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Dimensions of SURE-Farm Farm Typology for Farm Resilience Assessments

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1 Summary

The objective of this report is to develop the SURE-Farm farm typology. The document aims (i) to incorporate farm management literature into the construction of a farm typology for assessments of resilience, and (ii) to provide guiding questionnaire for implications for 11 SURE-Farm case study regions.

2 Introduction

The overall aim of SURE-Farm is to analyse, assess and improve the resilience and sustainability of farms and farming systems in the EU. For this purpose, a conceptual framework to measure the determinants of resilience of current and future EU farming systems will be developed within the project's Work package (WP) 1.

This report is the third deliverable (D1.3) of WP 1. The objectives of WP 1 are to elaborate the conceptual resilience framework of the project with three main tasks: (1) develop an analytical framework for measuring the resilience of current and future EU farming systems, as well as the determinants of this resilience (including the mechanisms that influence resilience and ability of the farming sector to deliver public and private goods in the long term); (2) elaborate future scenarios to test the robustness of the various indicators with regard to practices and policies developed throughout the project; and (3) design a typology of farms and farming systems to guide work in subsequent WPs.

The main objective of the SURE-Farm farm typology is to classify EU farms in groups that are homogeneous, characteristic and representative regarding their challenges to cope with requirements of sustainability and resilience of farms and farming systems. The constructed farm typology sets a structure for the following WPs with three main supporting aims:

- To be applicable to all 11 case study regions of SURE-Farm in order to capture the various dimensions of farm resilience. Regarding to the selection of a representative set of farming systems, the farm typology needs to link statistical sources and expert knowledge by organizing farm surveys, interviews, and stakeholder workshops.
- To set a structure for other work packages in the project, help to characterize farms within a system (e.g., for sampling purposes and to allow for generalisations in WP6).
- This report covers Germany (Altmark) case study region expert interview results as an example (section 9.2). Other selected 10 case study region interview results will be used as an input to WP 3 deliverable D3.1 Report on current farm demographics and trends for selected regions.

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3 Farm Resilience concept

In the SURE-Farm project, the resilience framework to analyse the resilience of EU farming systems builds on the concept of adaptive cycles (Holling et al., 2002). Resilience theory is an integrated framework to investigate the ability of complex social-ecological systems to cope with changing environments (Meuwissen et al., 2018). Recent literature goes beyond these definitions by considering three features of resilience which are robustness, adaptability and transformability (Anderies et al., 2013).

Regarding farming systems, these features of resilience have different strategies to respond to changes and shocks in the natural, social, economic and institutional environment (Meuwissen et al., 2018). In SURE-Farm, these subdivisions into robustness, adaptability and transformability follows the conceptual study realized by Folke et al. (2010):

Robustness: “ability to maintain desired levels of outputs despite the occurrence of perturbations” (Urruty et al., 2016). This concept has also been used with the definition of “buffer capability that allow persistence” in several studies which focusing on farm resilience (Darnhofer, 2014).

Adaptability: “capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory (stability domain)” (Folke et al. 2010). This concept represents farms which use their adaptive capability to cope with changes (e.g., increasing water scarcity, or policy changes in the water framework directive) over time (Darnhofer, 2014).

Transformability: “capacity to create a fundamentally new system when the existing system is untenable” (Walker et al., 2004). Transformation of the farming system organised around cattle on range land into ecotourism may serve as an example (Cumming, 1999).

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4 Farming system concept

The SURE-Farm project builds on farm resilience concept and develops a comprehensive framework to identify the conditions that enable the resilience of farming systems.

A farming system considered as a system that is hierarchy level above the farm (Giller, 2013) at which properties emerge as a result of the formal and informal interactions and interrelations among farms, available technologies, stakeholders in the value chains, actors in rural and urban areas, consumers, policy makers, and the environment (Meuwissen et al., 2018).

The boundary of a farming system includes actors who influence farms, and, conversely, farms also influence these actors (see Meuwissen et al., 2018 for the considered actors within system boundary of a farming system with examples).

In the SURE-Farm project, **resilience of farming systems** involves analyses on the agriculture sectors' economic, social and ecological environment challenges that becomes more and more complex and volatile (Meuwissen et al., 2018). The farm typology approach used to capture the resilience of farming systems within various dimensions. Selected set of 11 farming systems that reflect the diversity in EU agriculture has given in Table 1.

Table 1: Selected 11 farming systems

	Countries	Region(s)	Farming Systems
1	France	Bourbonnais	Cow-calf producers and beef finishers
2	Spain	Sistema Central and Aragón	Extensive beef and sheep farming
3	Sweden	Southern Region	Eggs and broilers production
4	Belgium	Flanders	Dairy farming
5	Germany	Altmark	Large-scale corporate farms
6	Bulgaria	North-East Bulgaria	Crops
7	Netherland	Veenkolonieen and Old-Ambt	Arable farming
8	UK	East Anglia	Arable farming
9	Italy	Viterbo	Hazelnut farms
10	Poland	Mazovian region	Horticulture
11	Romania	North-East Region	Mixed farming

Livestock
Crops
Perennials
Horticulture
Mixed farms

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5 Farm typology approach

In the European Commission (EC), the establishment of a Community typology for agricultural holdings (see EC, 1985 for historical details) principally comprises by two data-sets: The Community Farm Structure Surveys (FSS) and the Community Farm Accountancy Data Network (FADN).

The FSS provides a harmonised data on agricultural holdings, and gives information on the structure of agricultural holdings in the EU (e.g., number of agricultural holdings, land use and area, livestock, main crops, farm labour force, economic size of the holdings, type of activity). Overall, farm typology in FSS is usually constructed by type of farming, economic size classes by using standard output coefficients, as well as socio-economic and organizational characteristics (Eurostat, 2018).

The FADN presents a micro-economic data at farm level that consists of an annual survey carried out by the Member States (MS) of the EU. In the FADN survey, the selection of agricultural holdings is based on sampling plans established at the level of each region in the MS. The aim of the applied farm typology methodology is to provide three dimensions of farms: region, economic size and type of farming. These dimensions capture with (i) physical and structural data (e.g., location, crop areas, livestock numbers, labour force), and (ii) economic and financial data (e.g., value of production of the different crops, stocks, sales and purchases, production costs, assets, liabilities, production quotas and subsidies that are connected with CAP (EC, 2018).

However, these exclusively economically based farm typologies of FSS, and FADN are misleading when the farming sector is viewed according to recent reforms of CAP focusing on social and environmental objectives. In order to be able to assess the broader goals of the CAP by using farm typology approach, previous EU project (e.g., SEAMLESS, Catch-C) constructed a farm typology that allows an integrated assessment of farming activities in which economics is only one of the dimensions considered.

One of the biggest challenges for providing the data needed for these farm typologies is the linkage of farming data to the social and environmental data in the EU-wide datasets. Therefore, in these EU projects social and environmental information for farm typologies has collected by consulting farm advisors and researchers at regional or national level (see Hijbeek et al., 2014 for Catch-C farm typology and Andersen, 2010 for SEAMLESS farm typology). In these typologies, FSS and FADN have used as a framework for collecting additional data on social and environmental dimensions, and link them to the information in the EU-wide datasets.

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In the United States (US), the Census of Agriculture and analyses of agricultural statistics have been developed by a farm typology approach with Census of Agriculture Act of 1997. The US farm typology developed by the US Department of Agriculture's (USDA) Economic Research Service (ERS) divides the 2.1 million US farms into 8 mutually exclusive and relatively homogeneous groups: (1) limited resource farms; (2) retirement farms; (3) residential/lifestyle farms; (4) farming occupation/lower sales; (5) farming occupation/high sales; (6) large family farms; (7) very large family farms; (8) non-family farms.

Similar to the current Community typology, the rationale behind the ERS farm typology approach is exclusively economic base (e.g., income). The primarily focus given to the family farms, and classification base on gross cash farm income that includes the farm operator's sales of crops and livestock, fees for delivering commodities under production contracts, government payments, and farm-related income (USDA, 2015).

Alternative to ERS farm typology in the US, Briggeman et al., 2007 advocate a new US farm typology that is based on household economic theory via cluster analysis. Briggeman et al., 2007 argue that the segmenting farm households via their size (e.g., farm sales) would not capture the increasing heterogeneity of farm households in terms of sources of income, wealth, borrowing, saving and consumption behavior.

The study of Briggeman et al., 2007 proposes six mutually exclusive groups: (1) Single Income Ruralpolitan: The operator is the primary worker and is employed full-time off the farm: relatively large amount of non-farm assets compared to farm assets; (2) Double Income Ruralpolitan: The operator and spouse are the primary workers, and employed full-time off the farm; (3) Active Seniors: The operator primarily works on the farm, they have the lowest mean household debt-to-asset ratio, household consumption is the lowest, and they have unearned off-farm income (e.g., social security, pensions), operator is the oldest relative to all other groups; (4) Farm Operator with Spouse Working Off Farm: The operator and spouse are spending a significant amount of time on the farm; both of them have the highest mean on-farm hours; (5) Traditional Farms: The operator and spouse are spending a significant amount of time on the farm: have the highest mean on-farm hours; (6) Commercial Farms: the operator primarily working on the farm and the spouse not taking as active of a role on the farm compared with traditional farms. There is a high mean value of farm assets relative to labor allocation by the operator and spouse. In addition, there is a highest value of non-farm assets.

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6 Overview of SURE-Farm farm typology

6.1 Objective

The farm typology approach uses to respond to the research questions where statistics on average farm characteristics are not representative for the majority of the farms in the study regions. Taking into account the heterogeneity of agriculture within a region is the primary objective of the constructing farm typologies (Alvarez et al., 2014). The selection of factors that define the farm typology varies from study to study, and is governed by the research purpose (Goswami, et al., 2014).

The **objective of the SURE-Farm farm typology** is to classify EU farms in groups that are homogeneous, characteristic and representative regarding their challenges to cope with requirements of resilience of farms and farming systems. As described in detail in section 5, a farm typology is needed that is able to focus on 11 selected farming systems: extensive beef cattle systems (France), extensive beef and sheep farming systems (Spain), intensifying dairy farming (Belgium), high-value egg and broiler systems (Sweden), private family fruit and vegetable farming (Poland), intensive arable farming (the Netherlands), large-scale corporate arable farming (UK, East Germany and Bulgaria), small-scale farming (Italy) and mixed farming (Romania).

6.2 Theoretical and methodological basis

The theoretical basis of farm typologies mainly builds on the fundamental assumption of the **theory of the firm**. Accordingly, a firm's production decisions depend on its fixed assets, technical level and the pricing system (Brossier, 1977). Because the technical level and the pricing system are often considered as exogenous factors (Brossier, 1977), many studies base their firm structure analysis on endogenous factors, e.g. land, labour and capital.

Previous studies based on the theory of the firm explain economic resilience as an understanding of how firms use structural assets as effectively as possible and invest in repair and reconstruction following the objective to accelerate recovery (Graveline and Gremont, 2017; Dormadi, et al., 2017).

In the SURE-Farm typology, in order to ensure a systematic approach, we consider typology dimensions related to the structural characteristics at the farm level and their interactions with the outside/environment of the farming system level.

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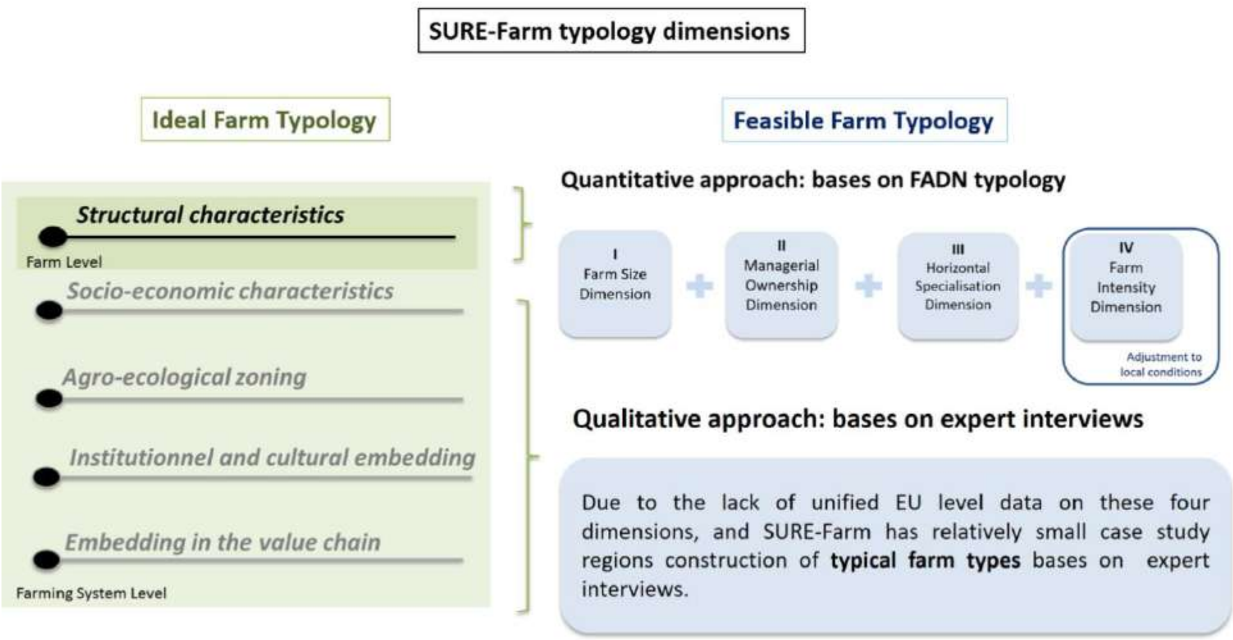
For the methodological framework, in the stage of selecting key variables, farm typologies can be grouped into structural and functional typologies (Alvarez et al., 2014). Structural typologies are based on variables that describe resources and asset levels. Functional typologies are based on variables that describe the outside of the farm (Tittonell, 2014).

The SURE-Farm project farm typology applied an integrated framework that covers **farm level dimensions** with (i) farm structural characteristics, and extends the typology within **farming system level dimensions** with (ii) socio-economic characteristics; (iii) agro-ecological zoning, (iv) institutional and cultural embedding, and (v) value chain integration dimensions (Figure 1).

Figure 1: Overview on SURE-farm farm typology dimensions



At the farm level, four structural characteristics of (I) farm size; (II) managerial ownership, (III) horizontal specialization; and (IV) farm intensity are selected. Due to access to unified key variables at the EU level on structural characteristics of case study regions, it is only possible by considering FADN typology, feasible farm typology based on a **quantitative approach**.

At the farming system level, ideal farm typology aims to improve by a **qualitative approach** based on expert knowledge (Section 8). Example indicators for selected four farm system level dimensions of socio-economic characteristics, agro-ecological zoning, institutional and cultural embedding, and embedding in the value chain are given in the following Table 2.

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Table 2: Examples of indicators in four farming system level dimensions

Socio-economic characteristics	✓ Age, education and gender structure of farm managers and workers ✓ Family types of farm managers and workers (single, married) ✓ Average family size in farms (number of family members) ✓ Frequently use sources of information for farm management ✓ Farm labour characteristics (permanent/temporary/hired labour, labour intensity) ✓ Work quality ✓ Access to medicines and health coverage ✓ Farmers' social engagement of (e.g., membership of farmers' association, civil, voluntary associations, professional organization) ✓ Farmers' social diversification activities to improve the image of farms and agriculture in local communities (e.g., participation to open day events, fairs and exhibitions)
Agro-ecological zoning	✓ Share of woodland area ✓ Diversity and abundance of key farmland animal, plant and insect species ✓ Water quality (e.g., pesticides and nitrates in rivers) ✓ Nutrient balance (Nitrogen Use efficiency (kg N output/ k N input) ✓ GHG balance (Mg CO2e M kcal-1) ✓ Use of pesticides (tons per 1,000 ha) ✓ Soil erosion (physical, chemical and biological quality of the soil) ✓ Waste management measures ✓ Protection of biodiversity of habitats, genes, and species ✓ Adoption of agri-environmental farming practices
Institutional and cultural embedding	✓ Presence of institutional patterns that promote mutual respect and trust ✓ Availability of human and financial resources to support policy measures ✓ Communities' perception of the presence and quality of services provided ✓ Acceptance of farming practices ✓ Consumer expectations towards cultural and ethical aspects ✓ Jobs created in supported projects ✓ Rural population benefiting from services/ infrastructures supported under the RDP ✓ Share of rural population covered by Local Action Groups (LAG) funded through the RDP
Embedding in the values chain	✓ Investment in the upstream economic activities (e.g., research and development, certified seeds, high-value varieties) ✓ Investment in the midstream economic activities (e.g., processing, high value end uses) ✓ Investment in the downstream economic activities (e.g., packaging, food safety, branding, targeted markets) ✓ Value chain integration by supporting internal providers (e.g., infrastructure, finance, human resource development) ✓ Value chain integration by supporting services (e.g., machinery, logistics, marketing) ✓ Contract farming models

Sources: Meuwissen et al., 2018; Pacini et al., 2010; Cardillo et al..; 2016; Majewski et al, 2011

The following section 7 presents further example of indicators that used in the previous studies both for the farm level dimension (structural characteristics) and for the farming system level dimensions (socio-economic characteristics; agro-ecological zoning, institutional and cultural embedding, and embedding in the value chain).

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7 The SURE-Farm farm typology

SURE-Farm typology aims to develop a coherent typical farm types from a heterogeneous farm population in 11 SURE-Farm case study regions. This section explore existing constrains and drivers of farms for the five farm typology dimensions of (I) structural characteristics; (II) socio-economic characteristics; (III) agro-ecological zoning, (IV) institutional and cultural embedding, and (V) value chain integration respectively.

7.1 Structural characteristics

Farm structural characteristics show farms' capacity to use their endogenous resources (land, labour and capital) as effectively as possible and invest in repair and reconstruction to accelerate recovery (Dormady et al., 2017).

In the previous EU project SEAMLESS, the constructed farm typology for the assessment of agricultural and environmental policies and technological innovations used the farm structural characteristics ***farm size, managerial ownership, combined farm specialization with land use,*** and ***farm intensity*** (Andersen et al., 2007).

The following EU project Catch-C, which investigates soil management and soil degradation, adopted two dimensions of the SEAMLESS typology: ***farm specialisation*** and ***land use*** (Hijbeek et al., 2014). While farm specialisation refers to the activity type that generates farm income (e.g., dairy cattle or arable crops), land use shows the grown crops (e.g., permanent crops or cereals). In these two EU projects, farm structural characteristics used information based on the FADN data-set.

A further structural characteristic, the ***orientation of farms*** (share of output from nonagricultural activities), has been used as an extra dimension in the study of Mandryk et al., 2012 with a focus on climate change impact assessment. Mandryk et al., 2012 considered the orientation of farms (within three categories: production base, nature conservation, and entrepreneur) as an important factor that influenced farmers' decision making, with the assumption that farms with different orientations adopt different adaptation measures when confronted with external changes. In this study, data on the orientation of farms is based on multifunctional activities of farms and is captured through literature review and consultations with stakeholders.

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The SURE-Farm typology farm level indicators of structural characteristics for resilience assessment followed the previous farm typology approaches as far as selection of four characteristics: (I) farm size; (II) managerial ownership, (III) horizontal specialization, and (IV) farm intensity (Figure 2).

Figure 2: SURE-Farm project farm typology: structural characteristics

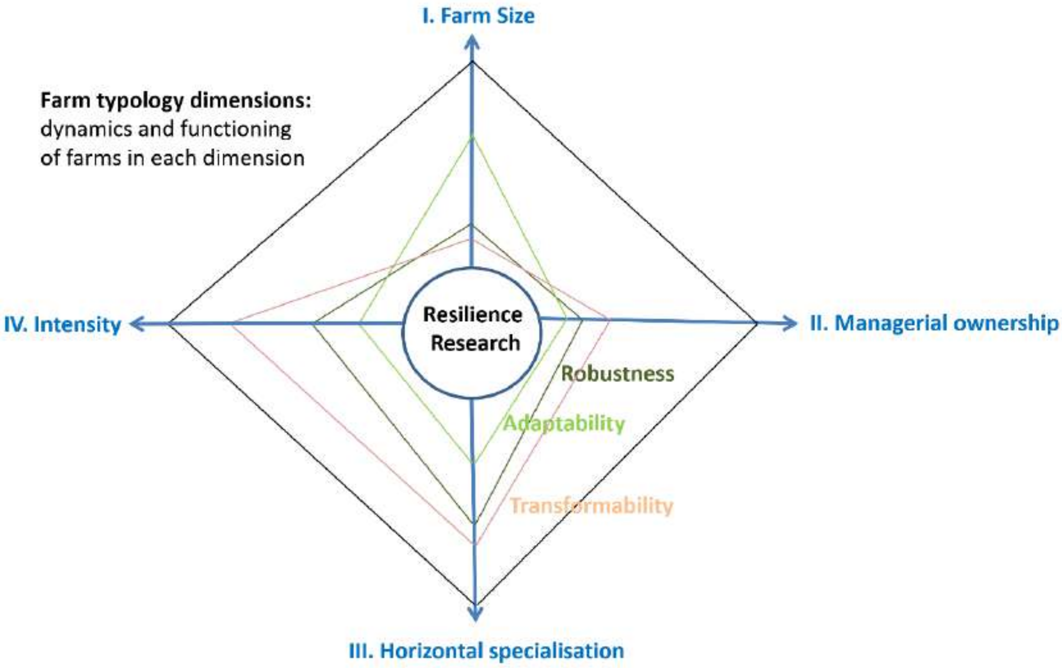
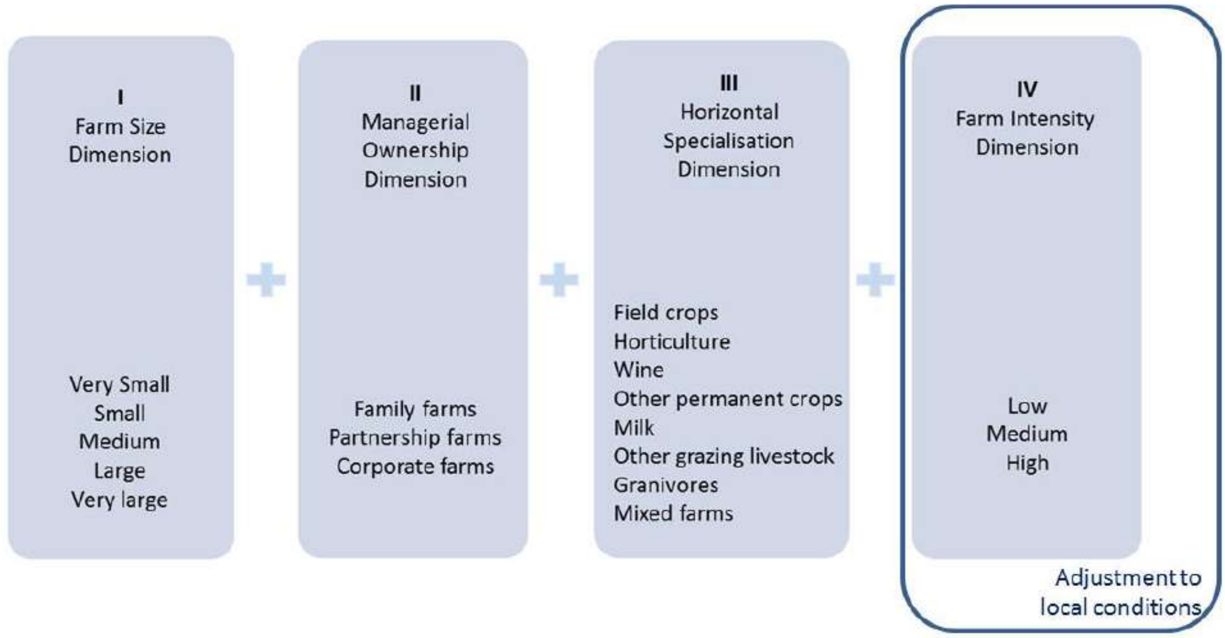


Figure 2 represents the selected four dimensions of the SURE-Farm farm typology structural characteristics according to the resilience concept subdivisions of robustness, adaptability and transformability (detailed in Section 3). In SURE-Farm, the subdivision of the resilience concept into robustness, adaptability and transformability follows a previous study realized by Folke et al. (2010). Dynamics and functions of farms in each dimension help to establish hypotheses on their robustness, adaptability and transformability. However, they are merely general dimensions of the farm typology and do not necessarily contribute to a higher level of resilience. The farm size dimension can be scaled from very small to very large. The managerial ownership dimension can be scaled from "low ownership of labour, land and capital" to "full ownership of labour, land and capital". This could be measured in terms of payments for wages, land rentals and interests relative to the total costs for labour, land and capital that measure with average wages, rents and interest rates for the hired factors. The horizontal specialization dimension can be scaled as a relative share of the most important specialization in terms of returns or costs. The intensity dimension can be scaled from a low to high intensity level, based on the relevant farm intensity indicator according to local conditions.

The feasible farm typology structural characteristics dimension is based on FADN data and consists of the classifications shown in Figure 3.

Figure 3: Farm typology**- farm level dimension**-: structural characteristics with classifications



The following sections provide further explanation on both farm level and farming system level dimensions with regard to their importance for the resilience assessment, by providing definitions and measurements.

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7.1.1 Farm size

Farm size is an important structural characteristic of a farm, and many previous findings provide insight on the relationship between farm size and the economic, social and environmental resilience of farms.

Flexibility advantage of small farms

In recent decades, studies on farm sustainability and resilience try to answer a related question whether "small farms are more sustained and resilient?". For example, D'Souza and Ikert (1996) conclude that future farms may need to be smaller, rather than larger, if they are to remain productive and competitive in the post-industrial, knowledge-based era of economic and social development. Allen and Lueck (1998) consider "seasonality" and "randomness" as a nature of farming in discussing the reasons for the resilience of the small farms while considering economies of scale as less important in agriculture. The importance of farm size can mainly be found in the response differences to shocks of small farms relative to large farms, and might, in many cases create management flexibility in adapting to change. Weiss, 1999 provides an explanation of resilience of small (family) farms, despite the existence of economies of scale in large farms with their tactical (adjustment capacity of aggregate output) and operational (adjustment capacity of production mix) flexibility to exogenous shocks.

The role of socio-economic factors on farms' resilience

Besides the flexibility advantage of small farms, the importance of socio-economic factors on small-sized farms' resilience is continuing to drive changes in farm size structures in different ways. For example, Peerlings et al., 2014, highlight that not only the farm size, but also the combination of farm size with specific structural characteristics (such as social capital of farm managers) plays a role in resilience assessment in EU farms. Peerlings et al. find that large, more specialised farms with young farm managers are the most resilient, and small, more diversified farms managed by old farmers are the least resilient. Looking to transitional economies, Rizov and Mathijs, 2003, support their findings with a case study from Hungary, and highlight that older (experienced) and larger farms are more likely to survive. A study on the resilience of bergamot farmers in Southern Italy shows that farm household resilience is directly proportional to farm size: the farm household resilience index (that combine with seven the components of economic connectivity, agricultural assets, non-agricultural assets, access to economic resources, social networks and information, household structure, and human capital) shows higher score coefficient numbers in large farms relative to small farms (Ciani et al., 2016).

Consumers starting to demand sustainability: which role for small farms?

Looking at the market issues of sustainability, studies that focus on the future role of small farms gives mixed results.

There is an emerging trend among key buyers who seek “sustainability” criteria with specific demands on farming practices, such as on the production process and location, environmental standards, and animal-welfare requirements. In the US, these developments have allowed small-scale agriculture to expand in proximity to towns and cities, to meet demands for locally grown foods, as well as, increased implications of contract agriculture for small farmers (Saitone and Sexton, 2017). Despite the observed possibility of profitable niches for small-scale food marketers, food manufacturers in many industries are highly concentrated. However, the findings of Saitone and Sexton 2017, on the performance of the food-marketing sector in meeting these developments stress that small farmers have a difficult role in modern agricultural supply chains, and are likely to be inefficient compared with larger operations.

Improving the resilience of the small farm

A recent study on the resilience of farms in the UK concluded that heterogeneity in small family farms (that represents a spectrum of different farm types such as business farms, family farms, ‘lifestyle’ farms, part-time farms) is more likely to be reflected in a range of different responses to the resilience assessments (Winter, et al., 2016). Authors highlights that the heterogeneity in small family farms means that there is a need for different approaches to assess the resilience of different farm types in small family farm population. In SURE-Farm farm typology, beside farm size dimension, managerial ownership dimension aim to capture this point.

Measurement of farms size dimension

Farm size is often measured by the total number of hectare, size of the UAA, economic size in European Size Unit (ESU), standard gross margin (SGM), or total sales. Regarding the Community typology, until 2007, the FADN and FSS used SGM to classify agricultural holdings by economic size. From 2010, this classification started to be use the standard output (SO) and was replaced by Commission Delegated Regulation (EU, 2014) for FSS 2016 and onwards.

The SO of an agricultural product (crop or livestock) is defined as the average monetary value of the agricultural output at farm-gate price, in Euro per hectare or per head of livestock (Eurostat, 2017). There is a regional SO coefficient for each product, as an average value over a reference period (5 years). The sum of all the SO per hectare of crop and per head of livestock on a farm is a measure of its overall economic size, expressed in Euro. The SO does not take into account input costs, and therefore does not provide an indication as to the profitability of farms

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(Eurostat, 2017). The main calculation differences between SGM and SO is that SO excludes direct payments and includes the production costs as:

SGM = Output + Direct Payments – Costs, and

SO= Output.

SGMs are measured in euros and are presented in size ranges which relate to ESU.

Table 3: Farm size dimension based on the total standard output (SO) of the holding expressed in Euro.

Farm Size Dimensions	Limits in Euros
Very small	less than 8 000 euro
Small	from 8 000 to less than 40 000 euro
Medium	from 40 000 to less than 200 000 euro
Large	from 200 000 to less than 1000 000 euro
Very large	equal to or greater than 1000 000 euro

SURE-Farm typology: farm size dimension

In the SURE-Farm typology, five farm size classes of very small, small, medium, large and very large have been used, and these four classes are measured with Economic Size Units (Table 4). For the German case study region, the reason for using ESU is that the accessed FADN data for quantitative analyses (Section 9.1) covers year 2013, and provides farm size dimensions by ESU.

Table 4: SURE-Farm typology: farm size dimensions with 4 farm types

Farm Size Dimensions	Economic Size Units (ESU)
Very small	< 8
Small	< 40
Medium	< 200
Large	< 1000
Very large	>= 1000

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7.1.2 Managerial ownership

Managerial dynamics provide an important starting point for understanding farm-level decision making, and are important factors in resilience assessments, especially for the adaptability and transformability of farms.

Farm resilience can be strengthened or eroded by managerial dynamics (Darnhofer, 2014). A management approach based on resilience "*would emphasize the need to keep options open, (…) to devise systems that can absorb and accommodate future events in whatever unexpected form they may take*" (Holling 1973: 21 from Darnhofer, 2014). Alongside the farm level, managerial dynamics contribute to community resilience: the presence of family-based farms may be important for the social vitality of rural areas (Longhitano et al, 2012).

Measurement of managerial ownership dimension

The measurement of management dynamics of farms is often based on two major farm typologies: "labour responsibilities" and "stage production". In the "labour responsibilities" based farm typology, managerial ownership is distinguished by labour use classifications (see Ferto and Fogarasi, 2005 for the detailed definition). An example application can be found in Hill(1993) and Ferto and Fogarasi(2005) where farms are divided into three managerial classes of the European Community typology: (1) family farms: the ratio of Family Work Unit per Annual Work Unit (FWU/AWU) greater than 0.95; (2) intermediate farms: family farms that are supplemented by hired labor, but still does not exceed 50 per cent (0.5<FWU/AWU<0.95); and (3) non-family farms: farm where hired labor contributes the majority of work (FWU/AWU<0.5).

In the "stage production" based farm typology, farm ownership is distinguished as family farms, partnerships, and corporate farms (Allen and Lueck, 1998). However, definitions of "family farms" differ in a number of ways in which the study subject has been approached (for a review on the different definitions of family farmer used, see Brookfiled and Parsons, 2007).

Recently, an alternative measurement of management dynamics for sustainability assessments has been suggested in the FLINT project (Kelly et al., 2016). This project highlights the importance of the use of external knowledge and advisory services, level of agricultural or management training undertaken by on-farm work force for farm sustainability. A recent study on the resilience of dairy farms to milk crises in Finland shows that an adaptation to change based on the anticipated future changes in food production by an increase of farmers' knowledge via mutual learning and expands farmers' networks with other interest groups (Rizzo, 2017). Overall, these alternative indicators put forward the role of sociological approaches in

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the managerial ownership dimension of farm typology. To apply resilience thinking to SURE-Farm case study regions, it is necessary to adequately capture the managerial functioning and dynamics with regard to the use of external knowledge, and mutual learning trends with local experts.

SURE-Farm typology: managerial ownership dimension

In SURE-Farm farm typology, the managerial ownership dimension is based on three organisation classifications that bases on FADN variables of family farms, partnership farms, and corporate farms (Table 5). This enables comparisons of decision making processes with respect to resilience thinking across different organisation levels, in all case study regions.

Table 5: SURE-Farm typology: managerial ownership dimension with 3 farm types

Managerial ownership dimensions	Classification
Family farms	Farm where the profits cover unpaid labour and own capital of the holder and the holder's family
Partnership farms	Farms where the profits cover the production factors brought into the holding by a number of partners
Corporate farms	Farms without unpaid labour or which are not included in the other two groups (e.g., legal persons, corporate farms, and producer cooperatives).

Source: *EC, 2013.*

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7.1.3 Horizontal specialisation

Horizontal specialization of farms in agricultural activities is an important dimension of resilience research due to its consequences at **economic**, **ecological**, and **socio-cultural perspectives.**

From an **economic perspective**, the economic performances and future choices of farm management are closely linked to horizontal specialization in agricultural activities. The economic effect of horizontal specialization of farms in agricultural activities could seen as twofold: while highly specialized farms (in terms of the crops they produce) increases their dependency on inputs from other sectors in the economy, they could also acquire the potential to increase their economic efficiency and to reduce marginal costs of production via economies of scale (Blaxter et al., 1995; Kim et al., 2012). In the previous literature, unintended drawbacks of highly specialized farms are reported as (i) lack of resilience to changing market and environmental conditions (Döös, 1994; Abson et al., 2013), and (ii) increase in income volatility (Blank, 1992; Baumgärtner abd Quaas, 2010).

From an **ecological point of view**, specialisation of farms often leads to trade-offs between economic gains and ecosystem services: an increase in the degree of specialisation and enlargement of internal economies of scale (with increased investments and improved infrastructure) endangering ecosystem functions, also at broader spatial scales (Klassen et al., 2016).

As a parallel trend, the **socio-cultural impact** of farming is related to the degree of specialisation. The social costs in terms of non-material benefits, cultural values, sentimental attachment to land and place are more often associated with the degree of specialisation of a farm in the region (Chan et al., 2012). This makes the specialisation on agricultural activities as an important characteristic of a farm from a social resilience perspective.

Measurement of horizontal specialisation dimension

Contrary to the case of vertical specialisation, horizontal specialisation characteristics are well established in the Community typology.

In the SEAMLESS farm typology (Andersen et al., 2007), a combination of specialisation and land use are applied to develop a dimension that is more related to environmental impacts (land use). While specialisation has been measured as the standard gross margins of different types of crops and livestock, land use is measured as the proportion of the agricultural area covered by

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specific types of crops. The combination matrix of these two dimensions is used to determine the farming activities and required inputs and outputs.

The CATCH-C farm typology (Hijbeek et al., 2014) has been adapted from SEAMLESS, and used specialisation and land use dimensions (without a combination matrix), as well as, ass agro-ecological zoning characteristics for the assessment of soil management and degradation issues in eight EU countries.

For the single country level studies, for example in the study of Cardillo et al., 2016 for Italy, the degree of specialisation has been measured by the Community typology, and classified farms according to the incidence of single production over total gross income. Farms having more than 2/3 of their standard output (monetary value of agricultural production at farm-gate price, calculated on the basis of the crop area and the number of livestock) depending on a single production are defined as 'specialised'.

SURE-Farm typology: horizontal specialisation dimension

In SURE-Farm farm typology, different than SEAMLESS farm typology, we choose to not use explicitly land use dimension. This is mainly due to the high number of combined results with already selected four structural characteristics. Potentially, with given four dimensions (5 farm size classifications, 3 managerial ownership classifications, 8 horizontal specialization classifications, and 3 farm intensity classifications) we will have 360 farm types. It is not feasible to involve an additional dimension that will increase the potential number of farm types. Especially this would create more conflicts for our relatively small case study regions.

In the SURE-Farm typology, we followed the specialisation variable that has been the basis of the well-established Community typology of farms used in FADN, as well as for FSS. The farm specialisation and land use dimensions have been combined with 8 different specialisation types (Table 6).

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Table 6: SURE-Farm typology: horizontal specialisation dimension with 8 main farm specialisation types.

	Farm specialisation types	The basis of principal types of farming
1	Field crops	Specialist cereals, oilseeds and protein crops General field cropping Mixed cropping
2	Horticulture	Specialist horticulture indoor Specialist horticulture outdoor Other horticulture
3	Wine	Specialist vineyards
4	Other permanent crops	Specialist fruit and citrus fruit Specialist olives Various permanent crops combined
5	Milk	Specialist dairying
6	Other grazing livestock	Specialist cattle – rearing and fattening Cattle – dairying, rearing and fattening combined Sheep, goats and other grazing livestock
7	Granivores	Specialist pigs Specialist poultry Various granivores combined
8	Mixed	Mixed livestock, mainly grazing livestock Mixed livestock, mainly granivores Field crops – grazing livestock combined Various crops and livestock combined

Note: *Classification depends on FADN definitions and reference to farm specialization variable. Details on sub divisions are provided in the Annex (Table A2).*

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7.1.4 Farm intensity

The literature on the economic, and especially ecological systems provides ample evidence that considering farm intensity is crucial to assessing the long-term sustainability of farms (Dietrich et al., 2012; Ruiz-Martinez et al., 2015; Lin 2011). During the last decades, agricultural sector developments have led farming systems to intensification and specialisation. Resilience of these systems is started to be questioned, especially of livestock production (ten Napel et al., 2011). The animal disease crises and their harmful effects on farm income, animal welfare, and the environment raises the problem of social acceptance of intensive farming systems (Lebacq et al., 2013). For the whole food supply chain (production, processing and distribution), a number of assessment tools are employed for economic, social and environmental sustainability such as Sustainability of Environmental functions of Farming Systems (FAO, 2013) and Eurostat Sustainable Development Indicators (Eurostat, 2015).

Measurement of farm intensity dimension

Regarding measurements and thresholds used to identify farm intensity, previous studies have provided indicators which change according to the research context and the study location (see Ruiz-Martinez et al., 2015, for a literature review on the indicators of agricultural intensity). As highlighted in Ruiz-Martinez et al., 2015, there are few thresholds which have been defined in the previous studies.

In the SEAMLESS typology, farm intensity measured as the total output in Euro per ha, and threshold values adjusted according to producer price indices (PPI) for total agricultural production in EU-15 to take into account the change in prices over time. Farms with no agricultural land are included as high intensity farms.

SURE-Farm typology: farm intensity dimension

For SURE-Farm farm typology, it is decided that to define a unified farm intensity indicator and a threshold level would not be adequate for all case study regions. In addition, this would not sufficiently enable cross-sectoral assessments. To overcome this drawback, as suggested by the study of Castoldi and Bechini, 2010, SURE-Farm farm typology construction take into account the expert point of view towards a **relevant farm intensity indicator** and related threshold levels (high, medium, low) in the region. Analytical steps of identification of farm intensity indicators by regional expert are detailed in Section 8.

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7.2 Socio-economic characteristics

Resilience thinking highlights the interdependencies between structural and socio-economic factors, both of which are essential to understand farming systems. While a farming system might demonstrate a high structural capability to cope with shocks through further intensification of production practices, socio-economic factors might make up another aspect of the resilience of the farms.

Socio-economic characteristics have been examined by a number of studies to show their importance in understanding persistence, adaptability, and transformability in resilience research (Walker et al., 2006). Some of these interventions include studies that show the relationship between social capital and community resilience (Aldrich and Meyer, 2015), social capital and ecological resilience (Adger, 2000), social capital and actors' behavior for institutional resilience (Daedlow et al., 2013), social capital and socio-agricultural resilience (Darnhofer et al., 2016).

Examples of socio-economic characteristics of farms includes age, education, gender, family type (single, married), family size (number of family members), sources of income, social participation, management skills, labour characteristics (permanent hired labour, temporary hired labour, labour intensity). These farm level indicators can partly be captured from FADN, FSS, and Labour Force Survey (LFS) with unified EU level key variables.

Recent understandings of socio-economic characteristics at the farm level additionally cover indicators such as communication skills, social learning capacity, mental models, and social networks (Folke, 2006) of farmers, which can be captured through in-depth interviews. Furthermore, assessing the agro-ecosystem resilience of farms with an index of behaviour-based indicators of social capacity for self-organisation, ecological self-regulation, and reflected and shared learning from past experiences has been discussed by Cabel and Oelofse, 2012.

As detailed in the recent EU-funded FLINT project on sustainability indicators, the social engagement of farmers (e.g., membership of farmers' association, voluntary associations, and professional organisations) and social diversification to improve the image of both farmers and agriculture in local communities (e.g., participation to open day events, fairs and exhibitions) (Kelly et al., 2016) could be included in examples related to the socio-economic characteristics of farms.

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7.3 Agro-ecological zoning

The agro-ecological zoning dimension captures the different environmental characteristics of farming systems including the current biophysical conditions of farms.

The FAO study on Sustainability Assessment of Food and Agriculture systems (SAFA) defines six main themes that help to assess the sustainability of environmental functions of farming systems (FAO, 2013):

1. Atmosphere: Greenhouse gases, Air quality

2. Water: Water withdrawal, Water quality

3. Land: Soil quality, Land degradation

4. Biodiversity: Ecosystem diversity, Spices diversity, Genetic diversity

5. Materials and Energy: Material use, Energy use, Waste reduction & Disposal

6. Animal Welfare: Animal health, Freedom from stress

SAFA indicators provide a harmonized sustainability approach for environmental integration. Through these indicators, nitrogen and soil organic matter (soil quality) is often used as the key indicator for modeling the resilience of farms (see the study of Van Appeldoorn et al., 2011 for dairy farms). Studies of Bennett et al. 2005, and Reijs et al. 2004, contribute to the literature by modeling the resilience of agroecosystems by providing measurements to be used to identify resilience measures.

The importance of the agro-ecological zoning dimension for the construction of farm typologies has previously been considered in several studies (Metzger et al., 2005; Andersen et al., 2007; Hazeu et al., 2011; Hijbeek et al., 2014). In the SEAMLESS project, for example, biophysical characteristics at the farm level are captured with climate zone, soil, land use, and topography aspects. For the climate zone aspect, administrative NUTS regions are divided into agri-environmental zones with homogenous soil characteristics. Constructed farm types (via FADN farm structure characteristics) are spatially allocated into defined agri-environmental zones. In the SEAMLESS project, the two main data-sets used to derive climate zones are the European soil database[1] and climate data from Monitoring Agriculture with Remote Sensing (MARS)[2].

[1] http://eusoils.jrc.ec.europa.eu/
[2] http://mars.jrc.ec.europa.eu/

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The Catch-C project has followed a similar approach with differences in the consideration of administrative NUTS levels and the selection of farm typology dimensions. In the Catch-C project, to assess the soil management practices at a farm level, agri-environmental zoning is defined within three agro-ecological zoning characteristics:

1. Climate: Derived from a previous study by Metzger et al., 2005, in which climate zoning divisions are based on differences in climate data, ocean influence and geographical position in Europe, with 13 different zones (Alpine North, Boreal, Nemoral, Atlantic North, Alpine South, Continental, Atlantic Central, Pannonian, Lusitanian, Anatolian, Mediterranean Mountains, Mediterranean North, and Mediterranean South).

2. Soil texture: Derived from the European Soil database (which provides homogeneous data on soil texture with percentages of sand and clay fractions in the soil) and includes comparisons of soil texture data across study regions.

3. Slope: Derived from a previous study by Klijn et al.,2005, in which Digital Elevation Models (DEM) are used to estimate 5 different slope classes, which are defined by altitude differences (from 0% to >14% slope in percentage).

In the SURE-Farm farm typology, agro-ecological zoning dimensions are based on typical regional characteristics (instead of processes) that will be captured through expert interviews (Section 8).

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7.4 Institutional and cultural embedding

Institutional embedding

Institutions have an important influenc on individual behavior, risk perception and expectations regarding the availability of future resources (Eakin et al., 2016). As suggested by Ostam, 1996, to understand how institutions influence the behavior of individuals and groups, one must address those attributes of a system that affect how rules are implemented, how they evolve and what implications they have on social interactions. Following that perspective, institutional characteristics have been examined by a number of studies, which aim to give insights on their importance for understanding resilience in farming systems with different approaches. The illustrative articles and their study approaches are listed in Table 7.

Table 7: Examples of resilience research with institutional economics framework

Authors	Approach
Olsson et al., 2006	Assessment of transformability of socio-economic systems with case studies
Anderies, et al., 2006	Assessment of resilience implications of current institutional arrangements
Gupta et al., 2010[3]	Assessment of the characteristics of institutions to enable adaptive capacity of society
Deadlow et al., 2013	Integration of new institutional economics and resilience thinking with analytical approach
Lebel et al., 2006[4]	Relationship between governance and the ability to manage resilience with analyses of governance system attributes
Eakin et al., 2016	Assessment of the institutional influences on the adaptive capacity of farms with farm level data and interviews.

Source: own compilation

Of the major approaches outlined in Table 7, the studies by Lebel et al., 2006, and Gupta et al., 2010 typically represent the literature on assessing the role of institutions' capacity to affect actors in society.

[3] The main study question is "*How can the inherent characteristics of institutions to stimulate the capacity of society to adapt changes (climate change) be assessed?*" On the basis of the literature, the authors present six dimensions (variety, learning capacity, room for autonomous change, leadership, availability of resources and fair governance) that help to quantify the effect of institutions on the adaptive capacity of society.

[4] The main study question is "*How do certain attributes of governance function in society to enhance the capacity to manage resilience?*" The relationship between governance and its ability to manage resilience has been analysed via three main governance system attributes of (1) public participation and deliberation, (2) polycentricism and multilayeredness, and (3) accountability and social justice.

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Cultural embedding

Cultural embedding of farming systems address the capacity of farms to cope with cultural and social responsibilities and duties towards multiple actors, such as employees, suppliers, consumers, communities and society.

Examples of **indicators for the cultural embedding of farming systems** include rural communities' perception of the presence and quality of services provided, acceptance of farming practices and consumer expectations towards cultural and ethical aspects.

In the FLINT project, defined **indicators that asses the effect of social inclusion** in rural areas covers variables such as jobs created in supported projects, share of rural population covered by Local Action Groups (LAG) funded through the Rural Development Programme (RDP), rural population benefiting from improved services/ infrastructures supported under the RDP, jobs created in supported projects (LEADER), and rural population benefiting from new or improved services/infrastructures (ICT).

Impact of cultural and social issues in agricultural supply chains could also capture with subjective and qualitative base indicators of farmer's sense of ownership, perception of empowerment, perception of community feeling, trust, increase in bargaining power, perception of improvement in relationships between workers and management (Sala et al., 2015; Lemeilleur and Vagneron 2010).

Considering the capacity of farms to cope with responsibilities towards their community and society, Corporate Social Responsibility (CSR) models function as a self-regulatory mechanism and ensure to achieve the ethical standards, and norms. The literature on CSR has shown that it is very hard to demonstrate any significant positive correlation between social performance and economic performance (Walsh et al., 2003). Therefore, in the previous studies (Piñeiro and Romero-Castro, 2011; Harwood, et. al, 2011), CSR and resilience are considered as complementary tools to build a new type of firm that is oriented to the creation of sustainable value.

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7.5 Embedding in the value chain

Embedding in the value chain through vertical integration allows a farm to control the entire production process with varies relations where farmer-processor integration at one extreme and spot markets at the other extreme (Sexton and Lavoie, 2001). For the vertical integration possibilities, agriculture sector is relatively unique among other sectors in that governments often permit and/or encourage farmers to form selling coalitions or cartels (Sexton and Lavoie, 2001). Embedding in the value chain within various forms of coalitions or cartels could bring low cost, but the drawback of this control could be the loss of flexibility and resilience. Previous studies provide mixed results on how the degree of agricultural value chain integration influences the resilience of farms. This is partly due to the vertical integration analyses are highly sensitive to the used measures (Maddigan and Zaima, 1985). Table 8 listed illustrative studies on the measurements of vertical specialization.

Table 8: Measurements of vertical integration in the previous studies

Authors	Measurement of vertical specialization
Wojtaszek, 1980	Share of one activity in potentially commercial production: >60% for highly specialized farm; 40-60% for one activity oriented farm; <40-60% diversified farms with one leading activity ;<30% for diversified farms.
Pacini et al., 2010	% of final price received by the farmer at farm-gate.
Was and Sulewski, 2011	Concentration index of sales structure depending on the production orientation and economic size of farms.
Cardillo et al., 2016	Dummy variable: whether or not a group of farms that sells all or part of their products directly to the industry.

***Source:** own compilation*

Agricultural value chain integration refers to a range of goods and services needed for an agricultural product to move from the farm to the consumers. Examples to the forms of agricultural value chain integration could divide into two management strategies (Wong 2016): (1) **Supply chain management**: provide economic support to various levels in the agricultural value chain such as (i) to support economic activities (e.g., income, employment), (ii) to support services (e.g., machinery, logistics, marketing), and (iii) to support internal providers (e.g., infrastructure, finance, human resource development, regulatory environment, new information and communication technology); (2) **Investment management**: supporting investments in the (i) upstream (e.g., research and development, certified seeds, high-value

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varieties, farming systems), (ii) midstream (e.g., processing, high value end uses), and (iii) downstream (e.g., packaging, food safety, branding, targeted markets) economic activities in the agricultural value chain.

The **importance of agricultural value chain integration** for the resilience assessment both at farm and farming system levels could find from previous literature. A recent study in Italy (Cardillo el al., 2016) on the effects of a vertical integration (measures as a group of farms that sell all or part of their products directly to the industry) in the Italian durum wheat supply chain, for pasta production showed that vertical integration increases farms' competiveness and profitability. In East European farms -where transition has been associated with emergence of significant number of small holdings- agricultural value chain integration propose as a strategy for resilience of small farms in order to not let them excluded from modern market chains (Csaki et al., 2008). A case study realized by Bachev, 2017 on organic dairy sheep farming in Bulgaria gives that vertical integration and modernization brought a positive economic sustainability effect. Study of Pieniadz et al., 2007 investigate on the determinant of flexibility in the Polish farms during transition. Authors' results gave that milk farms specialized in capital intensive technologies turned out to be less flexible.

Contracting is another most observed form of vertical control on agricultural production process, and includes farmer's motivation of incentive alignment, risk sharing (e.g., for price risks, and price enhancement see Musser and Patrick, 2002), market power and efficiency gains. An OECD survey on the role of contacting in agriculture highlights that agricultural contract could slow down reaction to market signals and can provide more rigid commercial relationship (Vavra, 2009). Several findings indicate that agricultural contracts may help small farms to access to markets (see Vavra, 2009 for the literature review).

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8 To integrate farm level dimensions to the farming system level dimensions

To integrate farm level dimensions (structural characteristics) to the farming system level dimensions (socio-economic and agro-ecological zoning characteristics; institutional and cultural embedding, and value chain integration), four analytical steps are included in the expert interviews:

Aim I: Construction of farm typology in the case study region (Figure 4):

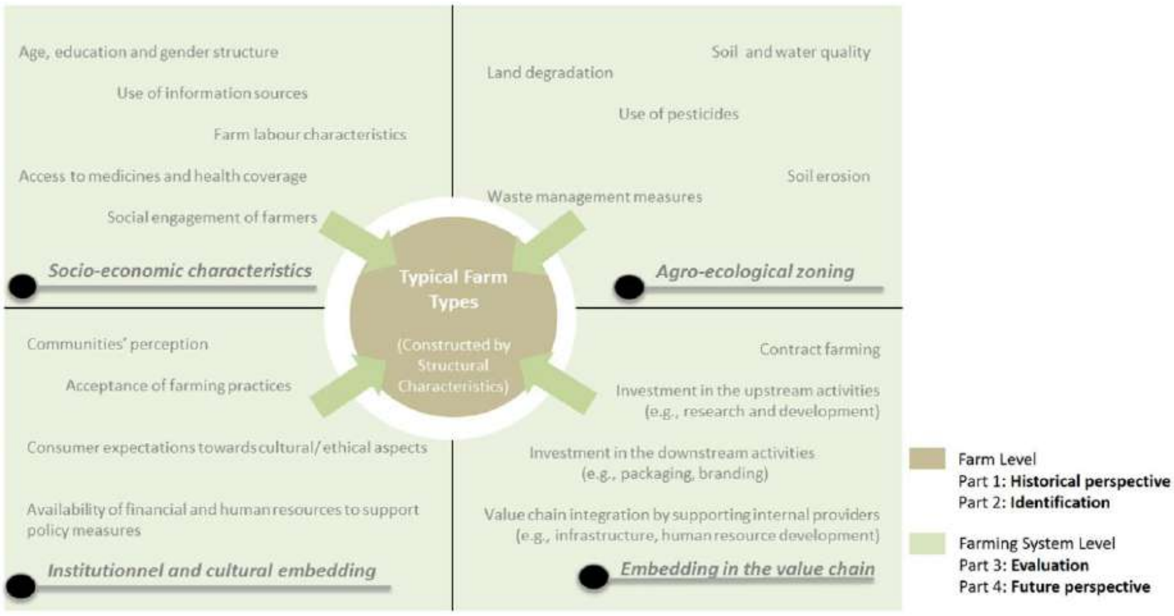
Part 1: Historical perspective: an assessment of the evolution of farm structure characteristics by size, managerial ownership, and specialization over the last 20-30 years.

Part 2: Identification of farm types: an identification of typical farm types by structural characteristics, and relevant farm intensity indicators for the study region.

Part 3: Evaluation: an evaluation of the importance of four farming system level dimensions for the resilience of typical farm types.

Part 4: Future perspective: an assessment of the evolution of typical farm types with respect to future challenges.

Figure 4: Aim I: construction of farm typology in the case study region



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The last part of the survey focuses on the selected farming system in case study region, and aims to identify stakeholders and functions of farming system with local experts.

Aim II: Identification of stakeholders and functions of farming system

Part 5: Identification of farming system: an identification of stakeholders and functions of selected farming system in case study region.

The main objective of the questionnaire is to construct a farm typology and to identify farming system with expert knowledge for 11 SURE-Farm project case study regions.

Overall, the questionnaire consists of five parts. The first and the second part of the questionnaire aim to classify case study region farms in groups that are homogeneous and representative regarding to farm size, managerial ownership, and specialization. These groups defined by expert knowledge are entitled "typical farm types". The third and the fourth part of the survey aim to search for the importance of socio-economic and agro-ecological zoning characteristics, institutional and cultural aspects, and value chain integration dimensions of farms, in order to understand the resilience of "typical farm types". The last part of the survey focuses on the selected farming system in case study region, and aims to identify stakeholders and functions of farming system with local experts.

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8.1 Expert interviews: procedure

Geographic focus: For each partner country in the SURE-Farm project, a survey will be done both for your selected case study region (Parts 1, 2, 3, and 4), and selected farming system (Part 5). The first four parts of the survey focuses on the case study region -not on the selected farming system in the case study region-. We would like to know a general description of the typical farm types in each case study region. For example, in German case study survey, we did not focus on the selected farming system of "large scale corporate arable farming", but we focused on our regions' most "typical farm types". The fifth part of the survey focuses on the selected farming system in the case study region.

Timing: For each case study partner, one interview (2 to 2, 5 hours) should be held with one or more experts who has/have knowledge on farm types and the farming systems in the study region.

Selection of regional expert: We leave the decision on regional expert selection to the case study leaders. Selected expert(s) should have/has a capacity to classify case study region farms in groups that are homogeneous, characteristic and representative regarding to farm structural characteristics, as well as a capacity to identify stakeholders and functions of selected farming system. To discuss with a knowledgeable expert in your own institute could be also an option. For Germany case study survey, we interviewed head officer at the Agriculture, Land Consolidation and Forestry of Altmark region. For example, experts from National Farmers' Union or agricultural advisory bodies can be relevant.

- Please follow the questionnaire by the order of the five parts and translate the questions to your own language. If possible, share the questionnaire with an expert before the interview.
- Please introduce yourself, the main objectives of SURE-Farm project, and provide a definition of the resilience concept and farm typology approach before the interview.
- Each case study region interview results will tabulate according to five analytical parts of the survey by IAMO, and will be used as an input to D 3.1 Report on current farm demographics and trends for selected regions.

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8.2 Expert interviews: questionnaire

GUIDING QUESTIONNAIRE

Questionnaire with description of the terms used, and examples

SURE-Farm project, WP 1[5]

Objective: Construction of farm typology in the case study region (Part 1, 2, 3, and 4) and identification of stakeholders and functions of farming system (Part 5) with expert knowledge.

General Information:

Date:
Country:
Case study region:
Name of interviewer:
Institute of interviewer:
Name of interviewee:
Organisation/ Institute of interviewee:

[5] D 1.3 covers Germany (Altmark) case study region interview results as an example (section 9.2). Other selected SURE-Farm project 10 case study region interview results will be used as an input to WP 3- D 3.1 Report on current farm demographics and trends for selected regions.

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PART 1: Historical perspective

Part 1: Historical perspective: an assessment of the evolution of farm structure characteristics by size, managerial ownership, and specialization over the last 20-30 years.

Q1. Can you describe the evolution of the farming sector over the last 20-30 years in terms of farm size (very small, small, medium, large, very large), managerial ownership (family farms, partnership farms, cooperate farms), specialization (field crops, horticulture, wine, other permanent crops, milk, other grazing livestock, granivores, and mixed farms)?

(Size, ownership, and specialization classifications (bases on FADN) are provided in Table A1 and A2. If the respondent would have a difficulty to respect the given FADN classifications, or these classifications would not fit to the case study region characteristics, please construct the appropriate classifications bases on respondent (or interviewer) thresholds and provide us the constructed classifications with interview results).

PART 2: Identification of farm types

Part 2: Identification of typical farm types: an identification of typical farm types by structural characteristics (size, managerial ownership, specialization), and relevant farm intensity indicators for the study region.

Q2a. Identification of typical farm types: Please specify the most important some 3 to 10 farm types of your region according to dimensions of size, managerial ownership, and specialization.

(Please be aware that typical is not just addressing the numbers of farms but also a farm type's share in production or land use. Examples of identification of typical farm types are provided in Table A3, and an example photo from Germany case study interview given as Photo A1.)

Q2b. Identification of relevant farm intensity indicator: Which potential indicator (and threshold levels of high, medium, and low) is relevant to study the farm intensity in the region? Could you please provide information on the farm intensity characteristics of typical farm types?

(It is necessary to take into account the expert opinion towards a relevant farm intensity indicator and related threshold levels (high, medium, low) in the region. This question aims to let the respondent to identify the intensity level of farm types in the region, and to understand which intensity indicator the respondent is using to give his opinion on the intensity level of farm types.)

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PART 3: Evaluation

Part 3: Evaluation: an evaluation in terms of robustness, adaptability and transformability. Interviewer should present resilience concept (Table A6) to the respondent, and to be specific about the function(s) addressed.

Q3a. Identification of important characteristics in four dimensions: What is the importance of socio-economic characteristics, agro-ecological zoning, institutional and cultural aspects, and value chain integration aspects for the resilience of typical farm types in the region?

(If respondent has a difficulty to classify important characteristics under the division of four dimensions, interviewer may show the example Table A4).

Q3b. Evaluation in terms of robustness, adaptability and transformability: In which way defined important characteristics (defined in Q3a) play a contributing or partial role in terms of robustness, adaptability and transformability of typical farm types in the region?

(Example table for evaluation steps is provided in Table A5).

PART 4: Future perspective

Part 4: Future perspective: an assessment of the evolution of typical farm types (in terms of robustness, adaptability and transformability) with respect to future challenges.

Q4a. Identification of future challenges: What are the future economic, social, environmental, and institutional challenges in the region?

(Examples of challenges provided in Table A7)

Q4b. Assessment in terms of robustness, adaptability and transformability: What are the effects of defined future challenges (defined in Q4a) in terms of robustness, adaptability and transformability of typical farm types in the region?

(Example table for assessment is provided in Table A8).

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PART 5: Identification of farming system

Part 5: Identification of farming system: an identification of stakeholders and functions of selected farming system in case study region. Different than previous four parts of the survey, this part focuses on the selected farming system in case study region. For example, for this part, in Germany interview, respondent need to address the following two questions within the scope of selected farming system of "large scale corporate arable farming". Other farms should be incorporated in case of close cooperation (e.g., land sharing, manure buying etc.).

Q5a. Identification of main stakeholders: What are the main stakeholders in the selected farming system in case study region? For which of these stakeholders there is strong mutual dependence? (Actors influence farms, and conversely, farms also influence these actors)?

(Figure A1 provides the definition of a farming system. Please fill Table A9 with respondent).

Q5b. Identification of functions in terms of public and private goods: If you have to characterize the selected farming system, what do you consider to be key functions? Which key functions are valued by stakeholders? Which of these key functions shape the identity of the farming system? Which functions need to change in order to consider the farming system to be transformed?

(Example on the functions of farming systems in terms of public and private goods are provided in Table A10).

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9 Implications for Altmark (Germany) case study region

9.1 Quantitative approach: FADN results for the Altmark (Germany) region

For Germany, the selected case study region of Altmark is located in the Saxony-Anhalt Federal State, and captures important features of the large-scale agricultural structures of East German agriculture. By using FADN 2013, the result of the application of the farm size, managerial ownership, and horizontal specialisation dimensions of the SURE-Farm typology is shown in Table 9,10,and 11 according to number of farms, share of land, and total utilised agricultural area respectively. The current typology for the Altmark region does not yet capture intensity levels. These need to be adjusted by considering regional characteristics and require further research.

Table 9: Altmark case study region: number of farms according to the farm size, managerial ownership, and horizontal specialisation dimensions

Horizontal Specialisation Types	All Sample				Managerial Ownership Dimension by Four Farm Size Types											
					Family Farms				Partnership Farms				Corporate Farms			
	S	M	L	VL	S	M	L	VL	S	M	L	VL	S	M	L	VL
Field crops	3	19	12	4	3	17	7			2	4	2			1	2
Milk			12	10			6	1			6	1				8
Other grazing livestock		6	1	1		6					1					1
Granivores				2												2
Mixed	1	5	5	13	1	3	3			1	2			1		13
All Specialisation Types	4	30	30	30	4	26	16	1		3	13	3		1	1	26

Source: FADN, 2013

Note: For the farm size dimensions used abbreviations are: S: small; M: medium, L: large, and VL: very large farms. Very small farms (VS) are not considered. Three horizontal specialisation types of horticulture, wine, and other permanent crops are eliminated due to non-available results.

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Table 10: Altmark case study region: share of land (%) according to the farm size, managerial ownership, and horizontal specialisation dimensions. (The percentage values given for each specialization type)

					Managerial Ownership Dimension by Four Farm Size Types											
Horizontal Specialisation Types	**All Sample**				**Family Farms**				**Partnership Farms**				**Corporate Farms**			
	S	**M**	**L**	**VL**	**S**	**M**	**L**	**VL**	**S**	**M**	**L**	**VL**	**S**	**M**	**L**	**VL**
Field crops	1,1%	19,7%	49,8%	29,3%	1,1%	16,3%	29,3%			3,5%	12,8%	2,9%			7,6%	26,5%
Milk			16,7%	83,3%			7,7%	4,6%			9,0%	6,0%				72,8%
Other grazing livestock		43,5%	6,8%	49,8%		43,5%					6,8%					49,8%
Granivores				100,0%												100,0%
Mixed	0,2%	3,6%	5,6%	90,5%	0,2%	1,6%	2,7%			1,3%	3,0%			0,7%		90,5%
All Specialisation Types	1,2%	26,5%	72,4%		1,2%	21,4%	42,6%	0,0%		5,0%	18,7%				11,1%	

Source: FADN, 2013

***Note:** For the farm size dimensions used abbreviations are: S: small; M: medium, L: large, and VL: very large farms. Very small farms (VS) are not considered. Three horizontal specialisation types of horticulture, wine, and other permanent crops are eliminated due to non-available results.*

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Table 11: Altmark case study region: Total Utilised Agricultural Area (ha) according to the farm size, managerial ownership, and horizontal specialisation dimensions

Horizontal Specialisation Types	All Sample				Managerial Ownership Dimension by Four Farm Size Types											
					Family Farms				Partnership Farms				Corporate Farms			
	S	M	L	VL	S	M	L	VL	S	M	L	VL	S	M	L	VL
Field crops	120	2114	5342	3147	120	1743	3146			371	1377	308			819	2839
Milk			2252	11248			1042	618			1210	805				9825
Other grazing livestock		1349	211	1545		1349					211					1545
Granivores				1139												1139
Mixed	44	814	1258	20231	44	348	598			299	660			167		20231
All Sample	164	4277	9062	37309	164	3440	4785	618		670	3458	1113		167	819	35578

Source: FADN, 2013
Note: For the farm size dimensions used abbreviations are: S: small; M: medium, L: large, and VL: very large farms. Very small farms (VS) are not considered. Three horizontal specialisation types of horticulture, wine, and other permanent crops are eliminated due to non-available results.

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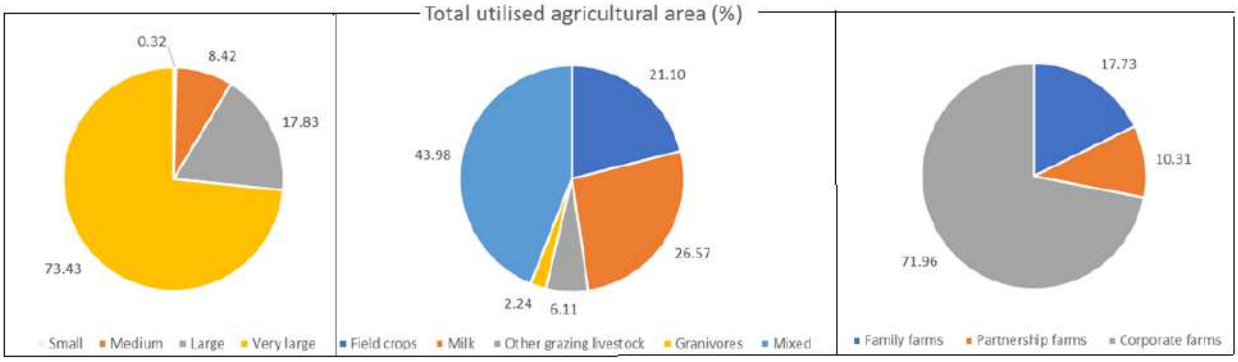
9.2 Overview: distribution of farm types in the Altmark (Germany) region

The distribution of farm types in the Altmark region (based on FADN calculations) gives an overview of the typical farm size, specialisation, and ownership structure in the region.

Farm size

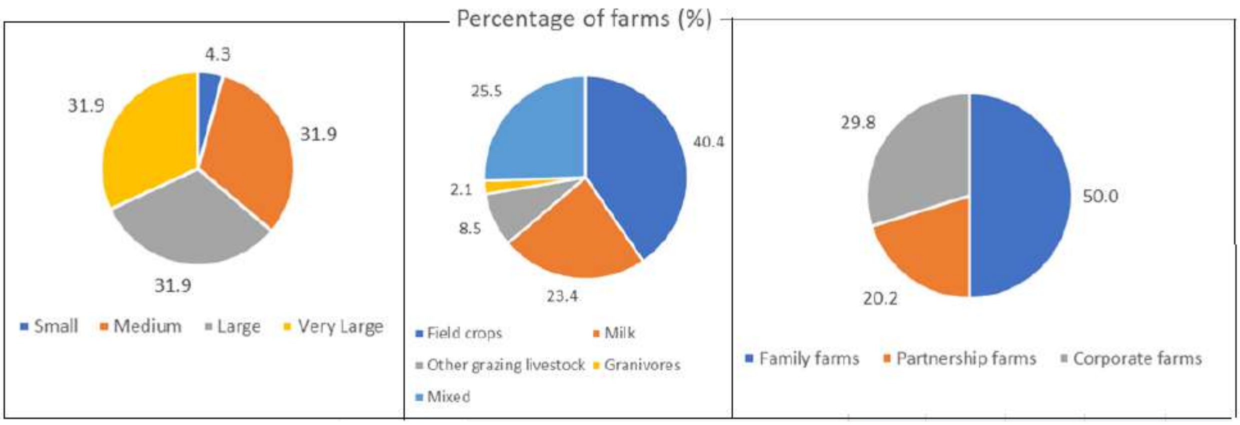
In the region, very large farms represent around 30% of farms and manage approximately 70% of the UAA (Figure 5, 6). However, large-scale farms represent around 30% of farms but manage approximately 17% of the UAA. Consequently, medium size farms account for 30% of farms but manage a very small area (8,4% of UAA) relative to large and very large farms.

Figure 5: Distribution of farm types -the share of farms by Utilised Agricultural Area (UAA)-



Source: FADN, 2013

Figure 6: Distribution of farm types -the share of number of farms-



Source: FADN, 2013

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Farm specialisation

Field crop farms have the highest share in terms of number of farms in the region, but only manage 21% of UAA. Mixed farms cover around half of the region (43, 9%), and make up the most dominant specialisation in the region in terms of UAA. Milk farms also manage a large share of UAA (26%), and represent around 23% of farms.

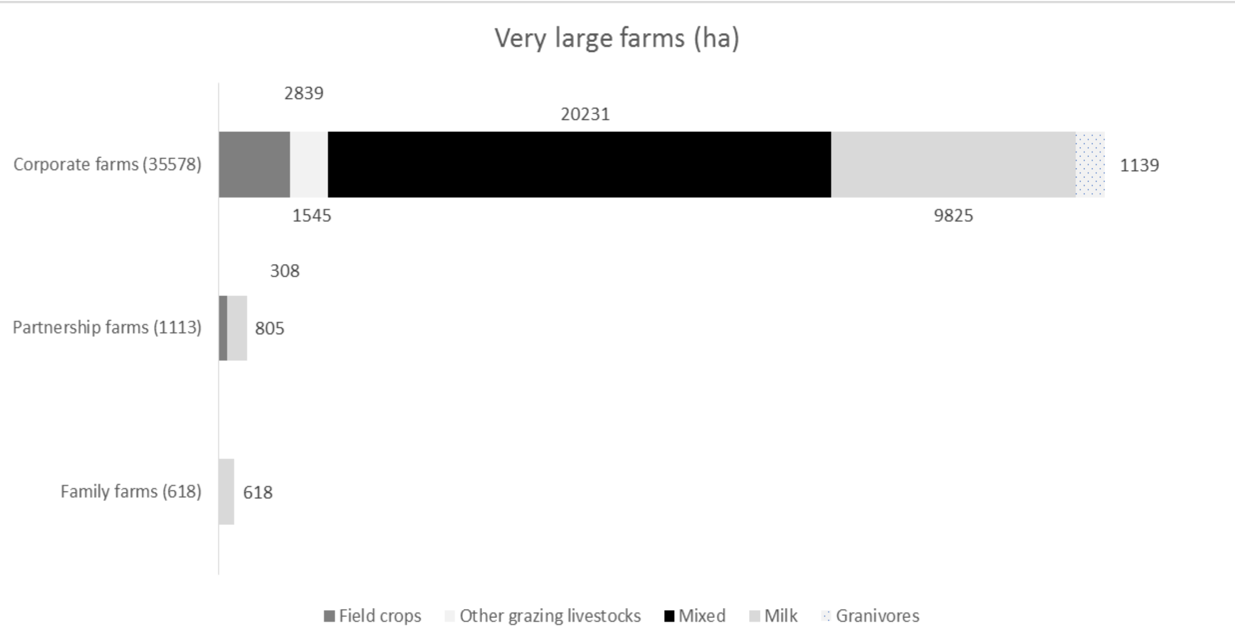
Managerial ownership

The most important ownership structure in terms of UAA is corporate farms (Figure 5): they represent 29% of all farms in the region (Figure 6). Regarding the number of farms, family farms are the most important ownership structure: half of the farms in the region run as family farms, but these farms manage 17% of UAA. Partnership farms represent 20% of farms in the region, and manage only 10% of UAA.

Very large farms

In Figure 7, the distribution of farm specialisation and ownership structure on very large farms in terms of UAA are shown. For very large farms, the most important ownership structure is corporate farms, which are mainly specialised as mixed (20231 ha), and milk farms (9825 ha).

Figure 7: Distribution of farm types with specialisation and ownership for very large farms



Source: *FADN, 2013*

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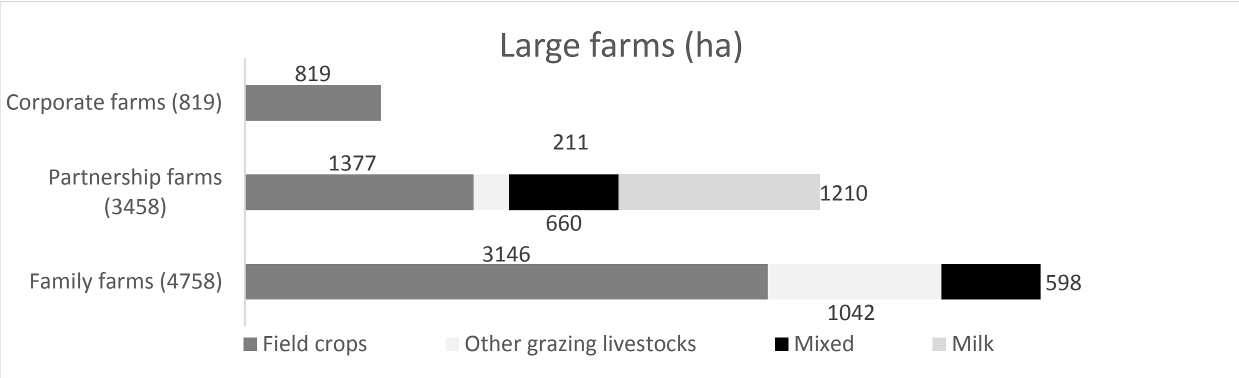
Large farms

Figure 8 shows the distribution of farm specialisation and ownership structure on large farms in terms of UAA. For large farms, the most important ownership structure is family farms (4758 ha), mainly specialised in field crops (3146 ha). Partnership farms are the second most important ownership structure among large farms (3458 ha), with a high amount of UAA for field crops (1377ha), and milk production (1210ha).

Figure 8: Distribution of farm types with specialisation and ownership for large farms

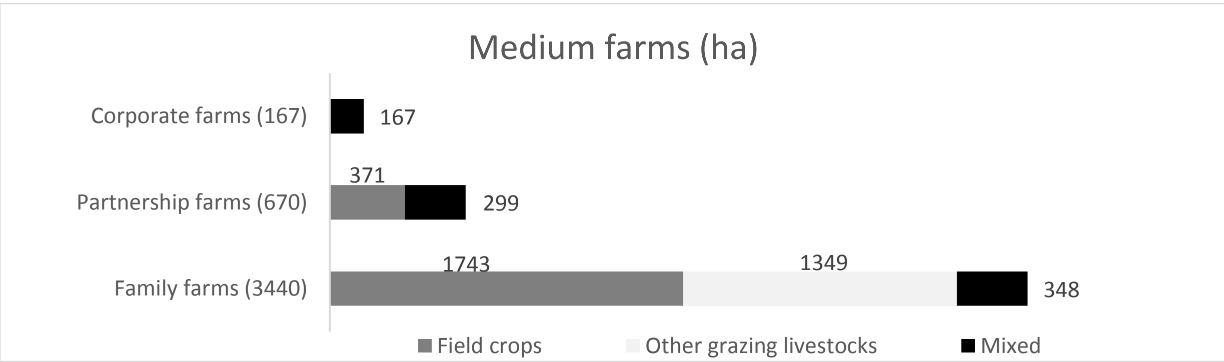


Source: FADN, 2013

Medium farms

Similar to large farms, for medium farms, the most important ownership structure is family farms (3440 ha) (Figure 9). Partnership and corporate farms manage a lower UAA relative to family farms.

Figure 9: Distribution of farm types with specialisation and ownership for medium farms



Source: FADN, 2013

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9.2 Qualitative approach: expert interview results for the Altmark (Germany) region

General Information

Date: 02.02.2018 (face to face interview) and 23.03.2018 (phone interview) **Country:** Germany **Case study region:** Altmark **Name of interviewer**: Franziska Appel and Ilkay Unay-Gailhard **Institute of interviewer**: Leibniz Institute of Agricultural Development in Transition Economies (IAMO) **Name of interviewee**: Horst Blum **Organisation of interviewee**: ALFF Altmark (Amt für Landwirtschaft, Flurneuordnung und Forsten Altmark)

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Part 1: Historical Evolution

Farm Size:

- An increasing number of medium and large farms (especially medium farms). Slightly increasing number of large and very large farms. A decreasing number of small farms.
- **A special case for small dairy farms during the milk crises period**: small dairy family farms were unstable relative to large farms (over 1000 cows) in terms of the management aspect. This doesn´t mean that large dairy farms were highly resilient during the milk crisis: they had some advantages dealing with fluctuating milk prices. Some small dairy farms exited the market and transformed their farms into crop production. Additionally, generational renewal problems of farms played a role in decreasing the number of small dairy farms (not only the owners but also their children recognised that the dairy business is very risky).
- **A special case for large farms**: there is an increasing farm size due to specific land market behavior of new investors. Investors prefer to buy several farms at the same time and to establish a farm association (or holding). It is difficult to capture this trend with existing data.

Managerial Ownership:

- **Several family farms disappeared after unification**: as in other regions in Germany, a lot of profit-based investors (with limited agricultural knowledge) started to invest in farm businesses after unification. However, this trend disappeared over the years.
- **Milk crises had a negative impact on family milk farms**: Around 60% of dairy family farms had a relatively favorable operating account and did not exit the market. Their success relied on specialisation in one of two productions: milk and crop production.
- **Currently, there is a growth of milk family farms** (about 400 cows): these farms are professional and stable.
- **An increasing number of changes in terms of managerial ownership**: this true especially for large farms.
- Cooperative farms are decreasing; legal persons like GmbH´s are increasing

Farm specialization:

- Establishment of biogas plants (mainly by large milk farms) is the biggest production change in the last 20-30 years.
- No significant specialisation towards new production fields. It is mostly field crop farms and milk farms.
- **A growing interest in organic food:** increasing numbers in organic egg production by new investors.
- **Fast development in crop production**: an increase of corn fields because of the biogas plants.

Farm intensity:

- Farm intensity levels have increased both in the field crop and milk farms after unification.

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Part 2: identification

Typical Farm Types (TFP):

- TFT1: 300-350 ha + Family farms + Arable land (Field crop farms)
- TFT2: > 1000 ha + Corporate farms + Arable land (Field crop farms)
- TFT3: < 800 ha + Corporate farms + Arable land (Field crop farms)
- TFT4: 200-400 ha + Family partnership (GbR) + Milk farms (around or less than 300 cows) and Arable land (Field crop farms)
- TFT5: > 1000 ha + Corporate farms + Milk farms (>1000 cows) and Arable land (Field crop farms) (mainly these farms are establishing biogas plants)

Non-typical farm types:

- Farm specialization on poultry, pig production and horticultural farms are not typical in the region (only a very low number).
- Horticultural farms: There is a decreasing tendency on the horizontal specialization (one cooperative business with around 800 ha combined production of poultry, and crops).
- Pig farms: mostly owned by corporate farms (there are less than 10 farms with 800-1000 pigs). Around 3 pig farms are cooperative units with less than 400 pigs.
- Poultry sector: exists as a side effect of other farm specialisations.

Relevant farm size indicator:

- Typical farm size (not average) is about 270-300 ha, and this number is slightly bigger for field crop farms.
- Relevant farm size indicator is not the number of employees.

Relevant farm intensity indicator:

- Land rent price (this data providing by administrative district in regular base each year)

Farm intensity characteristics of typical farm types:

- An increase in farm intensity levels due to high farm land rent prices.

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Part 3a: Evaluation - Identification of important characteristics in four dimensions

Socio-economic characteristics:

- **Lack of skilled/educated workers**: for all field crop farms, access to skilled and well-educated workers is becoming more and more problematic both for family and corporate farms. However, some family farms and a few cooperative farms have some advantages, especially access to local labour, relative to corporate farms (this is due to the deep connectedness of family and cooperative farms to the region). For milk farms, the lack of skilled/educated workers problem is different than for crop field farms. Due to the importance of financial support for acquiring technical equipment (e.g., milking and feeding), corporate dairy farms compensate the lack of skilled workers problem by using more technological tools. There is a low level of salary payments to workers at large corporate dairy farms (TFT2 and 5). These farms can attract more skilled workers if they increase the salary level.
- **Generational renewal problem**: difficult to find a replacement for retiring managers (especially at cooperative farms with 800 to 1000 ha).

Agro-ecological zoning:

- **Water pollution:** an increase in farm intensity levels (in all typical farm types) created a water pollution problem.
- **Unequally distributed water canals** limit to access to clean water: many water canals are from pre-unification time, and owned by corporate farms. This kind of ownership structure increases the difficulty for farms which are dependent on artificial irrigation.
- **Sandy soils:** half of the region has sandy soils, but this characteristic is not a current problem
- **Clay-rich soils:** half of the region has clay-rich soils and this characteristic creates a problem for farmers.

Institutional and Cultural embedding:

- **Protests towards intensive pig farms**: the region experienced protests against large pig farms (mainly for Straathof Holding owned farms). This has negatively influenced the investment plans in the region, and many pig farms exit the market. For milk farms, the region has seen minor protests. This is because milk farms in the region are very well integrated with the rural population via good communication, and large scale successfully implemented projects.
- **Odor pollution**: in some locations, odor pollution from biogas plants created a negative perception in the society. Therefore, more and more biogas plants are currently being established outside of the villages.
- **A weak internet connection**: a general problem for the infrastructure of all types of farms.

Embedding in the value chain:

- **Weak values chain integration for organic farms**.
- **Typical chain integration for poultry and pig farms**.
- **Stabilised level vertical chain integration for field crop farms**: especially bio potato producing farms (not conventional) reached a much more stable level in the vertical chain integration.
- **Problems with milk marketing:** the majority of milk farms (regardless of farm size) are marketing their milk to large dairy factories. Only very small group of farms are working collaboratively and try to avoid marketing their local milk to large dairy factories. This established trend influences milk prices in a negative way.

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Part 3b: Evaluation- Evaluation in terms of robustness, adaptability and transformability

Socio-economic characteristics:

- **Lack of skilled/educated workers**: access to educated labour is very important for corporate dairy farms. For large dairy farms, use of machines without the proper number of educated workers may create a challenge in terms of keeping up a stable amount of milk production.
- **Generational renewal problem** may increase the involvement of external investors to the region in the future. Cooperative farms could transform into a holding structure -which brings its own employees for management-.

Agro-ecological zoning:

- **Unequally distributed water canals**: currently, large crop field farms already have good access to water canals that were built in GDR-times. These farms have advantages in transforming their water systems relative to farms that were established after unification. An interesting question is "*Whether the Altmark region (flat and characterized by drainage, trench system) could manage to establish centralised water reservoirs?*" This is important for unexpected droughts. Farms are flexible for such a transformation. However, government payments should compensate farms that are willing to invest in such technologies.
- **Climate change:** crop field farms may switch to the production of plants that have higher dry resistances. However, this kind of transformation has difficulties (e.g., market adaptation, and yield security). With the new EU regulations, it is no longer possible to use plant protection products on the grassland. This challenges our vegetable producers. In this aspect, there is not any difference between the farm types in terms of the adaptability of new cultures.

Institutional and Cultural embedding:

- **New fertilizer and plant protection laws:** these regulations brought about problems with the use of fertilizers and plant protection. A successful adaptability of farms depends on the acquisition of new technologies (e.g., georeferenced fertilizer spreading machines). These regulations could be a big challenge for farms that are producing very high quality wheat.
- **Cultural aspects do not carry any potential future challenges** because milk and field crop farms are not in societal focus.

Embedding in the value chain:

- Farms in the Altmark mainly produce standard productions: the question is "*Whether the Altmark will lose its competitiveness against other regions that are specialised in the label products (e.g., hay milk or pasture milk) that have a higher demand potential?*"
- **Farms in the Altmark do not have a potential to specialise in label products**: transformation to organic milk production is more realistic (only small farms have converted to organic farming until now). Hay production is very difficult and pasture grazing is not possible with typical dry summer seasons.

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Part 4a and b: Future Perspective

Social challenges:

- **Lack of skilled/educated workers**: newly established highways may allow for a rising number of big companies, and increasing labour problems. Family farms that are dependent on external labour could experience increased difficulties accessing both skilled and non-skilled workers. Medium-sized corporate farms (800-1000 ha) may exit the market as a reaction to struggling with succession.
- **Challenges with lack of managerial-level labour:** technological development may compensate challenges with lack of on-farm labour but not managerial-level labour. Agro holdings have some advantages in this respect; due to their management structure, they do not depend strongly on the local labour market.

Environmental challenges:

- **Rainfall:** more rainfall and milder temperatures in the winter period is expected by experts. Farmers have already experienced that trend year by year. In the future -depending on the rainfall distribution- more rainfall could influence milk farms' grassland areas. Milk farms might benefit from increased rainfall in terms of higher silage production.
- **Extreme dry weather:** more extreme dry periods in the summer period are expected by experts. However, against those predictions, last year, we had a rainfall during the harvest time that created a problem for the field crop farms.

Institutional challenges:

- **New fertilizer regulations** (currently under discussion at the EU-level) couldn't create a negative effect on the region. Typical farms in the region do not have a very high farm intensity levels, and they are not highly dependent on nutrients.
- **Challenges towards emission standards and animal welfare regulations:** these developments need careful consideration on farms.
- **Low payments at EU level**: large milk farms may suffer from lower level payments. A decrease in the payment level will negatively influence labour issues. This is especially true for large farms. Low-level payments may lead to large farms exiting the market. As opposed to small farms, large farms are heavily dependent on an educated and skilled labour force.
- **Highly volatile market conditions for dairy farms:** fluctuation in milk prices (around 10-15%) is not a big problem, neither for family farms nor for other farms. However, an increase in the number of huge regressions (which the region experienced two times in the last years) is a big threat. Large farms (both family and corporate) with biogas plants could compensate for low milk prices, and help keep their advantages compared to small farms.
- **Internet access problem**: we expect that connection speed will increase. Currently, farmers without internet access are appealing to us (we have an administration union who is dealing with digital infrastructure and broadband expansion), or asking their neighbors who have a better connection. Due to lack of financial support, initial plans have not been completed yet.

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PART 5a: Identification of farming system with main actors		
MAIN ACTORS	Does actor influence farms, AND do farms have influence on this actor? (YES/NO)	Does actor influence the farming system, BUT the system has little influence on this actor? (YES/NO)
Policy makers[6] (agricultural policy)	Politics and policies influence farms at a high level, and farms have an influence on these actors at a medium level.	Politics and policies are influencing the agricultural system. It is hard to give an answer to the question of "Weather the existing agricultural system is influencing politics?" It depends on the region and the people in politics.
Financial institutions (especially banks and credit unions)	Credit unions and banks have a high influence on farms. Farms have moderate influence on these financial actors.	Credit unions and banks have a high influence on the agricultural system (and vice versa): they are fulfilling the demand coming from regional-level actors in the agricultural system. 10/10 for the influence of banks and credit unions on agricultural system, and rate as 3/10 (much lower) for the influence of agricultural system on the banks and credit unions.
Retail	The retail system influences farms, but farms have no influence on this actor at a national level (only at a local level).	Farms have influence on the local direct marketing system and provision of local products to the market.
NGOs	NGOs influence farms via media, but farms have no influence on this actor.	NGOs influence the whole farming system, but the system has no influence on this actor.
Media	Media have a high influential power over farms, but farms onlynhave an influence on media at the regional level.	Media have an important influence on the farming system, but the farming system has no influence on media.
Foreign and non-agricultural investors	A rise in the number of foreign investors has increased land and rental prices. The land ownership issue is becoming more and more important. Farms have difficulties dealing with those external effects, regardless of farm size.	Non-agricultural investors have a big influence on farm structure and management.

[6] Media and NGOs have a big influence both on politics and retail systems. It is difficult to assign the influence level of NGOs on political and retail system, because the answer to the question of "Are NGOs part of the politics or are they part of a whole farming system?" is not very straightforward.

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Part 5a: Examples related to identified main actors
Example 1: Politics
The influence of federal-level politics on the agricultural system may be bigger than the influence of regional (Saxony-Anhalt) politics, where the minister for agriculture is from a green party. Only one delegate has no influence on a particular farm (unless the farmers' association invites one delegate to address their policy making process).
Example 2: Use of Glyphosat
Has a big influence on both farms and the farming system (via media, NGO's, and politics).
Example 3: Milk producers
At a regional level, farms have some influence on dairy processors. In the Altmark, there are still high numbers of dairy cooperatives. These cooperatives have an influence on corporate, as well as family farms.
Example 4: Meat and grain producers
They have no influence on the processing level. However, those farms are closely related with the main actors that have a high influence on farms and farming systems.

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Part 5b: Identification of functions of framing systems in terms of public and private goods

Private goods:

Healthy and affordable food provision is the first function of the farming system. However, there is nearly no need for improvement.

Public goods:

To respect natural resources and to protect the biodiversity of habitat is the first function of the current farming system. Currently, biodiversity function of farming systems is a very hot topic due to our media. Following this, animal health and welfare is a second important function. Other functions, such as attractive rural regions and rural tourism, are not current discussion topics. Improvement is needed in the functions “to respect natural resources and the biodiversity”.

The main future challenges here are CO2 emissions and regulation of fertilizers. These challenges are not representative only for a regional level, but also at a country level. Currently, in the Altmark region, officials are working closely with farmers to build a green band to protect biodiversity. For example, to protect the bird “European robin”, farms need to build 1-2 meters of fences on unmown land, behind the grassland. However, there are also some policy measures that decrease subsidies in case land is not used efficiently. These two policy measures (the one related to protection of biodiversity and another one related to land use) are mismatched in that point. A new combined system is needed for the improvement of public goods that is more related to political level actors.

Another improvement needed for policy measures regards the protection of species. When I participated in the meeting of the Landesamt für Umweltschutz (Environmental Authority), I informed that there is a need for hundreds of policy measures to save all different kinds of regional species. However, CAP covers only 3-4 measures for edge strips.

The main three steps towards a solution are:
(i) territorilisation (localization) of environmental measures;
(ii) providing consulting to farmers by regional level environmental authorities;
(iii) increasing the information exchange between authorities and farmers on the methodologies to apply environmental measures.

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Annex

Table A1: Classifications of farm size, ownership, and specialization characteristics

Structural characteristics	Description
Farm Size (by European size unit)[1]:	
Very small farms	< 8
Small farms	< 40
Medium size farms	< 200
Large farms	< 1000
Very large farms	>= 1000
Managerial ownership	
Family farms	Farms where the profits cover unpaid labour and own capital of the holder and the holder's family
Partnership farms	Farms where the profits cover the production factors brought into the holding by a number of partners
Corporate farms	Farms without unpaid labour or which are not included in the other two groups (e.g., legal persons, corporate farms, and producer cooperatives).
Farm specialization[2]	
1. Field crops	Specialist cereals, oilseeds and protein crops; general field cropping; mixed cropping
2. Horticulture	Specialist horticulture indoor and outdoor
3. Wine	Specialist vineyards
4. Other permanent crops	Specialist fruit and citrus fruit, olives, and various permanent crops combined
5. Milk	Specialist dairying
6. Other grazing livestock	Specialist cattle rearing and fattening, sheep, goats and other grazing livestock
7. Granivores	Specialist pigs, poultry
8. Mixed farms	Mixed livestock, mainly grazing livestock; field crops – grazing livestock combined; various crops and livestock combined; sheep, goats and other grazing livestock

Note: *(1) Farm size dimension based on the total standard output (SO) of the holding expressed in Euro: very small farms: less than 8 000 euro; small farms: from 8 000 to less than 40 000 euro; medium farms: from 40 000 to less than 200 000 euro; large farms: from 200 000 to less than 1000 000 euro; very large farms: greater than 1000 000 euro. During the survey, for the farm size classes, it is important to take into account expert references towards measurement of farm size. For the German case study interview, we experienced that interviewed expert prefer to use Utilized Agricultural Area (UAA) rather than ESU to discuss on the farm size classifications. If the respondent would have a difficulty to respect the given FADN classifications, please construct the appropriate measures (e.g., hectare, number of cow, etc.) and classifications bases on respondent thresholds, and provide the constructed classification with interview results. (2) If given 8 classification would not fit well to your study region, please check the following detailed Table A2.*

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Table A2: Detailed farm specialization classifications base on FADN

General type of farming	Principal type of farming	Particular type of farming
1. Specialist field crops	15. Specialist cereals, oilseeds and protein crops 16. General field cropping	151. Specialist cereals (other than rice), oilseeds and protein crops 152. Specialist rice 153. Cereals, oilseeds, protein crops and rice combined 161. Specialist root crops 162. Cereals, oilseeds, protein crops and root crops combined 163. Specialist field vegetables 164. Specialist tobacco 165. Specialist cotton 166. Various field crops combined
2. Specialist horticulture	21. Specialist horticulture indoor 22. Specialist horticulture outdoor 23. Other horticulture	211. Specialist vegetables indoor 212. Specialist flowers and ornamentals indoor 213. Mixed horticulture indoor specialist 221. Specialist vegetables outdoor 222. Specialist flowers and ornamentals outdoor 223. Mixed horticulture outdoor specialist 231. Specialist mushrooms 232. Specialist nurseries 233. Various horticulture
3. Specialist permanent crops	35. Specialist vineyards 36. Specialist fruit and citrus fruit 37. Specialist olives 38. Various permanent crops combined	351. Specialist quality wine 352. Specialist wine other than quality wine 353. Specialist table grapes 354. Other vineyards 361. Specialist fruit (other than citrus, tropical fruits and nuts) 362. Specialist citrus fruit 363. Specialist nuts 364. Specialist tropical fruits 365. Specialist fruit, citrus, tropical fruits and nuts: mixed production 370. Specialist olives 380. Various permanent crops combined
4. Specialist grazing livestock	45. Specialist dairying 46. Specialist cattle — rearing and fattening 47. Cattle — dairying, rearing and fattening combined 48. Sheep, goats and other grazing livestock	450. Specialist dairying 460. Specialist cattle rearing and fattening 470. Cattle; dairying, rearing and fattening combined 481. Specialist sheep 482. Sheep and cattle combined 483. Specialist goats 484. Various grazing livestock

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6. Mixed cropping	61. Mixed cropping	611. Horticulture and permanent crops combined 612. Field crops and horticulture combined 613. Field crops and vineyards combined 614. Field crops and permanent crops combined 615. Mixed cropping, mainly field crops 616. Other mixed cropping
7. Mixed livestock holdings	73. Mixed livestock, mainly grazing livestock 74. Mixed livestock, mainly granivores	731. Mixed livestock, mainly dairying 732. Mixed livestock, mainly non-dairying grazing livestock 741. Mixed livestock: granivores and dairying combined 742. Mixed livestock: granivores and non-dairying grazing livestock
8. Mixed crops — livestock	83. Field crops — grazing livestock combined 84. Various crops and livestock combined	831. Field crops combined with dairying 832. Dairying combined with field crops 833. Field crops combined with non-dairying grazing livestock 834. Non-dairying grazing livestock combined with field crops 841. Field crops and granivores combined 842. Permanent crops and grazing livestock combined 843. Apiculture 844. Various mixed crops and livestock

Source: *Eurostat, 2012.*

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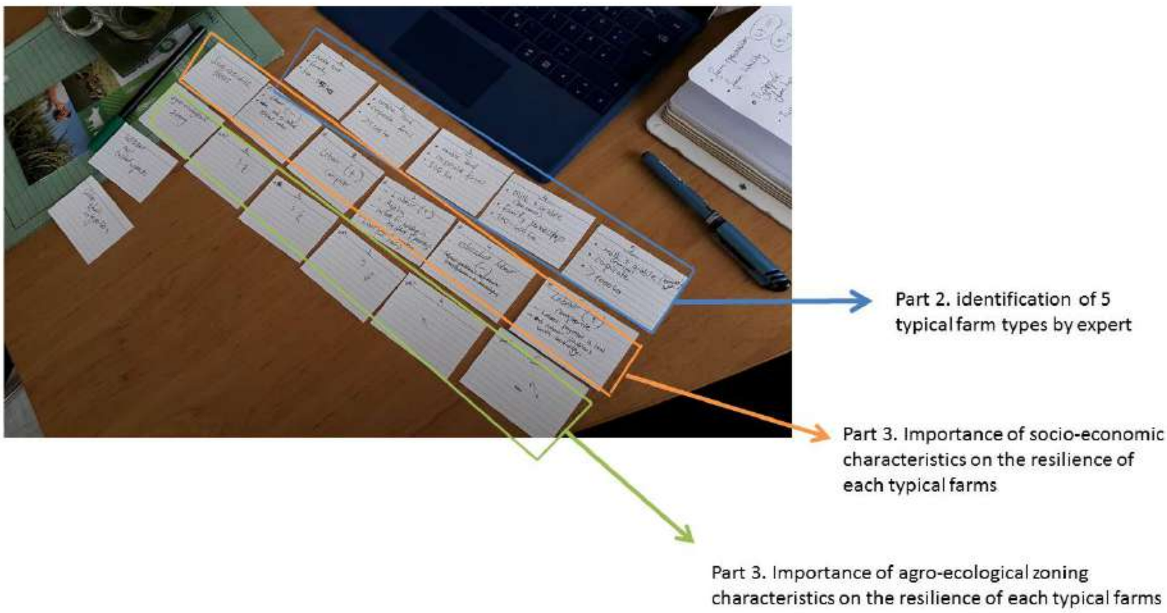
Table A3: Examples of identification of typical farm types with three structural characteristics

Typical Farm Type 1= Very small farm size + Family farms + Field crop farms
Typical Farm Type 2= Medium size farms + Family farms + Milk farms
Typical Farm Type 3= Large farms + Corporate farms + Field crop farms

Photo A1: Photo from Altmark (German) case study interview: a detail from Part 2 (identification) and Part 3 (Evaluation)



Note: *Given photo is an example from German case study interview. We would not expect from partners to conduct their interview with card sorting exercises. This exercises worked well with German case study respondent.*

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Table A4: Examples of indicators in four dimensions

Socio-economic characteristics	✓ Age, education and gender structure of farm managers and workers ✓ Family types of farm managers and workers (single, married) ✓ Average family size in farms (number of family members) ✓ Frequently use sources of information for farm management ✓ Farm labour characteristics (permanent/temporary/hired labour, labour intensity) ✓ Work quality ✓ Access to medicines and health coverage ✓ Farmers' social engagement of (e.g., membership of farmers' association, civil, voluntary associations, professional organization) ✓ Farmers' social diversification activities to improve the image of farms and agriculture in local communities (e.g., participation to open day events, fairs and exhibitions)
Agro-ecological zoning	✓ Share of woodland area ✓ Diversity and abundance of key farmland animal, plant and insect species ✓ Water quality (e.g., pesticides and nitrates in rivers) ✓ Nutrient balance (Nitrogen Use efficiency (kg N output/ k N input) ✓ GHG balance (Mg CO2e M kcal-1) ✓ Use of pesticides (tons per 1,000 ha) ✓ Soil erosion (physical, chemical and biological quality of the soil) ✓ Waste management measures ✓ Protection of biodiversity of habitats, genes, and species ✓ Adoption of agri-environmental farming practices
Institutional and cultural embedding	✓ Presence of institutional patterns that promote mutual respect and trust ✓ Availability of human and financial resources to support policy measures ✓ Communities' perception of the presence and quality of services provided ✓ Acceptance of farming practices ✓ Consumer expectations towards cultural and ethical aspects ✓ Jobs created in supported projects ✓ Rural population benefiting from services/ infrastructures supported under the Rural development Programme (RDP) ✓ Share of rural population covered by Local Action Groups (LAG) funded through the RDP
Embedding in the values chain	✓ Investment in the upstream economic activities (e.g., research and development, certified seeds, high-value varieties) ✓ Investment in the midstream economic activities (e.g., processing, high value end uses) ✓ Investment in the downstream economic activities (e.g., packaging, food safety, branding, targeted markets) ✓ Value chain integration by supporting internal providers (e.g., infrastructure, finance, human resource development) ✓ Value chain integration by supporting services (e.g., machinery, logistics, marketing) ✓ Contract farming models

Source: *Meuwissen et al., 2018; Rumelt, 1974; Wojtaszek, 1980; Pacini et al., 2010; Cardillo et al., 2016; Was and Sulewski, 2011.*

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Table A5: Example of evaluation table by each defined typical farm types

Identified important characteristics in Q3a	**Identified typical farm types in Q2a**			
	Farm Type 1	Farm Type 2	Farm Type 3	Farm Type …
I. Socio-economic characteristics Q3a: Identification Q3b: Evaluation (Robustness, Adaptability Transformability)				
II. Agro-ecological zoning characteristics Q3a: Identification Q3b: Evaluation (Robustness, Adaptability Transformability)				
III. Institutional and cultural aspects Q3a: Identification Q3b: Evaluation (Robustness, Adaptability Transformability)				
VI. Value chain integration aspects Q3a: Identification Q3b: Evaluation (Robustness, Adaptability Transformability)				

Note: *It is not necessary to fulfill the evaluation table. It is designed with a purpose to advance in a systematic way to the open questions of Q3a, Q3b, and Q3c.*

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Table A6: Farm resilience concept in SURE-Farm

In the SURE-Farm project, the resilience framework to analyse the resilience of EU farming systems builds on the concept of adaptive cycles (Meuwissen et al., 2018). Resilience theory is an integrated framework to investigate the ability of complex social-ecological systems to cope with changing environments (Meuwissen et al., 2018). Recent literature goes beyond these definitions by considering three features of resilience which are robustness, adaptability and transformability (Anderies et al., 2013). Regarding from farming systems, these features of resilience have different strategies to respond to changes and shocks in the natural, social, economic and institutional environment (Meuwissen et al., 2018). In SURE-Farm, this subdivision into robustness, adaptability and transformability follows the conceptual study realized by Folke et al. (2010): **Robustness:** Ability to maintain desired levels of outputs despite the occurrence of perturbations (Urruty et al., 2016). This concept has also been used with the definition of "buffer capability that allow persistence" in several studies which focusing on farm resilience (Darnhofer, 2014). **Adaptability:** Capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory (stability domain) (Folke et al. 2010). This concept represents farms which use their adaptive capability to cope with changes (e.g., increasing water scarcity, or policy changes in the water framework directive) over time (Darnhofer, 2014). **Transformability:** Capacity to create a fundamentally new system when ecological, economic or social structures make the existing system untenable in order to provide important functionalities (Walker et al. 2004). Transformation of the farming system organised around cattle on range land into ecotourism may serve as an example (Cumming, 1999).

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Table A7: Examples of economic, environmental, social, and institutional challenges

Economic challenges	Social challenges
✓ Price drops ✓ Food safety crisis ✓ Changes in interest rates ✓ Reduced access to bank loans	✓ Changing societal concerns about agriculture ✓ Changing consumer preferences ✓ Demographic change
Environmental challenges	**Institutional challenges**
✓ Extreme weather events (droughts, floods) ✓ Climate change ✓ Deforestation	✓ Changes in access to markets ✓ Changes in land tenure regulations ✓ Changes in food safety regulation

Source: Meuwissen et al., 2018

Table A8: Example of assessment table by each defined typical farm types

Identified future challenges in Q4a	Identified typical farm types in Q2a			
	Farm Type 1	Farm Type 2	Farm Type 3	Farm Type …
I. Economic challenges Q4a: Identification Q4b: Assessment (Robustness, Adaptability Transformability)				
II. Social challenges Q4a: Identification Q4b: Assessment (Robustness, Adaptability Transformability)				
III. Environmental challenges Q4a: Identification Q4b: Assessment (Robustness, Adaptability Transformability)				
VI. Institutional challenges Q4a: Identification Q4b: Assessment (Robustness, Adaptability Transformability)				

***Note:** It is not necessary to fulfill the evaluation table. It is designed with a purpose to advance in a systematic way to the open questions of Q4a and Q4b.*

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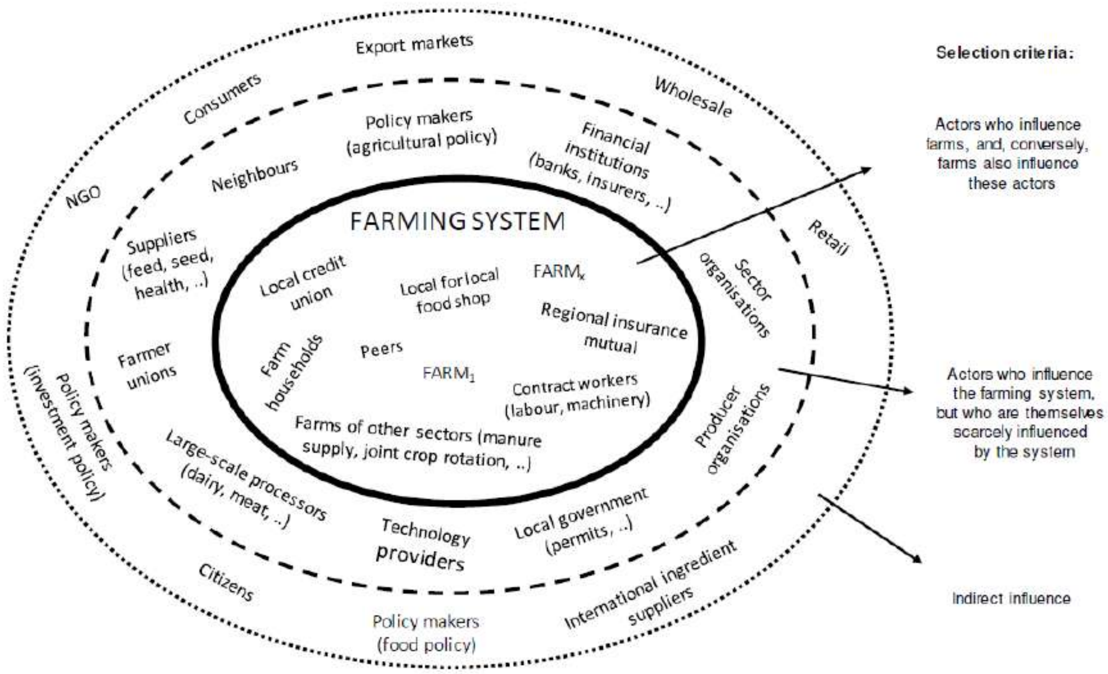
Figure A1: Actors within the system boundary of a farming system with example actors



Source: *Meuwissen et al., 2018*

Note*: In SURE-Farm, farming system is considered as a system hierarchy level above the farm, and the boundary of a farming system is such that we include actors who influence farms, and, conversely, farms also influence these actors.*

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Table A9: Identification of main stakeholders in the selected farming system

ACTORS	**Does actor influence farms, AND farms have influence on this actor? (YES/NO)**	List some examples, where relevant	**Does actor influence the farming system, BUT the system has little influence on this actor? (YES/NO)**	In case of companies or institutions, list some examples
Policy makers (agricultural policy)				
Financial institutions (banks, insurers, investment funds,); large-scale versus local (credit union, mutual), ...				
Local governments (permits, ...)				
Technology providers				
Suppliers (feed, seed, health, ..)				
Processors (dairy, meat, grain, ...); large-scale versus local, ...				
Contract workers (labour, machinery, ...)				
Farms of other sectors (e.g. regarding manure, joint crop rotation schemes, ..)				
Farm households				
Knowledge providers				
Neighbours				
Wholesale				
Retail; large-scale versus local-for-local food shop				
Consumers				
NGOs				
Citizens				
Policy makers (food policy)				
Export markets				
International ingredient suppliers				
Media				
Land owners				
.....if relevant, please add other relevant actors in selected farming system.				

Note: *(1) Please fulfill the identification table with respondent; (2) For policy makers, please identify which policy makers (in case there are several relevant local governments), and provide specific examples*

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Table A10: Functions of farming systems subdivided into private and public goods

Private goods	**Public goods**
- Deliver healthy and affordable food products	- Maintain natural resources in good condition (water, soil, air)
- Deliver other bio-based resources for the processing sector	- Protect biodiversity of habitats, genes, and species
- Ensure economic viability (viable farms help to strengthen the economy and contribute to balanced territorial development).	- Ensure that rural areas are attractive places for residence and tourism (countryside, social structures)
- Improve quality of life in farming areas by providing employment and offering decent working conditions.	- Ensure animal health & welfare

Source: *Meuwissen et al., 2018*

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