission nach Art 45 ☐ verbindliche interne Datenschutzvorschriften nach Art 47 iVm Art 46 Abs 2 lit b ☐ Standarddatenschutzklauseln nach Art 46 Abs 2 lit c und d ☐ genehmigte Verhaltensregeln nach Art 46 Abs 2 lit e iVm Art 40 ☐genehmigter Zertifizierungsmechanismus nach Art 46 Abs 2 lit f iVm Art 42 ☐ von der Datenschutzbehörde bewilligte Vertragsklauseln nach Art 46 Abs 3 lit a ☐ Ausnahme für bestimmten Fall nach Art 49 Abs 1 ☐ Ausnahme für Einzelfall nach Art 49 Abs 1 Unterabsatz 2

Wie lange werden die Daten gespeichert bzw. nach welchen Kriterien wird die Dauer der Speicherung festgelegt?

Die Audioaufnahmen der Interviews werden spätestens ein Monat nach Transkription und Pseudonymisierung gelöscht.

Pseudonymisierte Transkripte und andere nicht persönlich zuordenbare Daten werden für die Dauer des Forschungsprojektes sowie darüber hinaus für den Zweck der Archivierung von Forschungsdaten sowie für weitere Forschung aufbewahrt.

Kontaktdaten zur Ergebniszusendung und zur Einladung zum Ergebnispräsentationsworkshop werden so lange aufbewahrt, bis die Einladungen bzw. Ergebnisse versandt wurden (bis max. 1 Jahr nach dem Ende des Forschungsprojektes), und danach gelöscht.

Sonstige Daten (z.B. Schlüssel zur Pseudonymisierung) werden im Rahmen der gesetzlichen Aufbewahrungspflichten gespeichert.

Welche Rechte haben Sie als Betroffene*r?

Ihnen stehen grundsätzlich die Rechte auf Auskunft, Berichtigung, Löschung, Einschränkung, Datenübertragbarkeit und Widerruf zu.
Um diese Rechte geltend zu machen wenden Sie sich bitte an unsere*n Datenschutzbeauftragte*n (Kontaktdaten siehe Punkt 8).
Darüber hinaus haben Sie das Recht, allfällige Beschwerden bei der Datenschutzbehörde einzubringen.

Kontaktdaten

Verantwortliche und Datenschutzbeauftrage*r
Universität für Bodenkultur Wien
Gregor-Mendel-Straße 33
1180 Wien

Muthgasse 11/II
1190 Wien
datenschutz@boku.ac.at

Allgemeine sowie weiterführende Informationen zum Thema Datenschutz an der Universität für Bodenkultur Wien finden Sie unter www.boku.ac.at/datenschutz.

Declaration of consent

on the basis of Article 30 of the RSL Phil.-nat. 18

Name/First Name: Bütikofer Nicole

Registration Number: 14-116-818

Study program: Climate Sciences

Bachelor ☐ Master ☑ Dissertation ☐

Title of the thesis: Swiss Farmers' Views on the Role of Soil Management to Mitigate Impacts of Droughts and Extreme Precipitation

Supervisor: PD Dr. Annelie Holzkämper
Dr. Heidi Leonhardt

I declare herewith that this thesis is my own work and that I have not used any sources other than those stated. I have indicated the adoption of quotations as well as thoughts taken from other authors as such in the thesis. I am aware that the Senate pursuant to Article 36 paragraph 1 litera r of the University Act of 5 September, 1996 is authorized to revoke the title awarded on the basis of this thesis.
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Bern, 24.08.2023

Place/Date

Signature