Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Natural Resources and
Agricultural Sciences

Thinking outside the CAP

– reducing domestic cattle farming as strategy for resilient food systems, in the context of Sweden's Defence Policy

Miriam Augdoppler

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Miriam Augdoppler

Supervisor:	Madeleine Granvik, Swedish University of Agricultural Sciences, Department of Urban and Rural Development
Assistant Supervisor:	Walter Wenzel, University of Natural Resources and Life Sciences Vienna, Department of Forest- and Soil Sciences
Examiner:	Kristina Marquardt, Swedish University of Agricultural Sciences, Department of Urban and Rural Development

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Abstract

In the context of the newly created Defence Policy, Sweden is trying to improve overall national preparedness for times of crisis. Preserving productive arable land by reducing resource-intensive agriculture is expected to improve self-sufficiency levels in the country and thus secure the supply chain in the event of war.

This research aims to identify management options for domestic livestock production that increases resilience in the Swedish food system. Potential limitations and opportunities by Pillar I programs of the Common Agricultural Policy (CAP) are identified, for assessing compatibility of EU and national objectives for future production systems. Lessons learned from past crisis management throughout the 20th century have been used for selecting existing scenarios of Swedish livestock management that can contribute to national preparedness. Three defined strategies for domestic cattle farming are based on these scenarios and ensure adaptability in agriculture. Feasibility of the results under the current conditions of the CAP has been assessed, by looking at cross-interactions between national and EU level.

The analysis indicates that adaptive capacity is required for crisis situations and could be ensured by the derived strategies for the livestock sector. *Ecological Leftovers* provide localized and circular agricultural systems for higher diversity in the sector. *PLANT* involves innovations for less resource-intensive production options which can generate new knowledge. *Economic Sustainability* increases redundancy of arable land through pasture management and thus ensures flexibility in domestic resource management. A combined implementation of the strategies is proposed for higher levels of resilience in the national food system and can further facilitate sustainable transformation of Sweden's agriculture. Objectives of the current CAP would support the stated suggestions, but inefficiencies of low targeted payments limit related opportunities. Changing conditions for basic direct payments are therefore suggested for future policy reforms that could improve effectiveness of CAP supports and prevent further capitalization into land.

Keywords: Sweden's Defence Policy, food systems, resilience, cattle farming, Common Agricultural Policy

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Abbreviations

CAP	Common Agricultural Policy
EU	European Union
GATT	General Agreement on Tariffs and Trade
LSU	Livestock Unit
SES	Social-Ecological System
SLU	Swedish University of Agricultural Sciences
SNG	Semi-Natural Grassland

1 Introduction

The Swedish Government considers Europe's current security policy as insufficient in ensuring full protection of the country, when facing military aggression (Löfven & Hultqvist, 2015). In this light, the new Swedish Defence Policy was created, for the period of 2016 to 2020, to improve Sweden's defence capabilities (ibid.). Main objectives of the policy involve the maintenance of a functioning society, protecting civilians and supporting Armed Forces (ibid.). The new security policy thus aims to increase the preparedness of responsible authorities again, by resuming civil defence planning (ibid.). During the 1990s, after the end of the Cold War, decreasing risks of war caused a reorientation of crisis management (ibid.). Plans for civil defence have been neglected and the focus of domestic resource management adapted (ibid.). Sweden's supply strategy changed in post-war times, relying more on international trade and consequently national food stocks have been discounted (ibid.). A geopolitical crisis, like wars, can disrupt a functioning supply chain and affect a country's economy in different ways (Federico, 2012). Production and supply is commonly expected to decline, just like the purchasing power of consumers, and certain imports need to be replaced by the national market (Federico, 2012). With current discussions about maintaining national security, the aim of self-sufficiency in the food sector was thus reintroduced in the Swedish Food Strategy (Eriksson & Peltomaa, 2017). This objective should be met by increasing overall production levels in Sweden and thus decreasing the vulnerability in the supply chain (Ministry of Enterprise and Innovation, 2016). With higher pressure on available resources, demand for meat is naturally lower during wartime and domestic production tends to focus on cheaper food alternatives (Federico, 2012). Resource management could therefore be another important factor that is affecting the vulnerability of the food system. The focus of this research is on finding other options for increasing self-sufficiency that are related to domestic land availability.

Drawing conclusions from history, a reduction of livestock production could be part of crisis preparedness that contributes to food security in wartime. According to the

Swedish Agricultural Board (Statistics Sweden, 2017), total meat consumption increased in the country by 38% since 1980, up to 88 kg per person and year. Dairy production is steadily declining but still considered important for Sweden's agriculture (Statistics Sweden, 2017) and consumption levels are relatively high when compared with other countries of the European Union (EU) (FAO, 2018). This trend reflects western diets, characterized by high intakes of animal products (Alexandratos & Bruinsma, 2012). Besides low domestic self-sufficiency levels (Röös et al., 2016b), livestock production is increasingly the focus of political and scientific discussions, due to negative environmental effects (greenhouse gases and nitrogen emissions, soil properties) and high land consumption, as addressed by various researchers (e.g. Taboada et al., 2011; Westhoek et al., 2014; Leip et al., 2015). Leip et al. (2015) state that 28% of EU land is used for livestock production as grassland and for feed cultivation, which makes up 65% of the 180 million ha of the agricultural area. When reducing livestock and thus the share of occupied area, productive arable land can be made available for less resource-intensive food production systems, as discussed by Westhoek et al. (2014). Since bovine animals have the highest livestock unit (LSU), representing feed requirements per animal type (Eurostat, 2013), reducing cattle farming is the focus of this research. It is recognized that cattle can be managed without competing with land for human food production, as opposed to pig and poultry (cf. Eriksson, 2018). Nevertheless, such extensive livestock farming is hardly the dominant production system in Sweden. This is evident when looking at large shares of arable land that is currently under ley cultivation for producing feed for beef and dairy cows (Statistics Sweden, 2017). Semi-natural grasslands have historically been a major fodder source in domestic agriculture and thus crucial for livestock production (Kumm, 2003; Hessle, 2007). Grazing these pastures can additionally be important to preserve biodiversity in Sweden's landscapes (Kumm, 2003; Hessle, 2007) and provide ecosystem functions that can also be important for today's agricultural production (Josefsson, 2015). Developing management options that is also fit for war situations might therefore include less resource-intensive production but still involves adequate shares of livestock.

Against this background, the aim of the research is to find potential national strategies that reduces Sweden's cattle farming and increases the country's resilience in the food system. These strategies should consider lessons learned from history, but also the current context of modern European agriculture. Management would focus on preserving and protecting productive arable land for plant-based foods, but do not exclude livestock from production. Since Sweden is a member of the European Union, agricultural measures must be compatible with the Common Agricultural Policy (CAP). Limitations and opportunities of this EU policy, for implementing national livestock strategies, are further derived to identify recommendations for

post-2020 reforms. Two research questions have been formulated and are stated below, that should help meeting the research's objectives:

- *Which production systems for Swedish cattle farms can increase resilience in domestic resource management?*
- *What limitations and opportunities are to be found in the Common Agricultural Policy, for implementing potential national livestock development strategies in Sweden?*

The theoretical framework for the analysis is following this introduction, including system and resilience thinking. A short summary of the materials used, and a more extensive description of the analytical approach is presented in chapter 3. The results are divided into subsections of the Swedish food regime, conceptualizing the system, discussing selected scenarios and a comparison of national strategies with the Common Agricultural Policy. The final sections cover the discussion and conclusions of the main findings.

2 Theoretical Framework

Modern systems are widely connected and exposed to high uncertainties and fast changing conditions. The connectivity between humans and nature on various levels of scales, is building complex systems. These complex social-ecological systems are increasingly facing the problem of high vulnerability and rigidity and are thus unable to adapt to an ever-changing context in a globalized world (Folke et al., 2002; Ericksen, 2008; Darnhofer et al., 2010a). The term *resilience* was thus introduced and is now frequently used as a tool to analyse the behaviour of social-ecological systems (SESs). The framework of resilience and its related theories and concepts are presented on the following pages and are building the backbone of this thesis' analysis.

2.1 Complex Adaptive Social-Ecological Systems

Natural and human environments are constantly interacting and are influencing one another across different dimensions (e.g. Folke et al., 2002; Berkes et al., 2003). Scholars thus emphasised that processes within these environments should not be addressed separately (Berkes & Folke, 1998; Berkes et al., 2003). Such an attempt is crucial to avoid further mismanagement of environmental challenges that have been observed for a range of resources (Holling et al., 2002a; Berkes et al., 2003). The need for a combined research approach created the idea of a social-ecological system (SES), a concept used by various authors in resilience research (e.g. Folke et al., 2002; Holling & Gunderson, 2002; Berkes et al., 2003; Walker et al., 2004; Anderies et al., 2006; Folke, 2006).

When these systems are discussed in the literature, they are described as complex and adaptive. This implies certain characteristics of formation and behaviour, summarized by Folke (2006) and defined as *rules*. These rules comprise that a system includes a diverse and heterogeneous set of individual elements which are

interacting in autonomous processes. Dispersed single interactions determine how the elements will develop further and ensure dynamic and non-linear behaviour. These processes allow continuous self-organization and renewal of the system, which can be described with the model of *adaptive cycles*, following Holling and Gunderson (2002). The cycle (Fig. 1) consists of four phases of development in adaptive systems, connected by a front- and a back-loop. Two distinct stages with separate objectives are illustrated, which can never occur at once. The front-loop passes through the exploitation phase (r) to the conservation phase (K) which indicates slow and more predictable processes, aiming to maximize growth and accumulate resources. The sequence ends in a state of high connectivity and fragility, allowing the emergence of change and the entrance into the second stage of the cycle. The back-loop is connecting the release (Ω) and reorganization phase (α) with rapid and unpredictable processes, maximizing innovation and recombination. An adaptive system must create a context that supports both objectives and hence comprises growth and stability, as well as change and variety (Holling & Gunderson, 2002). These dynamics in SESs create difficult conditions for management and policy-making (Berkes et al., 2003; Anderies et al., 2006). Resilience and panarchy thinking should thus support to understand systems' behaviour and build an analytical framework to improve management actions (Holling & Gunderson, 2002), which will be described in more detail in the following chapter. (Resilience Alliance)

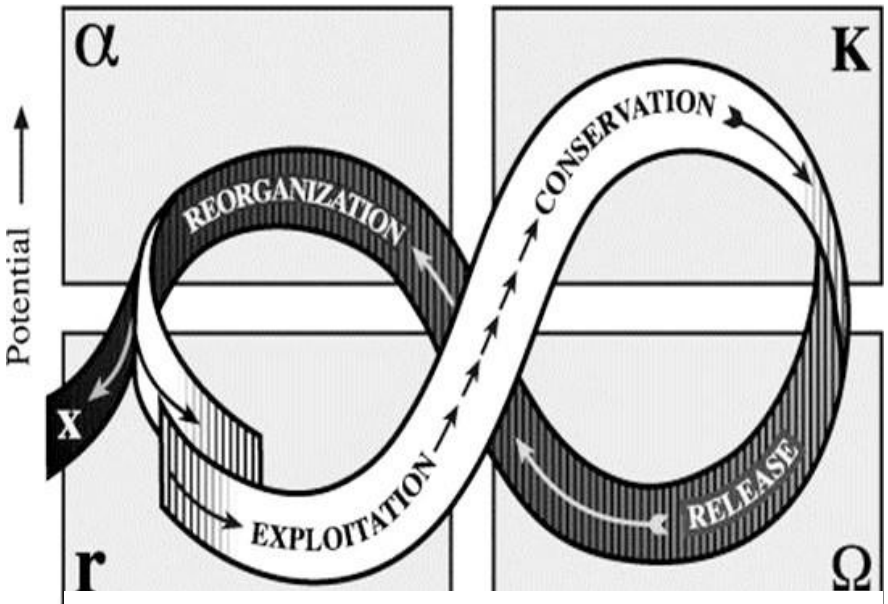

Figure 1. Model of the Adaptive Cycle (Resilience Alliance, n.a.)

2.2 Resilience and Panarchy

The concept of resilience was first introduced by Holling (1973), as an attempt to explain population dynamics within ecological systems. Resilience was then defined as measure of a system's ability to absorb disturbances, while maintaining its functions and structure (Holling, 1973; Holling & Gunderson, 2002). Dynamic, heterogenic and unpredictable characteristics of these systems require an evolutionary approach, for creating the capacity to adapt and reorganize (Holling & Gunderson, 2002). The concept thus challenges the traditional view on systems' performance which aims for a single near-equilibrium state stability and focuses on efficiency, constancy and predictability (ibid.). This perception is replaced by the idea of multiple stable state conditions, where the system can flip between different domains of stability (ibid.). Resilience is understood to provide information about the magnitude of change and a system's ability to persist, before changing its structures (ibid.). In other words: resilience determines the vulnerability to change (Folke et al., 2002; Holling & Gunderson, 2002). This perception implies that resilience is never static or finite and every system can be transformed or replaced, when disturbances are profound enough (Holling & Gunderson, 2002). Such transformability is by no means negative, which becomes evident when a system ends up in a resilient, but undesirable static state (Holling & Gunderson, 2002; Walker et al., 2004). A resilient system, where changes reveal new opportunities for development and renewal, consequently requires opportunities for adaption, self-organization and learning (cf. back-loop of adaptive cycle, 2.3) (Folke et al., 2002). Introducing resilience thinking into management of SESs therefore focuses on creating the capacity to cope with changes, instead of trying to control them (ibid.). This capacity primarily concerns the social component of an SES (Walker et al., 2004). Since human activities are an integral part of these systems, natural self-organization without external influence is impossible (ibid.). Adaptability depends on the capacity of the social to manage resilience and to stay in a desirable state (ibid.). Self-organization is yet found in the human component (Cabel & Oelofse, 2012) and in the response to the management of the system as a whole (Folke et al., 2002).

When aiming for effective management of SESs, an isolated consideration of this single system is most likely insufficient. Complex adaptive systems are connected in a hierarchical way, not involving top-down structures, but rather different levels with systems of similar characteristics (Holling et al., 2002b). To understand these dynamics, the concept of *panarchy* was created. According to Holling et al. (2002b),

panarchy implies a nested set of adaptive cycles which are interacting across different scales and levels. These dynamic processes are able to cascade changes to adjacent levels and can even, however rarely, trigger a major transformation of affected systems (ibid.). Such changes can lead to forced reorganization, but also to opportunities for improvement, which can be provoked intentionally to avoid sudden large-scale collapses (ibid.). Examples of human-related systems are changes following previously introduced policies (ibid.). These phenomena also occur in food and agricultural systems, the focus of this thesis and the subject of the following section.

2.3 Food and Agricultural Systems

Food systems combine natural and human environments and are thus social-ecological systems, with the aim to ensure food security (Ericksen, 2008). Processes (e.g. production) along the supply chain produce outcomes which are linked through feedback mechanisms with numerous global environmental and social changes (ibid.). Drivers of these changes are shaping food systems but are also influenced by them in return (ibid.). This interplay creates certain characteristics of our modern food system, as summarized by Ericksen (2008) as follows. One example relates to employment which is nowadays less focused on production activities, but rather on other parts of the supply chain, e.g. processing and retailing. Distances in food and resource distribution increased and are shifting the levels of influenced scales from the local to the national or global. Intensification, specialization and high inputs are common in industrialized agriculture, resulting in environmental degradation of water, air and soil resources. Changes in production systems are further leading to higher livestock production and consumption. Finally, major sources of external disturbances for domestic food systems, went from solely concerning production shocks, to economic and political crisis, affecting international financial and trade markets. This increasing complexity in the supply chain is linking actors, processes and outcomes in multiple ways, which can trigger sudden shocks or long-term stressors, affecting the entire system (Ericksen, 2008; Ericksen et al., 2009; Tendall et al., 2015).

Our food system can thus be seen as a network, consisting of countries with individually resilient food production systems, that are connected by international trade (Seekell et al., 2017). This global connectivity can pose not only another source of resilience, but also of increased vulnerability (ibid.) and may lead to cascading of disturbances, which was discussed in the previous chapter. Factors and processes at a global level can thus have major implications locally (Seekell et al., 2017). High

uncertainties are the result and are making planning processes in agriculture difficult (Darnhofer et al., 2010a). Besides weather and price, on-going globalization and policy reforms can create potential barriers in the sector (Darnhofer et al., 2010a). These changes are affecting different actors including producers, consumers or decision makers, who are interacting in various ways (Darnhofer et al., 2010b). Policy and management strategies hence need to address multiple, sometimes conflicting, goals and have to focus on the system's adaptive capacity (Ericksen, 2008). Resilience and panarchy thinking is therefore applied in the literature to understand and discuss the dynamic processes of food and agricultural systems and to find options for appropriate management (cf. Fraser et al., 2005; Ericksen, 2008; Darnhofer et al., 2010a; b; Dwiartama, 2014; Tendall et al., 2015). Dwiartama (2014), however, argues that historic developments and globalization is not appropriately considered within this mindset, but can be addressed when combined with the food regime framework. This idea is presented in the following and applied to the case of Sweden later on.

2.4 Linking Panarchy and the World Food Regimes

As indicated in the previous chapter, Dwiartama (2014) proposes to combine resilience and panarchy thinking with the *food regime theory*, strongly shaped by ideas of H. Friedmann and P. McMichael. The concept of food regime accordingly describes international economic relations in food production, within periods of the global capitalist transformation (Friedmann & McMichael, 1989). The resulting transnational economic organization is determined by the international food order in each time frame, which is defining the role of different actors (e.g. US, EU, Global South) and recomposes when structural changes occur (Friedmann, 1982). Globalization and trade thus created a shared history of developments in the agricultural sector, impacting nation-state systems (Friedmann & McMichael, 1989; McMichael, 1992). Dwiartama (2014) concludes that the theory concerns the rise and collapse of food systems, affected by transnational dynamics of the regime in place. It further describes the influence of global-scale processes on domestic agricultural policy and positions changes in our food system in the historical context of capitalism (Dwiartama, 2014). For combining this approach with resilience thinking, the author Dwiartama (2014) stressed two points of similarities. The first one refers to the understanding of stability domain and regimes, as is the space within a system can operate. These spaces are both affected by periodically occurring changes but are traditionally located on different analytical scales. Since resilience is usually related to small-scale issues e.g. landscapes (cf. Holling & Gunderson, 2002), the global perspective of food regimes allows a more comprehensive

analysis. Secondly, the dynamic characteristic of occurring and declining food regimes can be explained through the model of adaptive cycles. Changes in a regime's system are thereby depending on its position within this cycle. Additionally, the system's behaviour is affected by the adaptive cycle of adjacently smaller and bigger systems, as explained by the concept of panarchy. Nevertheless, as understood by Holling et al. (2002a), changes in a panarchy, cascading down from higher levels, are considered slow (Holling et al., 2002a). Since processes in the global food system that affect lower levels can appear promptly, a combined approach contradicts the traditional panarchy thinking in this point (Dwiartama, 2014). Dwiartama (2014) hence proposes the Food Regime-System Resilience framework, applicable to investigate systems' resilience. To fully capture the dynamics of scales and levels involved in this and other approaches, basic definitions and concepts are the issues of the next chapter.

2.5 Interactions of Scales and Levels

Cross-scale and cross-level interactions have been mentioned earlier in the text, when discussing complex adaptive systems. To understand its implications for SESs, the meaning of these terms will be present in this paragraph. Scales are understood according to Gibson et al. (2000, p. 219) as "the spatial, temporal, quantitative, or analytical dimensions used by scientists to measure and study objects and processes" and levels are the units of analysis positioned on these scales (ibid.). As shown in Fig. 2, Cash et al. (2006) specifies three most commonly used scales: (A) spatial, (B) temporal and (C) jurisdictional. To avoid misunderstandings, latter will be termed as 'administrative' in this thesis. As the name indicates, the *temporal* scale relates to different levels of rates, durations or frequencies. *Spatial* scales provide geographical divisions, from a local to national and global level and thus connects small processes across a large area. The *administrative* scale (cf. Figure 2, C. Jurisdictional) is connected to the spatial scale and forms political units, such as towns, states or nations. These political units typically follow a hierarchy of institutional rules, which can be considered a separate scale (cf. Fig. 2, D.), comprising e.g. constitutions, laws and regulations.

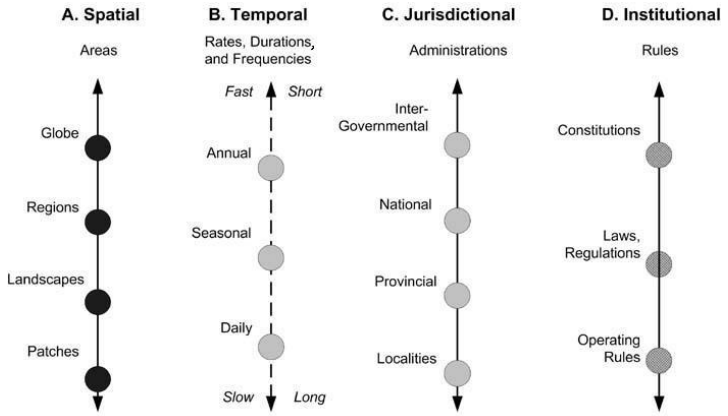

Figure 2.The most common scales comprise (A) Spatial, (B) Temporal and (C) Jurisdictional. The Institutional (D) scale describes the hierarchy of rules (Cash et al., 2006, p.3)

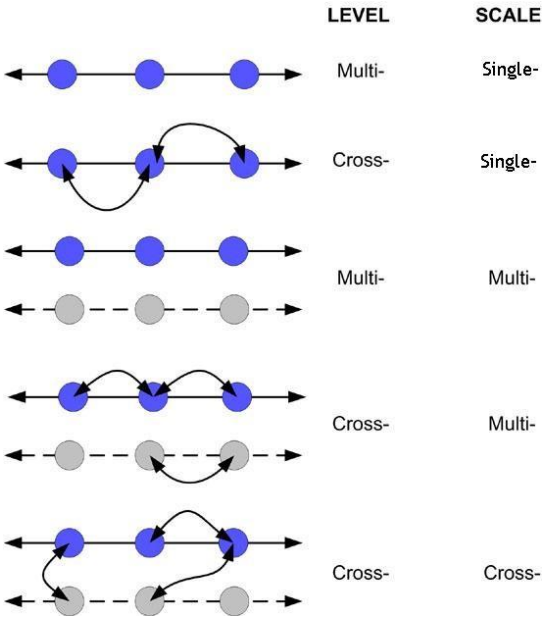

Figure 3. Illustration of cross-level, cross-scale, multilevel and multiscale interactions (Cash et al., 2006, p. 5)

As mentioned before, these scales and their levels can interact. Cross-level describes interactions within one scale and cross-scale, between two or several (Cash et al., 2006). In comparison to these terms, multilevel and -scale only imply the presence of more than one level or scale, but not necessarily links between these (ibid.), which is conceptualized in Fig. 3. This and other frameworks and concepts are defined for the analysis in the third chapter of the thesis, as well as a description of the materials used.

3 Materials and Method

This research involved a comprehensive literature review to collect publications on the selected theories, applied concepts and scenarios in the agricultural and food sector. Materials have then been used for creating an analytical framework, specifically tailored to the objectives of this thesis. The individual steps are presented in the following two sections.

3.1 Data Collection

This thesis is based on a literature review, using different search tools and databases. Scopus, Google Scholar and the online library catalogue of the Swedish University of Agricultural Sciences (SLU) was primarily used for background information on the research topic and the theoretical framework. For finding relevant publications from SLU for the analysis of latest research on the thesis' topic, the database *SLUpub* and the open archive *Epsilon* have been used.

The point of departure for this research is the paper by Westhoek et al. (2014) on environmental effects of meat consumption in Europe. *Backward Snowballing* (cf. Wohlin, 2014) was then used to find other literature on this topic. References in the text indicated the most relevant sources in the bibliography. Other publications with pertinent titles in English language have been selected in addition, with publication years within the past 15 years. This approach was then further applied to the newly selected literature, mostly consisting of journal papers. The starting set for snowballing was supplemented with a database search, by using and combining keywords like "livestock", "land use", "meat consumption", "meat production", "soil protection", "environmental impact", "food security" or "food supply", with geographical restrictions to "Europe", "EU", "Scandinavia" and "Sweden". After creating a basis for the research, a review of the theoretical framework *resilience thinking* was further conducted and related to the food sector. The term "resilience" was combined

in the search tools with keywords “food system”, “agriculture”, “agri-system”, “food security”, “self-sufficiency”, “panarchy”, “scale interaction”, “social-ecological system”, “vulnerability” and limited to the same spatial area as in the background review. Backward Snowballing was applied again, but with a larger time frame of the publication date and most relevant authors researching this topic have been identified. On this basis, publications of resilience scholars are identified by author searches in the databases for C. S. Holling, Lance Gunderson, Brian Walker, Carl Folke, Fikret Berkes, Steve Carpenter, John Ingram, Ika Darnhofer and Polly J. Ericksen. The same was done for scholars in food regime research, namely Philip McMichael and Herriet Friedmann. Backward Snowballing was then again applied to their work and additionally *Forward Snowballing* (cf. Wohlin, 2014), involving the search for papers including the work of these authors.

The literature for this thesis’ analysis is mostly restricted to research at the Swedish University of Agriculture. The review therefore started by browsing through webpages of SLU departments, to identify former and current research projects related to the topic. The departments *Urban and Rural Development, Energy and Technology, Economics and Animal Environment and Health* were considered most relevant. A search for publications of researchers working with agrarian history, food systems’ scenarios, cattle farming and the Common Agricultural Policy have been conducted in the following. Relevant literature was selected which helped to get a general picture of the research done. A historical review was additionally needed for the first approach of the analysis (cf. 3.2). This search was not restricted to SLU and lead to additional literature on Sweden’s history from other databases and libraries, as well as statistical publications from the Swedish Board of Agriculture. Based on intermediate results from the analysis, scenarios for Sweden’s cattle farming are selected, which is described in 3.2. The keyword-search was conducted for this purpose and restricted to research results at SLU. The university’s databases *SLUpub* and *Epsilon* were used for the search and included the following departments: Urban and Rural Development; Energy and Technology; Economics; Animal Environment and Health; Agricultural Science in Northern Sweden; Animal Nutrition and Management; Crop Production Ecology; Ecology; Plant Biology; Soil and Environment; Landscape Architecture; Work Science, Business Economics and Environmental Psychology; Planning and management; Biosystems and Technology; and the Research Center for Sustainable Agriculture. Terms related to cattle livestock farming (“cattle”, “dairy”, “suckler cows/suckler herds”, “grazing”, “feed/forage/fodder”, semi-natural grassland/pasture/ley”), food production (“food supply/food security”, “meat production/meat consumption”, “land use”, “arable land”, “self-sufficiency”) and trading (“import”, “export”, “trade”) have been used and combined in the search. Publications with keywords in title and/or abstract have

been evaluated to determine their relevance. A pre-selection of literature was then studied in more detail, for assessing the scenarios suitability for further analysis.

During this literature review, language barriers have been recognized to limit the research process. Four dialogues with SLU researcher took place, who have been contributing to the main publications used in the analysis. Additional information is considered in this work and referenced as personal communication (pers. comm.) in the text.

- 30th of May 2018: **Anna Hessle**; Department for Animal Environment and Health, Division of Production Systems
- 14th of June 2018: **Elin Röös**; Department of Energy and Technology, Division of Agricultural Engineering
- 21st of June 2018 (Skype-call): **Mark Brady**; Department of Economics, Division of Applied Analysis
- 3rd of July 2018 (Skype-call): **Carin Martiin**; Department of Urban and Rural Development, Division of Agrarian History

3.2 Analytical Approach

Within the context of the theories presented in section 2, five different analytical approaches have been defined which are supposed to help answering the asked research questions. A short title was ascribed for each, presented in an overview in Table 1 (cf. first column). The most relevant reference to each approach is further given in the table, which are the sources to the initial frameworks that are incorporated in this methodology. Outcomes have been defined (cf. column three) which build the starting point of the respective following approach, as listed below. The author's individual understanding of the related frameworks and their concepts, and the way in which those are applied in the thesis, is described in the next subsections.

Table 1. *Overview of the derived approaches, their related outcomes and references for background information of initial frameworks, included an approach*

Approach	Source	Outcome
Food Regime-System Resilience	Dwiartama (2014)	Swedish Food Regimes
Conceptual Framework	Ericksen (2008)	Food System Activities
Inductive Reasoning	NATO (2016)	Lessons Identified
Complex Adaptive Systems	Darnhofer *et al.* (2010a)	National Strategies
Scale Challenges	Cash *et al.* (2006)	Limitations & Opportunities

3.2.1 Food Regime-System Resilience

Past and present changes in the global food system are affecting domestic strategies and can be taken into consideration when discussing preparedness in production and supply. The food regime theory (cf. 2.4) therefore constitutes the basis of the first approach in the analysis. This approach is inspired by Dwiartama's (2014*) Food Regime-System Resilience* framework which is already mentioned in chapter 2.5. Dwiartama (2014) synthesizes the food regimes with resilience, as illustrated in Figure 4. The four phases of the adaptive cycle are integrated in the regime sequence, with time frames of several decades. Key historical events are highlighted in the figure and are explained in the following as summary of Dwiartama's (2014) comprehensive analysis.

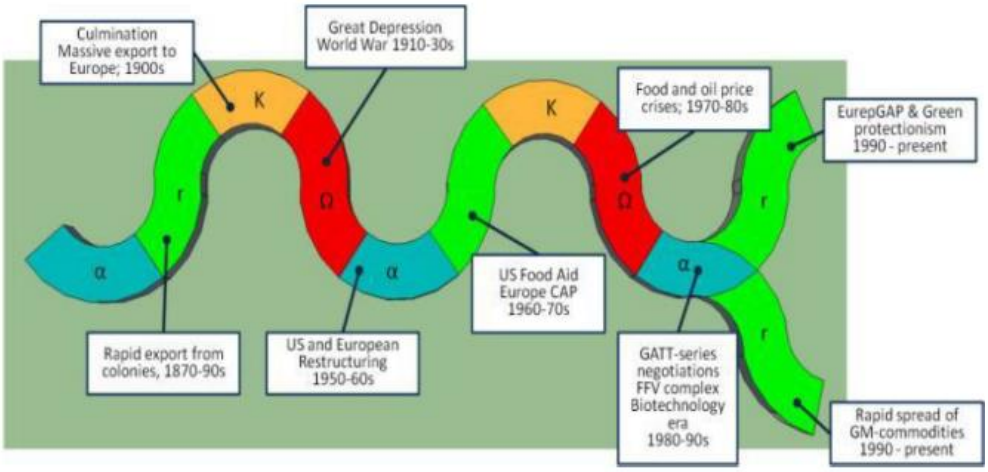

Figure 4. Adaptive cycles in the three global food regimes, showing the four phases (α) reorganization, (r) exploitation, (K) conservation and (Ω) release in different colours (Dwiartama, 2014, p. 222, adapted from Holling & Gunderson, 2002)

The 1st food regime was characterized by increasing growth in the first exploitation phase (r), due to rapid mobilization of resources from European colonies in the late 19th century (Dwiartama, 2014). The first conservation phase (K) was entered at the beginning of the new century and ended with saturated growth of accumulated resources and thus high rigidity in the system (ibid.). The decline of this regime and thus the beginning of the release phase (Ω) was triggered by the Great Depression and World War II (ibid.). A new order of the international economy was gradually built up through emerging agricultural policies (e.g. US food aid program) and economic networks (e.g. European Economic Community, EEC) in the reorganization period (α) (ibid.). The exploitation phase (r) of the 2nd food regime involved increased agricultural intensification and policy attempts for protecting domestic agricultural production (ibid.). To reduce impacts of depression, measures included constraints of imports and provide state support (ibid.). The creation of the Common Agricultural Policy in Europe and the expansion of the US aid program, dominated the emerging specialized livestock complex in the conservation period (K) (ibid.). Worldwide food shortage resulted in high market prices in the early 70s that caused destruction in the second release phase (Ω) (ibid.). Negotiations around the General Agreement on Tariffs and Trade (GATT) tried to find a new inclusive global order for the 3rd food regime in the reorganization period (ibid.). This α-phase, however, mainly resulted in new trade relations and expansions of sustained processes of the previous structure (ibid.). It therefore struggles to find common ground on decisive novel strategies for the global food system (ibid.). Dwiartama (2014) presumes that the current regime is either still in its initial phase of recalibration, or offers different options for growth simultaneously, depending on the national-level context.

The presented framework allows agri-food systems to position themselves within the global regime (Dwiartama, 2014). These systems often follow the global regime, but they have the capacity to act differently at the same time (Dwiartama, 2014). In this thesis, the case of Sweden's cattle farming sector is assessed. The findings should outline consistencies and dissimilarities to the global order in the past and present and explain domestic developments with characteristics of the assigned adaptive phases. The current position in the integrated cycle can further indicate potential future developments in Sweden's food system. Literature on former food supply management and related policies, social structures and major disturbances in Sweden is used in the historical analysis. Latest statistical data, EU regulations and more recent publications concerning the food and agricultural sector are combined for describing the current situation. Three food regimes are derived in the results for the Swedish example as an output and constitute the basis for future management recommendations.

3.2.2 Conceptual Framework

To be able to select suitable scenarios and create potential strategies, aspects of the Swedish food regimes, that are crucial for systems' resilience, need to be identified first. Ericksen's (2008) framework is therefore considered for the second approach, *Conceptual Framework*, which conceptualizes food systems by defining *activities* and their *outcomes* relating to food security, as presented in Figure 5. Applying the full framework with all components of the system would go beyond the scope of this research. This analysis, therefore, focuses on one out of three outcomes defined, namely *food availability*. Food availability as outcome is considered most essential for ensuring food security during war time. Production, distribution and exchange are the main determinants in this relation (Ericksen, 2008), which are introduced as concepts in the thesis. The most relevant aspects are described in the following and define the second analytical approach:

- *Production*: the type and amount of food that is domestically produced, influenced by the structure of farming systems and national resource management (ibid.);
- *Distribution*: how food is made available, which can be restricted e.g. by governance, trade barriers and borders (ibid.);
- *Exchange*: to what extend domestic production is replaced by other ways of food generation, determined by e.g. markets, terms of trade and subsidies (ibid.);

To understand the system's structure and performance of the national food regimes, activities in each time period, that impact food *availability*. are identified for the three above stated determinants.

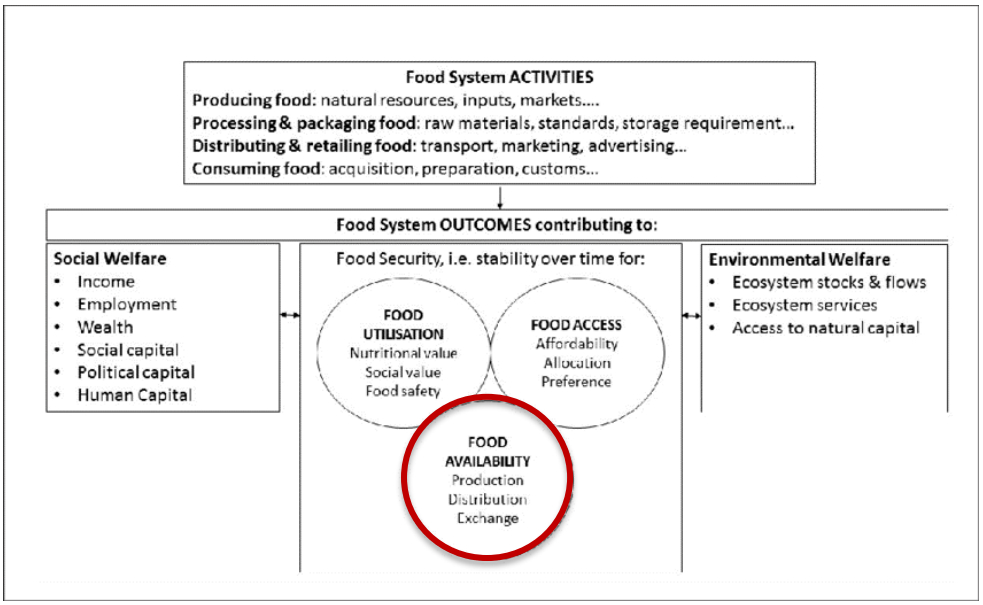

Figure 5. Components of food systems (Ericksen, 2008), with indicating the entry-point of the analysis

3.2.3 Inductive Reasoning

The concept of learning is included further in the analysis, to prepare the Swedish food system for changes in the future. An approach is created that incorporates the presented system's activities (cf. 3.2.2) and follows the idea of Lessons Learned, which is commonly used for developing and improving defence strategies (NATO, 2016). Looking at past events will help to avoid risks and thus contribute to higher chances of success, which legitimizes changes made for future proceedings (ibid.). When considering the process in the NATO handbook, three main learning stages are involved: identification, action and institutionalization (ibid.). The identification stage is applied in this research and is building the basis for creating *Lessons Identified* as the main outcome. The related approach is illustrated in the first part of the flowchart in Figure 6 and explained in the following. As a first action, observations that include shortcomings and successes of an operation are collected (ibid.). A subsequent analysis is needed to examine associated root causes (ibid.). *Inductive Reasoning* is stated as bottom-up method which involves finding patterns and trends that develop hypotheses for particular issues and constitutes the third approach in this thesis (ibid.). A hypothesis can eventually result in a theory that explains a given observation and assists to understand its root causes (ibid.). These findings are then

used to build recommendations for improvements and to define best practices (ibid.). For this research, the earlier identified activities in Sweden's food system are understood as observations (cf. Figure 6) that reveal potential opportunities and challenges for the sector. These results could be considered in strategic decision-making for domestic cattle farming. Patterns across the systems' activities of the Swedish food regimes are summarized in the results. Those indicate structures in the national agri-food system and give a general picture of the conditions in each period and developments over time. General conclusions are derived, to formulate lessons which are considered in the selection of livestock scenarios. Learning outcomes from past events could thereby help to find management suggestions that improve national preparedness. For assessing the scenarios' contribution to resilience in the sector, concepts for determining a farm's adaptability are considered and subject of section 3.2.4.

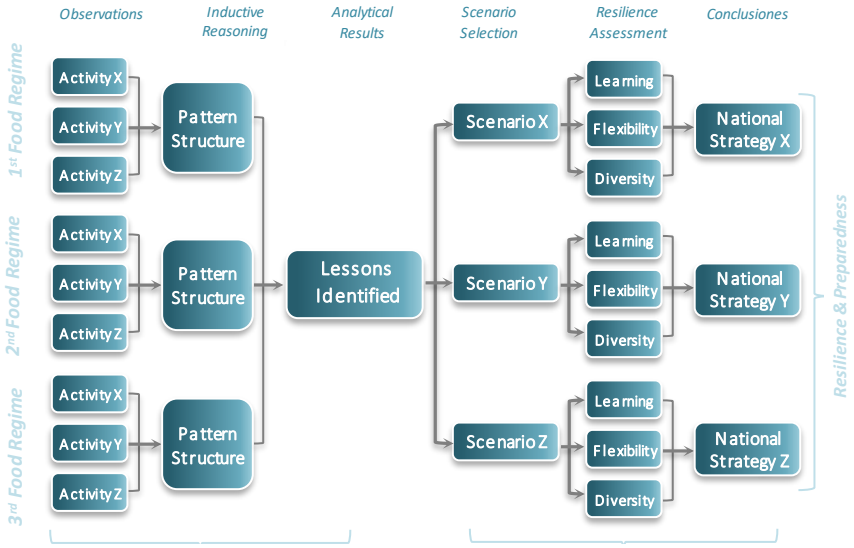

Figure 6. Flowchart of third (Inductive Reasoning) and forth (Complex Adaptive Systems) approach used, showing the different stages in the analytical process

3.2.4 Complex Adaptive Systems

Darnhofer et al. (2010a) claim that attempts to improve farming performance have been focused on increasing profitability and missed to prepare farmers to cope with increasing uncertainties. The authors propose to put more attention to long-term effects, complex dynamics and interdependencies in agricultural management (Darnhofer et al., 2010a). This is necessary when dealing with periodic disruptions, but

also if facing sudden disturbances which can lead to a reorganization of the systems' structure (Darnhofer et al., 2010b). These structural changes can be triggered by uncontrolled collapses or creative destruction (Darnhofer et al., 2010b). When discussing a country's preparedness for wartime, we may want to look for ways to control such transformative processes that minimizes the extent of a crisis. Darnhofer et al. (2010a) present the theoretical approach of a complex adaptive system and connect the idea to farming. They defined three characteristics in their paper which are needed in agriculture to be able to adapt. These characteristics are hence used as concepts in the fourth approach (*Complex Adaptive Systems*) of this thesis' research. They should help assess the scenarios' contribution to resilience in cattle farming. The most crucial aspects for improving adaptive capacity in Sweden's agriculture are then used to create strategies for the national food system. This analytical process is indicated in the second part of the flowchart of Figure 6. The illustration already indicates the three concepts used in this thesis, which are based on Darnhofer et al. (2010a) and defined for this research as follows: The process of *learning* is first introduced for generating new and diverse knowledge about the system and thus understanding the processes involved (ibid.). Acquired knowledge has multiple origins and can be newly created, through experimentation, or traditional and experiential (ibid.). Combining these different types of learning outcomes may also help to grasp the system's structure and dynamics (ibid.). Continues learning reveals new perspectives and allows different management solutions, which is crucial when dealing with a changing context in agriculture (ibid.). Flexibility, as second concept, can help to manage uncertainties (ibid.). It enables to react fast to surprises, but also to select long-term strategies and facilitate structural change (ibid.). *Flexibility* in agriculture can concern different factors in the system: production, processes and inputs (ibid.). The type of livestock farming, fodder availability and land use could potentially be involved, as examples. Flexible systems provide different options for management, by combining recourses and activities in different situations and thus adapt to changing conditions (ibid.). This adaptation also requires a certain degree of *diversity* in resources and functions in the system, that can be reorganized if needed (ibid.). To maintain diversity in any point of time, some resources must be reserved and sometimes implies higher costs and lower efficiency in the present (ibid.). Ideas presented in the scenarios that contribute to learning, flexibility and/or diversity in agriculture are used for building potential national strategies for Sweden's food system. Future livestock production systems therefore need to comprise these concepts to improve resilience and thus qualify as valuable management options.

3.2.5 Scale Challenges

As described in chapter 2, complex social-ecological systems are affected by multiple level and scale interactions. Figure 7 illustrates on which levels and scales this analysis is positioned. The Food Regime-System Resilience approach is connecting processes at the global to the national or local level of the spatial scale. This is indicated by the dashed line for the derived national regimes in the figure. *The Swedish Food Regimes* have a temporal frequency of several decades, but with a successively declining timeframe (cf. Figure 4 in 3.2.1). Processes involved in the regimes are therefore defined as more long-term. The thin circle in the illustration covers *Food System Activities* that are identified within the Swedish Food Regimes. Levels of the temporal scale remain the same as for the first approach but change for the spatial scale. The activities are a summary of conditions mainly on the national and local level. These are affected by interactions with higher levels, but their dynamics are not subject of this part in the analysis. *Lessons Identified*, shown as semicolons, are based on the food system's activities and therefore also concerned primarily with national and local level issues. Since these lessons present recommendations for future objectives, their temporal scale is set on mid- to long-term. The selection of scenarios comprises more precise measurements which should help to reach the stated targets. Such measurement can also be a short-term action, which explains the expanded time scale for formulated *National Strategies*. The administrative scale is included in the figure for the last approach of this analysis, which is described later in the text. The aim of the research, presented in this thesis, is not only to create national strategies for cattle farming, but also to assess their compatibility with the Common Agricultural Policy. The outcome will present *Limitations and Opportunities* at EU level, when implementing the stated strategies. These results can be a basis for policy recommendation of the upcoming Common Agricultural Policy (CAP) reforms which involves short- to mid-term decision making. This positions the outcomes at the temporal scale as shown in the figure. Interactions between EU and Member State level are of particular interest in this research, because administrative scales are commonly the source of disturbance in social-ecological systems (cf. Cash et al., 2006). This issue is the subject of the fifth approach, *Scale Challenges*, which is described below.

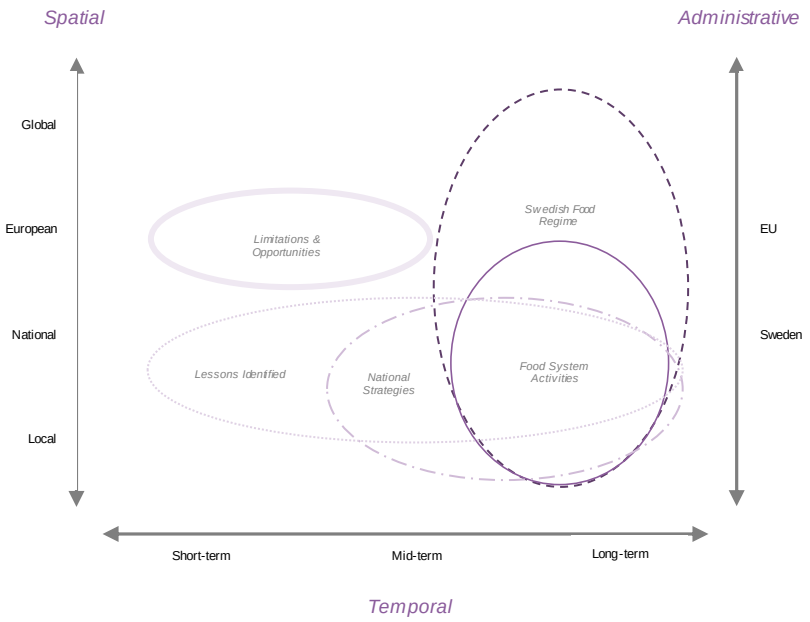

Figure 7. Positions of the five analytical outcomes on different levels of the spatial, temporal and administrative scale (inspired by Cash et al., 206)

Interactions across scales and levels the potential to affect resilience. Assessing the impact of interactions between EU and national level is therefore the purpose of the last approach, *Scale Challenges*. Since more than two third of the CAP's budget is allocated to the first Pillar (European Commission, 2013), the direct payment schemes are the focus of the analysis. The payments' envelope covers a compulsory part with *Basic Payments, Greening* and *Young Farmers Scheme*, and voluntary programs including *Redistributive Payments, Coupled Support, Natural Constraint Support and Small Farmers Scheme*. Goals of these programs and related conditions for Member States are compared with intentions of the derived national strategies of this research. Aspects in the CAP that could support the strategies (*opportunities*) are highlighted and an assessment of the AGRI Committee (cf. Ragonnaud, 2016) of the current program is used to identify potential *limitations*. If such conflicting interests are observed, the root cause of discrepancies on the administrative scale is determined.

Cash et al. (2006) defined three *Scale Challenges*, namely ignorance, mismatch and plurality. Those impede resilience in a system and could therefore help to derive effective management options for natural resources, especially for responses to problems on spatial and administrative scales (Cash et al., 2006). The stated

concepts are used in this research to understand the impact of EU legislation on national activities that are affecting the use of arable land. They are understood according to Cash et al. (2006) and outlined for the purpose of this thesis' approach as follows. *Ignoring* scale or level interactions commonly results in several management problems (ibid.). As an example, such condition is created when policies at one scale-level is restricting those on other levels (ibid.). A *mismatch* of levels and scales is the second concept and appears when management is disconnected or conflicts with the interests on the level of the concerned problem (ibid.). Finally, reducing problems to a single scale or level, despite its heterogeneity, poses another challenge (ibid.). The request to simplify political processes disregards the *plurality* of potential options for decision making and is leading to insufficient outcomes (ibid.). With this final approach, the basic structure of the methodology for the analysis is created. The results are stated in the next part of the thesis, with some preliminary conclusion along the sequence of approaches which should lead to answering research questions, as given in the introduction.

4 Results

This part of the thesis is divided into four subsections that present the findings of the analysis. The established framework has been applied and comprises different steps with intermediate results, in the processes of answering the main research questions. An historical analysis that create the Swedish food regimes is presented in 4.1 and followed by identifying Food System's Activities and Lessons from the past (4.2). The scenario selection, which is building on the former results, is shown in the third section (4.3), combined with an assessment of its resilience. Potential strategies for Sweden's livestock sector are formulized in the following and compared with objectives of the Common Agricultural Policy (CAP) in 4.4.

4.1 The Swedish Food Regimes

In the following three segments, the *Food Regime-System Resilience* approach is applied to Sweden, which is indicated in Figure 8. The different colours present the four phases of the adaptive cycle. The historical analysis identifies Sweden's key developments in agriculture and its effect on cattle farming for three main periods,

which is indicated in the boxes below the illustration. A description of the current situation in Sweden will show in which state the country can be positioned today.

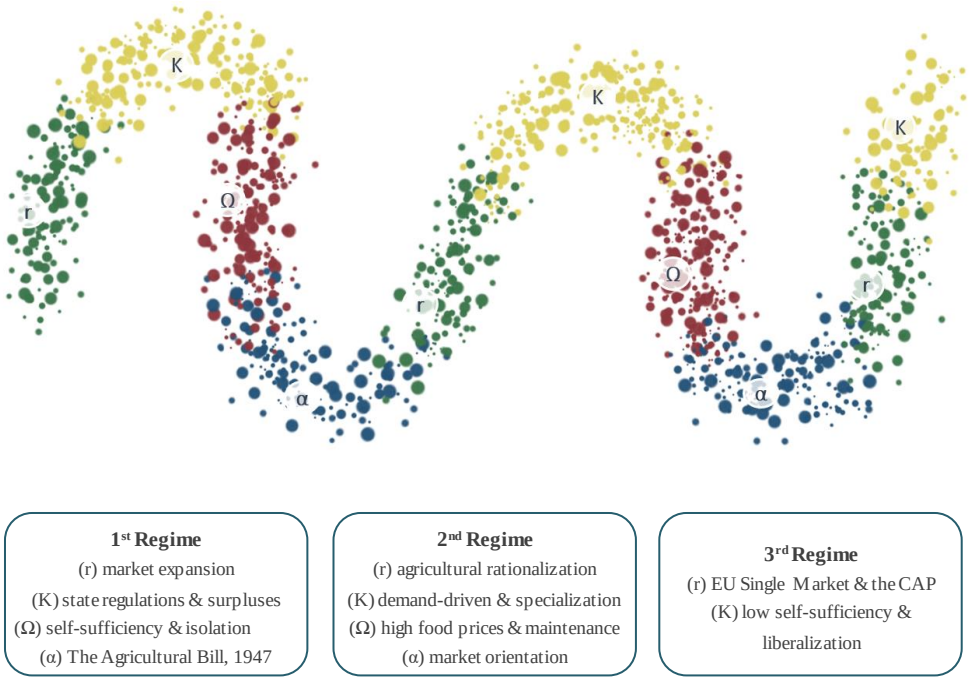

Figure 8. The three Swedish Food Regimes within adaptive cycles and some important characteristics for each regime period and adaptive phase

4.1.1 The First Food Regime: World Wars and Great Depression

Starting with the *exploitation* phase of the first food regime in the mid and late 1800, industrialization transformed Sweden's economy and agricultural structure significantly. More and more people followed non-farming related work and agriculture experienced a geographic expedition of the market (Morell, 2011). The declining number of farmers resulted in higher supply demand of agricultural products and the transport revolution enabled the country to export foodstuff (ibid.). Small-scale farming remained as dominant form of production, especially in northern Sweden (ibid.). Cattle was owned by these households primarily for on-farm consumption, implying that milk and dairy was not yet commercially sold by these farms (Martiin, 2017). Besides these traditional practices, bigger farms increasingly followed the example of Denmark and started to export butter (Martiin, 2017).

When income rates of the population increased, Sweden moved into the *conservation* period of the first food regime. This resulted in higher consumption of meat and dairy products, vegetables and imported goods and less spending on grain and potatoes (Morell, 2011). Arable land has been expanded (clearance, drainage) until the 20s and was then more and more used for livestock production (ibid.). Most farming systems included cattle, increasingly with indoor feeding or high-quality grazing (ibid.). Fodder-crops and ley have been introduced to crop rotation and hence increasingly cultivated on arable land (ibid.). Imported soy and maize fodder was further included and butter replaced oats as main export good of Swedish agricultural commodities (ibid.). Oat was mainly used as domestic fodder and animal products were sold on the marked instead (ibid.). Sweden's landscape was, despite increasing industrialization and urbanization, still defined by small farms with mixed production systems in the early 1900 (Martiin, 2010). In the 30s, roughly one third of the working population was active in agriculture (Martiin, 2016). With most holdings owning dairy cows, the number of cattle in Sweden was particularly high at that time (Martiin, 2010) and roughly 50% of the dairy producers delivered to dairy plants (Martiin, 2017). This share continued to increase in the following decades, which meant more farmers produced milk for sale (ibid.). This trend was facilitated by the government, which supported the establishment of dairy cooperatives (ibid.). Suppliers also comprised small holdings, owning only a few cows (ibid.). Not all of these farms delivered to the dairy plants, but they still accounted for 30% of the supply in the 30s (ibid.). This point in history has been marked as the begging of Sweden's agricultural regulations (ibid.). Domestic policies focused on economic protectionism, favouring farmers' interests who gained high political influence (Jörgensen, 2010). One of the most celebrated decisions was the so-called horse trade agreement in 1933 which involved a minimum price level for milk on the domestic market, independent from international market situations (Martiin, 2012). High output levels in dairy was a consequence, but also domestic forage production was supported through import taxes on feed concentrates (Martiin, 2017). The focus of production was the domestic market, particularly the urban areas (Martiin, 2010), but such high levels exceeded demand in the country (Martiin, 2017). These surpluses challenged the goal of securing farmers' income in inter-war times (Jörgensen, 2010). Butter export has therefore been promoted to manage overproduction, making up thirty percent of the of the output (Martiin, 2017). The continuing promotion of dairy consumption was additionally portrayed as necessary response, even though farmers were encouraged to further increase production levels (Martiin, 2010). The overall recovery of the economy in the late 30s improved the situation and increased consumption across Sweden (Martiin, 2012). The strong position of farmers was not only promoted by rural Sweden, but also by urban areas (Martiin, 2010). The

majority of inhabitants living in cities was born in the countryside and had still a strong connection to farming (Martiin, 2010).

It is difficult to pin down the definite transition from the conservation to the *release* period within the first food regime, since characteristics of both phases are found in the first half of the 20th century. Nevertheless, World War I is defined by the author as initial trigger in the process. During the war, mismanagement by the ruling government lead to shortages in national food supply (Martiin, 2012). When harvests failed in 1916/17 and access to grain imports became unstable, high domestic prices were related to insufficient food security measures (ibid.). The authorities responded with some interventions including rationing, but the overall management was rather weakly planned (ibid.). Additionally, despite food shortages, Sweden exported meat and livestock to Germany, leading to distrust especially among the urban population (ibid.). After World War I, economic conditions became more difficult across the country, also for the agricultural sector, with high land and production prices (ibid.). The recession followed a period of growth during the 20s, leading to higher wages and expanding modernization in urban areas (ibid.). Rural exodus, especially among young people, followed (Martiin, 2012), which not only affected the society on the countryside, but also posed new challenges for food supply (Åmark, 1952). Higher quantities had to be transported from producers to consumers (Åmark, 1952). As indicated earlier, agricultural regulations have been introduced in the following, for decreasing food imports and improving self-sufficiency (Jörgensen, 2010). Values for traded agricultural food fell rapidly after international prices decreased by somewhat 50% (González Esteban et al., 2016). This price development affected Sweden's butter exports and the number of dairy suppliers fell (Martiin, 2017). In times of the Great Depression, countries producing agricultural commodities hence suffered most and triggered a spread of agricultural protectionism (González Esteban et al., 2016). This tendency was also evident in Sweden, when the ruling Social Democrats have been supported by the Agrarians and created measures against free-trade (Jörgensen, 2010). Increasing self-sufficiency in food followed, when comparing the share of domestic production in calorie intake of 81% in the 1920s and 92% in the 30s (Åmark, 1952). These values, however, do not reflect all agricultural inputs, which means that imports for agricultural raw materials even increased, to boost production (ibid.). The actual levels are estimated at 71% and 78%, respectively (ibid.). High agricultural yields resulted from good weather conditions and innovations in animal farming, most notably in 1938/39 (Martiin, 2012). Increasing productivity allowed more production volumes, while fewer people working in the sector (Åmark, 1952). With the earlier introduced policies, overproduction continued which was declared economically insufficient by critics (Martiin, 2012). Supporters of high domestic production argued with risk prevention which was affirmed

with the beginning of the Second World War (ibid.). Learning from previous mistakes, Sweden's government implemented a range of measurements for crisis management early on (Åmark, 1952; Jörgensen, 2010; Martiin, 2012). In 1939, restrictions on imports had to be abolished and introduced for agricultural export commodities (Jörgensen, 2010) and a planned economy was further introduced for several years, during and after the war (Åmark, 1952). Stockpiling and rationing of certain food, raw materials, manure and feedstuff was part of the strategy (Åmark, 1952). The government feared to be entirely cut off from food and agricultural trade (Åmark, 1952), but further intended to convey a sense of security across the country (Martiin, 2012). Martiin (2012) considers this idea as an early stage of the Swedish welfare state. Actions taken have been crucial for Sweden, especially with the isolation by Nazi Germany in 1940, when supply from the European market was interrupted (Åmark, 1952; Jörgensen, 2010). Severe droughts brought bad harvests in 1940/41 and with limited trading and depleting stocks, the country was facing some maintenance problems (Jörgensen, 2010; Martiin, 2012). Shortages concerned feedstuff, except for beets and potatoes, and consequently the supply of manure as natural fertilizer (Åmark, 1952). Imports for these commodities were lower but continued during the war and is reflected in relatively steady production levels for certain products, e.g. dairy (ibid.). Total caloric consumption was similar during the war as in the 30s, but with minor per capita declines due to population increase (ibid.). 93% of the intake was met by domestic production during the war, but with significant variation between years and with a slight shift towards more vegetable consumption at the expanse of animal products (Åmark, 1952; Jörgensen, 2010). The stated mean value represents roughly the same self-sufficiency level as in pre-war years yet covering lower food demand due to rationing (Åmark, 1952). Beef production, primarily from culled cows, was mostly sufficient, but was still relying on imports, especially corn and oil cake (ibid.). Milk production was also high enough to maintain demands for consumption throughout the war (ibid.). Previously exported butter surplus was yet needed in the domestic market (ibid.). According to Martiin (2012), protective measures kept shortages in food supply relatively small and prevented an actual crisis situation in Sweden.

These developments influenced policy decisions in the *reorganization* phase of the following food regime in the post-war period. The Agricultural Bill of 1947 is considered Sweden's first coherent agricultural policy (Martiin, 2012) and was shaped by ideas of the 30s and 40s (Martiin, 2016). The main objectives of the bill emphasized the principle of preparedness, economic growth and income equality (Jörgensen, 2010; Martiin, 2012, 2016). The agricultural program implemented, still contained measurements of the planning economy (Martiin, 2016), such as price regulations and restricted imports (Jörgensen, 2010). Maintaining high agricultural

production was necessary to reach self-sufficiency goals of around 90% in peace time (Jörgensen, 2010; Martiin, 2016). This policy orientation was in line with the general tendency in Europe, to protect domestic production and stabilize the European market through high levels of market regulations (Jörgensen, 2010). To allow high efficiency and ensure equal income, structural rationalization in agriculture was considered necessary (Jörgensen, 2010; Martiin, 2016). This rationalization involved expropriation by the government, who then held the power over distributing land (Jörgensen, 2010). Larger and more profitable holdings with 20 to 30 hectares have been supported, to create so-called 'norm farms', on the expense of small-scale family farming (Jörgensen, 2010; Martiin, 2016). As a result, workforce was made available for other, fast growing industries in the country (Martiin, 2016). To prevent further rural depopulation, jobs in non-farming related sectors have been created as well (Martiin, 2016). Despite this development, the majority of Swedish holdings still had small-scale production in the 50s, but increasingly focused on dairy. (Martiin, 2017). Dairy production peaked in the middle of the century and milk was therefore crucial for farmers' income (Martiin, 2017). Cull and offspring from the dairy sector were the sources of beef production (Hessle, 2007). In the context of ongoing rationalization, the government tried to ensure a continuation of cattle farming in whole Sweden and hence stimulated production expansion in every region (Martiin, 2017).

4.1.2 The Second Food Regime: 70s World Food Crisis

The rise of specialized industrial agriculture of the *exploitation* phase was demanding even higher efficiency and productivity levels (Jörgensen, 2010). Fast economic recovery after the war and dropping trade tariffs facilitated growing international trade (González Esteban et al., 2016). Several commodities have been liberalized by European governments, but the focus agriculture remained on domestic markets and farmers' income (González Esteban et al., 2016). In Sweden, the previously determined level for peace time production was challenged, when addressing surplus production (Jörgensen, 2010). This turn was also a result of increasing importance of consumer demands, who asked for further rationalization and market orientation (Jörgensen, 2010). After the peak in dairy production in the early 50s, the amount of milk and number of cows fell in the following two decades (Martiin, 2017). Butter exports consequently decreased but imports of feed concentrates rose, and farmers started to purchase feed (Martiin, 2017).

Continuing rationalization in Sweden's agriculture was the political strategy of the 60s, further promoting large-scale agriculture and demand-driven production (Jörgensen, 2010). These processes characterize the *conservation* phase of the second

food regime and eventually shifted the focus from national preparedness to the market. The established 'norm farms' were already considered as too small and supported the expansions of farms with at least 30 hectares (Jörgensen, 2010). The Swedish dairy sector still produced mainly for domestic consumption, but traditional dairy farming with direct marketing was replaced by commercial cooperatives (Martiin, 2017). A simultaneous trend of fewer but larger herds, a decline in the total number of cattle and higher output per cow characterized the 1960s (ibid.). Farms with up to 10 hectares produced 22% of the total supply which means a reduction by almost half within a decade (ibid.). The demographic effects of farmers reaching retirement age was a main contribution to this development (ibid.). The government still aimed to continue dairy farming all over the country and yet, the decline in dairy farming was more evident in some regions, compared to others. This concerned plains with fertile soils and forest areas, latter especially of central Sweden (ibid.). The demand for high yields facilitated more imports of energy feed, technology investments and further specialization (ibid.). Farmers ceased mixed production and a focus on dairy lead to even higher dependence on the milk market (ibid.). More holdings started to rear suckler cows in the 70s, using specialized breeds for beef production (Hessle, 2007). Part-time farming with beef cattle was additionally increasing (Martiin, 2017). Specialization was, however, not only happening in the cattle sector but the general tendency in the 60s and 70s, which introduced the ending of subsistence farming (Martiin, 2017).

When the Food Crisis in the early 70s affected the international market, due to bad harvests in certain parts of the world, domestic prices increased accordingly to global developments (Jörgensen, 2010). Protests among producers and consumers triggered the *release* period, which forced the Swedish government to restructure the domestic food system (ibid.). Milk, cheese and pork had to be subsidized and the concept of maintenance ability was introduced, to regain national preparedness in a globalized context (ibid.). The latter was established after authorities ran into difficulties of defining self-sufficiency goals for the country, due to complexity of international networks (ibid.). The number of dairy cows has been low after the decrease in the 60s, but with even high yields, production have been increased again in the 1970s (Martiin, 2017). Farmers held high political influence and agricultural topics have been increasingly discussed outside the farming community (Jörgensen, 2010). The impacts of the green movements, capitalism and globalization on the food production and supply, are only some examples (ibid.). With this emerging attention and interest around Sweden, more and more people supported the ongoing farmers' movement (ibid.). In 1976, the Centre Party have been voted into office, which had roots in the farming community (ibid.). The new government promoted high production levels, to secure farmers' income (ibid.). High costs for subsidies

resulted in high food prices and lead to decreased purchasing power of consumers (ibid.). The decline in meat consumption affected the overall agricultural profitability negatively (ibid.).

Social Democrats reclaimed power in 1982 (Jörgensen, 2010), which is understood in this research as the beginning of the reorganization phase of the second food regime in Sweden. The party cut agricultural subsidies, for adjusting national production to the market situation (ibid.). An exception was the dairy sector, where subsidies have been kept in place, but livestock farmers still faced reduced investment payments (ibid.). The new government first increased dairy production after the decline in the 70s, but a milk quota has been implemented in the mid-80s as response to surpluses (Martiin, 2017). Income parity for farmers became less relevant on the political agenda with decreasing numbers of employment in the agricultural sector (Rabinowicz, 2003). Further deregulation in the food sector took place at the end of the 80s, in the context of GATT negotiations (Jörgensen, 2010). Despite these measures, Swedish food prices remained high and were even 60% above the EU average in 1990 (Rabinowicz, 2003). This lead to reforming the Swedish agricultural policy in the early 90s, with the aim of internal deregulation (Rabinowicz, 2003).

4.1.3 The Third Food Regime: current state in agriculture

By joining the European Union, Sweden entered the European Single Market (cf. European Commission, 2018) and implemented the Common Agricultural Policy (CAP). As a consequence, the country became more connected with the Member States, which indicates the *exploitation* phase in the early 90s of the current regime. Since decisions to liberalize domestic agriculture have been made shortly before applying for the EU membership (Rabinowicz, 2003), it is not surprising that Sweden had been one of the strongest supporters of deregulating the CAP (Eriksson & Peltomaa, 2017). The policy was introduced in the 60s and first reformed in 1992 (Cantore et al., 2011). Known as MacSharry reform, policy measures included the introduction of direct payments to farmers that replaced market price supports and aimed for limiting overproduction across the EU (Cantore et al., 2011). In 2003, higher focus on markets was achieved by decoupling payments from production that further contributed in decreasing surpluses (Cantore et al., 2011). Measures to protect environment, climate and consumers have been successively introduced over the past decades, as well as programs supporting rural development (Cantore et al., 2011). With each EU reform, this policy continues to enhance its market orientation (European Commission, 2013). It can hence be suggested that the *conversation* period has already been introduced within the EU (cf. Figure 8). It is expected that

global liberalization and big market sizes can mitigate instabilities in prices (Ragonnaud, 2016). Higher vulnerabilities, which is common in this adaptive phase, might be reflected in the severe fall of the milk price in 2009 and 2014, which was, and still is, affecting markets around the world (Ragonnaud, 2016). The current financial framework of the CAP (2014-2020) includes approximately 400,000 billion Euros (European Commission, 2013). ¾ is ascribed to Direct Payments in Pillar I and the rest is available for Rural Development programs of Pillar II (European Commission, 2013). Farmers are entitled to basic direct payments when meeting conditions of cross-compliance (ensuring good agricultural and environmental conditions) and Member States need to assign 30% of the payment envelope to greening measures (for improving environment and climate) and up to 2% for supporting young farmers (European Commission, 2013). Additional voluntary programs include redistributive and coupled payments, support when dealing with natural constraints and the scheme for small farmers (European Commission, 2013). These conditions are hence the frame of Sweden's agricultural sector, as it is today and will develop in the next years.

The tendency of fewer but bigger farm units, which was distinctive for the second halve of the 20th century, mostly continued until today, resulting in an average size of 41 hectares of arable land (Statistics Sweden, 2017). While Sweden's population was and is steadily increasing and almost doubled during the past 100 years, namely from 5.8 mil. in 1917, to 10.1 mil. in 2017 (Statistics Sweden, 2018), the rural population declined (Statistics Sweden, 2017). Only 2% of Sweden's labour force is currently working in farming, with a continuously ageing population (ibid.). At the same time, labour requirements are relatively small, which is reflected in declining working hours (ibid.). The total area of arable land continues to decline (ibid.). Domestic production is dominated by livestock farming and ley and wheat cover the biggest share of cultivation (ibid.). The share of holdings with crop production, however, increased in the past 20 years and decreased for livestock by roughly the same amount (ibid.). This reflects the significantly lower self-sufficiency levels for domestic livestock products, compared to cereals (beef 50%, pork and poultry 65%, dairy 90%, cereals 100%) (Röös et al., 2016b). Sweden is a net-importer for dairy products, except milk powder, and is nowadays exporting only minor amounts of butter (Lantbrukarnas Riksförbund, 2016). Farms in different regions of the country focus on production systems, depending on natural limitations (Josefsson, 2015). The south is thus characterized by cash-crop, poultry and pig production, the central part by cattle farming and the north by leys and barley cultivation (Röös et al., 2016b). This specialization resulted in a declined number of livestock holdings and growing herd sizes (Statistics Sweden, 2017). Dairy production remains important in Sweden's agriculture, but cattle farming is still declining and experiences a

structural change from dairy to suckler herds (ibid.). While the number of dairy decreases, farming with suckler cows becomes more popular (ibid.). Consequently, the total number of cattle farms dropped by almost 2/3 since 1990, but even stronger in dairy sector, which covered over 25,000 holdings in 1990, but not even 4,000 in 2016 (ibid.). Average sizes of dairy herds are at 85 cows and 19 for suckler (ibid.). Both numbers increased over time, yet more rapidly for dairy farming (ibid.). Cattle is commonly reared as intact bulls in Sweden, through forage-based intensive indoor feeding (Hessle, 2007). However, for grazing semi-natural grasslands, some farms changed to steer farming, especially when sufficient support payments were offered (ibid.). Such pastures emerged from traditional grazing management in the course of history and are mainly located in remote forest areas (ibid.). Today, these areas are rather managed to preserve biodiversity (ibid.). While domestic consumption of dairy is decreasing, numbers for meat goes up and doubled for cattle since the 90s (Jordbruksverket, 2017). According to Hessle (2007), this increase cannot be met with national beef production and is reflected by higher imports (Statistics Sweden, 2017).

4.2 Lessons from Food System Activities

Following the description presented in the methodology, Ericksen's (2008) idea of conceptualizing the food system is used to obtain system activities that are most relevant for the purpose of this thesis. The first column in Table 2 shows the selected elements *production*, *distribution* and *exchange*, which contribute to the system's main outcome of *food availability* (according to Ericksen, 2008). The three concepts are applied to the derived Swedish food regimes and activities of each period are identified, with a focus on cattle farming in the conservation and release periods. The results of this *Conceptual Framework* approach are summarized as keywords in the table below and elaborated further within the subsequent approach.

Table 2. *Food system activities of the three Swedish Food Regimes, concerning the factors Production, Distribution and Exchange*

1st Food Regime

Elements of Food Availability	Food System Activities
Production	1/3 active in farming; small-scale farms; diversified farming systems; focus on high production levels; wide regional distribution of cattle; most holdings with dairy cows; milk surpluses; 50% supplied to dairy plants; beef from culled dairy cows; coping with bad weather/harvests; slight shift towards vegetable production
Distribution	agricultural regulations; domestic food supply; support of dairy cooperatives; trade and price regulations; protected milk price; high land and production prices; planning economy: stock-piling, rationing
Exchange	protectionist policies; 93% self-sufficiency in food; temporal market isolation; varying butter exports; continues feed (corn, oil cake) and fertilizer imports

2nd Food Regime

Elements of Food Availability	Food System Activities
Production	agricultural rationalization; farm-size expansion; fewer, bigger cattle herds; specializing in farming (dairy); focus on demand-driven production; changing milk supplies; increasing yields and technological improvements; consumer influence
Distribution	internationally connected supply system; production for domestic market; high food prices; dependency on milk market; subsidisation for domestic livestock systems; milk quota
Exchange	free-trade policies; maintenance ability; imports of high energy feed; low but increasing butter exports

3rd Food Regime

Elements of Food Availability	Food System Activities
Production	2% agricultural employment; large-scale, specialized farming; low labour requirements; animal husbandry dominates but decreases; intensive indoor bull rearing; ley cultivation; abandoning of arable land; shift to more suckler herds and crop production; grazing for non-farming purposes; high regional variations
Distribution	market-oriented supply; the European Single Market; high supply demands
Exchange	liberalization of the Common Agricultural Policy; low self-sufficiency in livestock commodities; net-importer in dairy

The historical analysis, as presented in the table, gives an idea of the distinct domestic conditions for food supply within the context of a globalized world. For creating recommendations based on these results, *Inductive Reasoning* (cf. 3.2.3) is applied as approach in the following. The stated systems' activities are thereby understood as observations relating to the agricultural sector, at different points in time. Activities concerning food production (cf. Table 2) constitute observed patterns and trends that are involved in the production system. Food distribution and food exchange related activities (cf. Table 2) cover the structural foundation of its political economy. The patterns and structures have been identified for each regime and described in more detail as follows.

Patterns and trends in the production system:

In World War II, many people in Sweden have been actively farming. These farmers managed, to a major extent, small production units, consisting of different agricultural activities and outputs. Cattle was commonly included in the farming system, all over the country and meat production was based only on culled cows from the dairy sector. Production levels have generally been kept high and around half of the milk was supplied to dairy plants, and thus for sale. The dairy sector created surpluses which allowed sufficient milk supply during most of the second war. Severe droughts in 1916/17 and 1940/41 affected harvests and reduced yields and a slight shift towards more vegetable cultivation was evident in the early 40s. Sweden started to promote agricultural rationalization after the war, which lead to changes in the agricultural sector. The number of holdings has been reduced and remaining farmers started to operate bigger units. New technologies have been applied and demand-driven, high yielding and specialized production system created. Cattle herds became fewer, but bigger and milk supplies changed from the 60s to the 70s, according to market price and political agenda. Also, consumers' opinion started to have a bigger impact on the production process. By today, only 2% of Sweden's population is employed in agriculture and is increasingly managing large-scale, specialized farm businesses. Farming systems with low labour requirements emerged, arable land becomes more and more abandoned and production shows high regional variations. Livestock is dominating Sweden's agriculture, but the share of crop production increased, while cattle farming is declining. Ley cultivation and intensive indoor rearing of bulls is common in the sector. Dairy production remains important for Sweden, but the share of suckler herd farming becomes bigger.

Structural changes in the supply chain:

Market interruptions in the early 1900 resulted in high land and production prices. This lead to a spread of agricultural protectionism in the 30s, which was also marked

as the beginning of state regulations. Market regulations have been implemented, e.g. for stabilizing domestic milk prices and supporting the development of Swedish dairy cooperatives. Agricultural supply focused on the domestic market and showed self-sufficiency levels of 93% for food. Surplus production was managed with butter exports, which consequently decreased with market isolation by Germany in World War Two. Export bans have been implemented, and pre-war import regulations lifted. To prevent shortages, a planning economy was implemented, including food and other resource rationing and stock-piling. Sweden managed to continue feed (especially corn and oil cake) and fertilizer imports, which was important for maintaining domestic food supply. When regaining access to foreign markets after the war, free-trade policies have been introduced and an internationally connected supply system developed. Sweden's dairy production was, however, focusing on domestic supply, but increasingly depending on the global milk market. Imports of feed concentrates became more important and the objective of self-sufficiency was replaced by maintenance ability. When prices fell in the 70s on the international market, livestock products have been subsidized, which resulted in high prices for consumers. With a new government in the early 80s, milk quotas limited high production levels and lowered increasing butter exports. By becoming an EU Member State, Sweden entered the European Single Market. The implemented Common Agricultural Policy is progressively liberalized, and the supply chain focuses on market demands. With the decline of the rural society and the overall increase of Sweden's population, supply quantities are comparatively high nowadays. At the same time, self-sufficiency on the national market became lower for livestock commodities. More dairy products are imported than exported, including butter, and grazing on traditional pasture land is primarily done for nature conservation purposes.

Lessons Identified for the current regime:

To find scenarios that can build the basis of possible future strategies for Sweden's food system, some conclusions are made by the author at this point. Conclusions (or theories) from the historical analysis which gives the opportunity to include a learning process when selecting suitable research results (scenarios). Starting with the first regime, protectionist policies have been identified as important measure for crisis management in World War II. In the context of different state interventions, high self-sufficiency levels and diverse and flexible production systems have been maintained across the country. This involved sufficiently high production levels for rationed demands in most years. Bad weather conditions and limited imports of agricultural inputs have been identified by the author as major challenges for domestic supplies. When looking into the second regime, domestic agriculture became more connected with the international market. Agricultural regulations have been applied

as crisis measure but turned out to be inefficient for the domestic market. Considering these developments, it could be assumed that certain market interventions are less effective in a more liberalized and rigid system. This conclusion would indicate that limited abilities of national control is a potential challenge in the current regime. Three main lessons have been derived for this research, based on the findings described:

i. vulnerabilities in the current system could give reasons to initiate a guided transformation into a new food regime and hence introduce substantial structural changes
ii. new solutions in agriculture should be considered that address risks, related to changing international markets
iii. Sweden's EU context and changes in demographics need to be included in future strategies, to allow successful crisis management

These statements are understood as recommendations for potential strategies in Sweden's livestock sector and they will be addressed in the selection of scenarios, which are discussed in the following chapter.

4.3 Options for Future Swedish Cattle Framing

In this section, eight papers are presented, mainly research at SLU, which could help in developing national strategies for cattle farming. Conclusions from the previous analysis have been considered in the selection of the examples and are listed in Table 3, showing the respective lessons (cf. 4.2), title and author(s). Table 4 is pointing out scenarios of these papers, which are considered for this research, and how those are translated into the potential *National Strategies* (cf. 4.4). A short summary of the selection can be found in the following text, as well as an assessment on its contribution for resilience in cattle farming. The three stated concepts *learning*, *flexibility* and *diversity* are used for this fourth approach (*Complex Adaptive Systems*). The results are hinting at aspects in the scenarios which potentially increase the adaptive capacity of Sweden's agri-food system and could therefore be included in future strategies.

Table 3. *Selection of papers with relevant scenarios, their references and indication for the assigned Lesson*

Lesson	Paper	Author
i.	Gut feelings and possible tomorrows: (where) does animal farming fit	Garnett (2015)
i.	Protein futures for Western Europe: potential land use and climate impacts in 2050	Röös *et al*. (2017)
i.	Limiting livestock production to pasture and by-products in a search for sustainable diets	Röös *et al*. (2016b)
ii.	Producing oat drink or cow's milk on a Swedish farm—Environmental impacts considering the service of grazing, the opportunity cost of land and the demand for beef and protein	Röös *et al*. (2016a)
iii.	Sustainable management of Swedish semi natural pastures with high species diversity	Kumm (2003)
iii.	Does re-creation of extensive pasture-forest mosaics provide an economically sustainable way of nature conservation in Sweden's forest dominated regions?	Kumm (2004)
iii.	Use of beef steers for profitable management of biologically valuable semi-natural pastures in Sweden	Hessle & Kumm (2011)
iii.	Searching for economically sustainable Swedish beef production systems based on suckler cows after decoupling EU income support	Salvid & Kumm (2011)

Table 4. *List of the considered scenarios from the selected papers, references and categories for National Strategies*

Author	Cited Scenarios	National Strategies
Garnett (2015)	Livestock on Leftovers	
Röös *et al*. (2017)	Ecological Leftovers	**Ecological Leftovers**
Röös *et al*. (2016b)	E-Milk; Suckler	
Röös *et al*. (2016a)	PLANT	**PLANT**
Kumm (2003)	Continued grazing on existing farms; Nature conservancy entrepreneurs; Large pasture-forest mosaics	
Kumm (2004)	Extensive pasture-forest mosaics	**Economic Sustainability**
Hessle & Kumm (2011)	Steer 30 months	
Salvid & Kumm (2011)	Organic with high environmental grants; Conventional with outdoor wintering	

4.3.1 Long-term structural changes

When addressing the first lesson, identified in section 4.2, a national strategy is needed that involves transforming Sweden's agri-food system. With selecting scenarios that would facilitate bigger changes and objectives further in the future, high uncertainties are thus assumed. Starting with Garnett (2015), *Livestock on Leftovers* is one out of four predictions for future global food production and constitutes the basis for three additional scenarios, included in the analysis. The idea has been put into the context of Western Europe (Röös et al., 2017) and Sweden (Röös et al., 2016b). All of these scenarios imply that the food system is closed, according to geographical boundaries of their spatial scale, and livestock farming is based on feed from ecological leftovers. Meat and dairy supply is thus limited by pasture land and by-products, unsuitable for crop production and human consumption, respectively, and available within the boundaries. This creates a more localized system, but also requires restrictions in trading. The scenarios thus combine the production and consumption side of the livestock sector, aiming for sustainable use of resources, as well as achieving diets with lower meat intake. Arable land is consequently prioritized for plant-based food production and no-longer used for livestock. The objective of finding ways for sustainable consumption and production, in these scenarios, could be considered as learning process. Knowledge about scarcity or

mismanagement of resources is used for creating new ideas for agri-food systems. Prioritizing less resource-intensive production can offer options for alternative uses and thus more flexibility and potentially a diversified production. However, when it comes to supply and exchange, a closed and localized system is clearly limiting opportunities in this regard. Nevertheless, dairy production would depend less on markets and could be related to more flexibility in management.

When looking at the scenario for Western Europe, *Ecological Leftovers* (Röös et al., 2017), the proposed diet spares half of the agricultural land available. Opportunities for alternative uses are suggested in the paper, including biofuel production, exports and more extensive farming. This shows that higher redundancy of land is created in such system, which could provide flexibility in using the resource and enables more diverse production processes. It is assumed in the paper that yield gap can be closed and waste is reduced by 50%. This could, again, contribute to higher land availability with improving production efficiency, but it may also be understood as lower flexibility for intensification. Imports of protein feed and arable land for fodder production can be substituted by pasture land and food by-products (e.g. cereal bran, oil cakes) in the scenario. To increase the share of grazing animals, male calves are entirely raised as steers. Dairy cows are prioritized in the created system and suckler herds are only considered if feed is available after meeting dairy demands. Pigs are fed according to available food wastes and remaining by-products and poultry entirely excluded from all production. Such livestock management could offer more flexibility when it comes to the choice of production on released arable land. High diversity is potentially created for production processes (crop production, grazing, dairy and suckler), but the level for livestock could be low, when implemented only this system in the whole region.

Relevant scenarios on the scale of Sweden, *E-Milk* (extensive dairy production) and *Suckler* (suckler herds for semi-natural grassland, SNG) (Röös et al., 2016b), take conditions of national agriculture into considerations. 40-50% of agricultural land is made available, according to the research, and alternative uses are already included in the system, namely replacement crops for recommended diets and bioenergy. The area of grassland used is restricted to Sweden's semi-natural habitats for sustaining biodiversity. Losing these areas means losing ecosystem-services and would lead to less heterogenic landscapes. The scenarios would hence contribute to more diversity in Sweden's countryside. Preserving semi-natural pastures also means including traditional grazing management and combining it with modern farming practices. This approach can build knowledge and thus opportunities for new perspectives and solutions in agriculture. Within the Swedish context, some arable land is needed for winter feed and also concentrates, as stated in the paper.

The leftovers remaining after cattle feed is used for both, pigs and poultry, and for bioenergy production. These systems combined could be considered a diverse system. The two scenarios yet present extreme examples of cattle farming, either with 100% dairy or suckler cows. Meat production is relatively low in the scenarios. As indicated earlier, protein intake is substituted by plants, which requires a certain share of the land released by reduced livestock. Crop cultivation consequently covers less ley and cereals, but higher shares of legumes, oilseeds, fruits and berries. This would mean an increase in diversity in crop production. Limitations of cultivating legumes are addressed in the paper. More legumes and a decreasing share of ley potentially lower soil quality and especially an issue in the suckler scenario. This aspect might indicate that including dairy farming provides more variety in protein sources and thus increases flexibility in crop production. Dairy production is still reduced and finding plant-based alternatives could be crucial in the future, which is subject of the next scenario example.

4.3.2 New production concepts at the farm level

Dairy products are important in Swedish diets but are considered resource intensive. The scenario *PLANT* by Röös et al., (2016a) is thus introduced, which suggests a production system where milk is replaced by a substitute, based on oats and rapeseed oil. The boundary of this system is at farm level and the production system thus ends at its gates. It consists of arable land, SNG and is quasi self-sufficient in feed production (excl. fertilizers, pesticides, medicine). The number of suckler cows is restricted to the amount required to graze these pastures and are only additionally fed on crops during the winter. Land not needed to produce food and feed is cultivated with grass-clover for biofuel. 80% of the male off-spring is kept as intact bulls which requires additional arable land for feed. Suckler cows and their offspring yield some amounts of beef meat, but poultry and pigs are not included on the farm. Besides livestock and bio-energy, the production of oat drink is a main part in the system. By-products from oats and rape-seed oil therefore needed is further used as protein feed. This summary presents an option for farming that involves different production processes and outputs and thus offers a diversified system, when compared to specialized agriculture. By restricting cattle to the pastures, land resources are made available for other uses and allowing a more flexible production. Furthermore, knowledge is generated with combining traditional grazing management on semi-natural grasslands with the production of new agricultural commodities. Including plant-based alternatives instead of dairy creates possibilities for reorganizing resources and activities on the farm. Establishing innovative businesses that consider resource efficiency and the idea of a circular production approach, may be considered as response to the second lesson, stated in the previous chapter. More

resource redundancy and thus flexibility could be created at farm level that provides more possibilities to react in crises situations on a smaller scale. Resilience is built at the farms which are acting in the context of the modern globalized food system.

4.3.3 Pasture management as prerequisite

Kumm (2003, 2004) addresses vulnerability of Swedish farming systems concerning EU allowances and support payments that can account for 50% of farmers' income. Options for creating grazing management that is economically more efficient is hence discussed in the papers. Remaining at farm level, Kumm (2003) creates scenarios for cattle farming in different regions of Sweden that can preserve SNGs, consider social aspects in domestic agriculture and assess feasible management forms. Grazing of semi-natural pastures in the regions show different conditions, depending on the location (south, north), landscape (planes, forest area), livestock (owned, rented) and holdings (small-/large-scale). Existing small-scale farms in forest areas that are using their own livestock require external support for pasture management and housing in the winter for *continued grazing practices* on SNG. For pastures located primarily in southern plane-areas, grazing animals can be rented from nearby large-scale farms with expanding production. *Nature Conservancy Entrepreneurs*, which move cattle herds between different valuable pastures, are an option for small-scale farms in scattered forest regions that lack own livestock for grazing management. Finally, the creation of *large pasture-forest mosaics* re-establishes traditional landscapes of Sweden's forest regions. Latter involves an expansion of grazing area by using overgrown formally managed pastures and marginal adjacent arable and forest land. Economic sustainability of the latter approach is assessed in Kumm (2004). When creating these landscapes and receiving environmental payments for sustaining them, costs per hectare of grazed pasture can be reduced. This is explained with the increased area and low opportunity costs of the land. To be able to successfully graze these pastures, Hessle and Kumm (2011) address the issue of rearing beef cattle as intact bulls. These are finished after weaning with intensive indoor feeding within a shorter period until slaughter compared to steers, which can save costs. *Steer grazing* can be profitable when managing areas that are eligible for higher environmental payments and support, and also bigger pasture sizes. In addition to these two factors, Salevid and Kumm (2011) identified suckler grazing with *organic farming* and *conventional outdoor wintering* as more profitable systems. Income is either increased by receiving grants of organic production, or allowances and cost cuts with outdoor wintering.

The four scenarios consider the EU's effect on resilience in Sweden's agriculture and the socio-economic challenges of farmers. They could be useful for the third defined lesson and hence be taken into account for future crisis management. The presented approaches for cattle farming involve learning processes which acknowledge the importance of traditional landscapes but also recognize problems of farmers regarding profitable management of these areas. Preserving or re-establishing Sweden's SNG are further interesting when looking for alternatives to intensive cattle farming that is relying more on feed from crop-land. Using permanent pastures, especially in regions with natural con-strains for cultivation, could help to release arable land for plant-based production elsewhere. This may be considered a requirement when following scenarios presented earlier (cf. Röös et al., 2016a; b, 2017) that rely on using pastures for future meat production. It would therefore be necessary for different strategies to allow economic sustainability and thus keep farmers in business, who maintain the land now and onwards. Suggested ideas provide a range of grazing systems to farmers, suitable for different and changing conditions, e.g. varying needs and possibilities in all regions.

4.4 Connecting National Strategies with the CAP

By summarizing the results of the resilience assessment, *National Strategies* for Sweden's cattle sector have been developed. These suggestions are pooled into three categories, earlier indicated and explained in Table 5. These categories are derived from the scenario examples discussed in section 4.3. The author's conclusions for possible strategies are related to earlier identified lessons and positioned on the temporal scale, according to their future scope. *Ecological Leftovers* involves localized production systems, aiming for sustainable resource management. Sustainable management, in this regard, implies prioritizing plant over livestock production, since it is less resource intensive. When cattle is restricted to feed, availability from by-products and pasture, more land is released for alternative use and thus provides more flexibility in land use. Dairy production still has great importance in Swedish diets and the *PLANT* strategy is a resource-efficient option for covering dairy demands in times of scarcity. A production system is created which is innovative, requires fewer land resources and supports multifunctionality in farming. *Economic Sustainab*ility is crucial to counteract further losses of traditional pasture land. To be able to provide domestically produced food for a growing population, preventing further abandonment of agricultural land, and thus rural development, is key. The suggested ideas aim to preserve or re-establish grazing land, but also take farmers' economic reality into account. When creating measures on a national level, the EU framework should be taken into consideration. It is assessed if programs of the

CAP's first pillar are compatible with objectives and conditions for the stated strategies, or even support them (*opportunities*). In case of contradictions, *limitations* between the two administrative levels, EU and Member State, are recognized. These inconsistencies are further analysed with the final approach of *Scale Challenges* (cf. 3.2.5), as demonstrated in Table 6. The root of the problems is thereby assessed and could be considered in future policy decisions, to facilitate national preparedness within the CAP context.

Table 5. *Detailed description of the three derived national strategies for Sweden's livestock sector*

Strategies for Swedish Cattle Farming	
i.	*vulnerabilities in the current system could give reasons to initiate a guided transformation into a new food regime and hence introduce substantial structural changes*
Ecological Leftovers (long-term)	When aiming for national preparedness, food systems that are based on domestic production, are following sustainable resource use and deliver low-meat diets, are an interesting option for the future livestock sector. In these localized and extensive production systems, arable land is prioritized for plant-based production and by-products and pastures are determining the number of cattle. Permanent grassland is thus a central part of the system and offers potential for structural change. Male offspring is hence reared as steers for grazing. Imports and fodder crops are replaced by biomass from domestic grasslands and left-overs. Some arable land is cultivated for winter feed and concentrates, and remaining leftovers can be used in bio-energy production. Certain replacement crops (e.g. legumes) are further needed to ensure sufficient protein supply. Sparing arable land creates redundancy that allows reorganization of the resource and is making the production system more flexible. Aiming for sustainable farming could require new policies related to agricultural resource management.
ii.	*new solutions in agriculture should be considered that address risks, related to changing international markets*
PLANT (mid-/long-term)	Farming systems that offer an alternative to dairy production may become more relevant in times of scarcity. A strategy is therefore proposed that focuses on less resource-intensive production and delivers high self-sufficiency on the farm-level. It combines resource efficiency and a diversified farming structure with producing a plant-based substitute for milk. In Sweden, this product can be based on oat and rape seed oil, which additionally produces by-products suitable as protein feed. When limiting the size of suckler cow production to the area of available semi-natural pastures, more additional land can be used, e.g. for bio-energy. Linking traditional farming with the production of new commodities can stimulate new innovations in the agri-sector, which is less vulnerable to market changes.

	iii. Sweden's EU context and changes in demographics need to be included in future strategies, to allow successful crisis management
Economic Sustainability (mid-/short-term)	Pasture-land that was used for cattle farming in history or is still grazed, but now threatened to be abandoned, could become more important in the future. These areas are often unsuitable for cultivation and nowadays not profitable for grazing management but would increase land redundancy. A focus is set on suckler cows which are more suitable for preserving semi-natural grassland. To keep domestic cattle farmers in business, measures to improve economic sustainability is needed. This can comprise external support for small-scale farms with grazing and winter-housing. Establishing Nature Conservation Entrepreneurs are an option for taking over certain management tasks in forest dominated areas. In regions with poor conditions for agriculture, creating large pasture-forest-mosaics can further be a profitable option. This means re-establishing overgrown arable land and creating traditional farming landscapes. Economy of scale and low opportunity costs can improve profitability of grazing. Applying organic farming for increasing environmental payments or including new grazing concepts, like outdoor wintering, that reduces costs, can be considered in addition. Different approaches for different farming conditions could diversify the agricultural sector and provide farmers with more flexibility in the production design.

Opportunities:

The CAP's direct payments are decoupled from production which means that agricultural output is not required to obtain this support (Ragonnaud, 2016). The Basic Payment Scheme is a general income support for farmers (European Commission, 2017) which is granted per eligible hectare of the holding (Regulation (EU) 1307/2013) and makes up around 50-60% of the Pillar I envelope in most Member States, including Sweden (55%) (Ragonnaud, 2016). It is the most stable part of the income, especially crucial for grazing livestock and mixed production systems (Ragonnaud, 2016) and therefore considered important for proposed management options of the three strategies. Decoupled direct support was further observed to encourage farmers to continue agricultural management and thus helped in preventing further land abandonment (Brady et al., 2009). These payments could therefore help in maintaining domestic production which is required for the long-term vision of a localized system in the first strategy, *Ecological Leftover*. Since exiting farming is a major threat to semi-natural pastures (Kumm, 2003), the decoupled Basic Payments could prevent further decline. It can therefore help in achieving the key objective also in the *Economic Sustainability* strategy, of maintaining management on these grasslands. The income effect of direct payments can further provide farmers with the financial means to invest in new production solutions and the requirements for receiving bank loans (Ragonnaud, 2016). The basic payments could therefore promote investments in new innovations, such as milk alternatives or bio-energy, as proposed in the *PLANT* scenario.

The Greening payments are a compulsory scheme and is including environmental goals into Pillar I of the Common Agricultural Policy (European Commission, 2013). These goals are preserving permanent pastures, diversifying cropping and creating economical focus areas, such as agro-forestry, green cover or nitrogen fixating crops (Regulation (EU) 1307/2013). The scheme is therefore promoting cultivation of legumes (cf. nitrogen fixation), which are proposed as replacement crops in *Ecological Leftovers*. Measures that improve nutrient cycling could further help when aiming for closed production systems on a national and regional level (cf. *Ecological Leftovers*) or of a farm (cf. *PLANT*). The aim for self-sufficiency in *PLANT* is further related to diversified structures at the farm, which could also include diversity in crop production. As Greening supports management of permanent pastures, it can promote the management suggestions for cattle farming in *Economic Sustainability*. Permanent pastures are also an important part of the farming system in the other two strategies and the basis for meat production. The compulsory Young Farmers Scheme should benefit when first entering the sector (European Commission, 2013), which may help to establish new production systems. This could help in realizing ideas of *Economic Sustainability* and *PLANT*.

Among the voluntary programs of Pillar I, some coupled payments can still be introduced for specific productions or sectors (cf. Regulation (EU) 1307/2013). Such payments could promote higher shares of plant-based and sustainable production of *Ecological Leftovers*, establish crops which are necessary to produce milk alternatives and enable suckler herd farming in *PLANT*, and different grazing management of *Economic Sustainability*. The Small Farmers Scheme supports smaller units and Redistributive Payments can be used to rebalance payments for supporting small- and medium-sized farms (European Commission, 2013). These two schemes could therefore help in maintaining grazing where areal expansion is less likely and thus enable *Economic Sustainability* of all sizes. Payments for natural constraints should support farming in less-favourable areas (cf. Regulation (EU) 1307/2013) and thus realize all three strategies across Sweden and especially the North.

Challenges:

An assessment by the Agricultural Committee of the European Parliament showed that the new programs after the 2013 reform do not always meet their objectives (cf. Ragonnaud, 2016). Even though direct payments are stabilizing farmers' income, they do not necessarily contribute to decrease risks for the most dependent farms (ibid.). They state that direct support is not well targeted and had only limited affect in counteracting market instabilities (ibid.). More means for investing in new production systems in the *PLANT* strategy might therefore not be assured with direct

support. This can be seen as mismatch of measures set on the EU level, to address effects of the global markets on the local economy. The assessment further states that the majority of the direct payments (approx. 80%) is benefitting only 20% of all recipients and 95% of the funding is supporting farmers with higher income than the median level (ibid.). This is further related to low targeting and another mismatch, where EU basic payments do not improve the situation of farmers in need and make schemes for smaller holdings ineffective (opportunities of Small Farmers Scheme and Redistributive Payments).

Another major issue of direct support, and especially the untargeted basic areal payments, is the capitalization into land value and rents (Ragonnaud, 2016). Land prices increase over time and are benefitting big landowners in the most profitable regions (Mark Brady, pers. comm.). Basic payments are not fully connected to farming and leave the agricultural sector (ibid.). Especially farmers who are entering the market or trying to expand are disadvantaged (ibid.). With these increased land values, additional direct payments further become less effective, e.g. more targeted programs of Pillar I (ibid.). Keeping these basic areal payments is therefore considered as ignoring effects on competitiveness, of different regions and sectors (cf. Voluntary Schemes), and local land management (cf. Young Farmer Scheme). Instead of addressing the source of insufficiencies at the EU level the additional programs are added on top, to compensate effects on the Member State level. Such orientation is understood here as simplification of the problem which may conceal more appropriate options for future reforms. The Greening scheme seems to have potentials for implementing the three strategies, as described in the opportunities, but is again bearing the problem of a mismatch. There are only minor land changes currently related to payments for pastures and diversification (ibid.), which means lower opportunities for using the payments for creating the proposed production systems.

Table 6. *Potential Scale Challenges of the National Strategies and the Pillar I of the Common Agricultural Policy*

	Limitations		
National Strategy	Ignoring	Mismatch	Plurality
Ecological Leftovers	Basic Payments *(land capitalization)*	Greening *(land use effect)*	Voluntary Payments *(inefficiencies)*
PLANT	Basic Payments *(land capitalization)*	Basic Payments *(low income effect, low targeting)* Greening *(land use effect)*	Young Farmers *(inefficiencies)* Voluntary Payments *(inefficiencies)*
Economic Sustainability	Basic Payments *(land capitalization)*	Redistributive Payments *(low targeting)* Small Farmer *(low targeting)* Greening *(land-use effect)*	Young Farmers *(inefficiencies)* Voluntary Payments *(inefficiencies)*

The overview in Table 6 indicate those parts of Pillar I that should be addressed in the upcoming reform of post-2020, when following recommendations of this research. It is suggested to enable application of the proposed strategies for Sweden. Especially land capitalization and related low targeting becomes obvious and recommendations are presented in the following part, as well as a discussion of the general results.

5 Discussion

The findings of this research are discussed in the following subsections, starting with a reflection on the main results of the analysis in 5.1 and 5.2 will discuss the outcomes within the theoretic framework that has been selected for this thesis. These two chapters should give an answer to the questions asked in the very beginning of the research process:

a. *Which production systems for Swedish cattle farms can increase resilience in domestic resource management?*

b. *What limitations and opportunities are to be found in the Common Agricultural Policy, for implementing potential national livestock strategies in Sweden?*

Comparison with other research concerning different aspects of the approach and results can be found in 5.3, which can support and challenge the conducted research. In 5.4, the author discusses the broader context of food system's research, her own scientific contributions in this field of study and reflects on the methodology applied here.

5.1 Reflection on main results

During international crises, countries can be forced into a state of emergency. Looking at Sweden's experiences from the two major crisis periods of the past 100 years could provide valuable information about the most crucial processes. These may affect food security in comparable events in the future and are therefore discussed in the following. Adequate management seems to be key in preventing supply shortages when comparing the two World Wars. The government was able to learn from political mistakes made during World War I and minimized interruptions of supply and distribution during the years of isolation in the early 40s (cf. chapter 4.1). To allow appropriate consideration of lessons from the past in today's decision making,

the changing context over time should be taken into consideration. When referring to measures introduced in World War II as successful management for that time, an orientation towards more protectionist policies could be discussed for future proceedings. Protectionism has been a common response to international market changes in Europe. With given conditions of today's society, feasibility and legitimacy for re-introducing planned economies are probably more difficult to achieve. Even if current consumption is reduced to a significantly lower but healthy level, demographics and structural changes in the agricultural sector could pose obstacles for successful food security. A much bigger share of Sweden's society is nowadays fully depending on a functioning food supply system, which is increasingly affected by international markets, and also influencing them in return. Before decoupling CAP payments from production, the EU produced surpluses that have been dumped on the international market which affected other, especially weaker, economies negatively (Mark Brady, pers. comm.). This outcome indicates that individual attempts to secure domestic markets bear a risk for inefficiencies and could have major implications for other countries. High global connectivity therefore implies higher dependency on international markets and also higher sensitivity to changes. It can further be concluded that, besides adequate management and good weather conditions, constant international trade opportunities of agricultural inputs have been crucial for supply maintenance in past crisis situations. With lower self-sufficiency levels in Sweden's agri-food system (cf. Röös et al., 2016b), larger shares of agricultural commodities would need to be substituted by domestic production in similar crises today. Such conditions could be managed by creating more circular, innovative and diverse farming systems that focus on locally or regionally available resources. This might be achieved with the ideas of *PLANT* and *Ecological Leftovers*, which are options to address concerns about self-sufficiency.

In the context of ongoing land abandonment in Sweden (cf. Statistics Sweden, 2017) and an expected weaker economy during war (Federico, 2012), increasing land competition could make marginal land more interesting for meat and dairy production. Preserving these areas potentially increases opportunities for food production during wartime, especially when used for grazing. The strategy of *Economic Sustainability* aims for higher redundancy of arable land and could therefore form a suitable future livestock system for Sweden. As a member of the European Union and part of the European Single Market, Sweden cannot easily apply trade or price regulations, as a response to economic instabilities. This limits the political scope for national authorities in domestic crisis management and could be considered as additional uncertainty for national preparedness. How this can affect the government's role in securing food supply, as part of Sweden's social system, may be interesting to discuss. More flexibility in land use for different possibilities of agricultural production

might help authorities to prevent shortages in domestic supplies, even with fewer means to interfere. Redundancy of agricultural land, and hence management suggestions of *Economic Sustainability*, is therefore, again, considered as option for improving preparedness in farming. Preservation or re-establishment of permanent pastures are also part of the more medium- or long-term objectives in *PLANT* and *Ecological Leftovers*. Prioritizing arable land for plant-based foods requires alternative sources for feed, to ensure resource efficient production.

With the EU membership, Sweden implemented the Common Agricultural Policy, as indicated earlier and described in more detail in chapter 4.1. This context needs to be considered when talking about options for future strategies on a national level. The analysis shows that objectives of Pillar I programs, especially voluntary schemes, seem to accord with the ideas of the derived strategies in several points. Mechanisms that can actually support their realization are, however, lacking and the stated opportunities exist to a larger part in theory only. Effectiveness of the support is considered low, due to weak targeting of payments, and leads to problems of land capitalization, when basic areal direct payments a granted almost unconditionally. It is therefore suggested to address the current scope and the general conditions for obtaining untargeted income support through the CAP, in the new post-2020 framework. Future reforms could improve targeting or even remove the Basic Payments Scheme altogether. The extent of changes for the next periods should, however, still be adequate for agricultural planning and coincide with farmers' realities.

5.2 Empirical findings in the light of the theoretical frame

The analysis presented in this research is an attempt to increase resilience in the Swedish food system and thus increase the preparedness of the country. New management ideas in cattle farming should contribute to the long-term objective of reducing production. A reduction does, however, not necessarily contribute to higher resilience, especially when considering that grazing cattle is associated with the lowest vulnerability among the livestock sector (Eriksson, 2018). The strategies involve an overall decrease in cattle production, while preserving the most resource-efficient forms of livestock farming. To ensure a resilient food supply system, production must remain adaptive and can be expressed through characteristics of flexibility, diversity and learning. *Economic Sustainability* is in particular concerned with increased flexibility in cattle farming, through higher land redundancy. *PLANT* involves an innovative idea for the production system that can create new knowledge and facilitate learning processes, and the idea of *Ecological Leftovers* involves a circular economy which requires more diversity in the sector. It is therefore

expected that a combination of these approaches would have the highest impact on food systems' resilience.

Creating a national food regime for Sweden (chapter 4.1) was needed to understand the past and current conditions in the domestic system and see dynamics affecting cattle farming over time. It can be observed that resilient and vulnerable stages of the system are changing according to structural changes of the food order. Strategies that improve the resilience between regimes can hence affect actors in the system differently over time. While domestic farmers influenced and benefited from the first regime, consumer demands became more important in the second and are now replaced by interests of the Member States. The current position in the adaptive cycle indicates high vulnerability for Sweden. The context of the EU of the third regime needs to be taken into consideration in national decision making. This could be understood as restricted control over crisis management by the Swedish government. Insufficiencies within the Common Agricultural Policy could therefore be considered a threat for EU countries, when dealing with vulnerabilities in domestic production. Pointing out the source of problems on the administrative scale could help create recommendations for future CAP reforms. The suggested changes could pave the way for implementing national strategies that increase resilience and preparedness in Sweden's agri-food system.

5.3 Introducing other research

The historical analysis in this research is based on the concept of global food regimes and broken down to the national level as shown in the results. The political economy of the first and second global regimes (McMichael, 2009) are reflected in the Swedish example. Capitalist resource accumulation developed in the spatial expansion of the market of the early 90s and agricultural rationalization during the post-war period (cf. 4.1). In this thesis' analysis, a third Swedish food regime has been identified, within the context of the European Union. When following Friedmann's (1993) understanding, food regimes are governed by implicit rules that determine power structure and patterns in production and consumption in the food system. If such hegemony is already found today as a third regime on the global level is debated in McMichael (2009) A food regime genealogy. By becoming a Member State, Sweden has committed to incorporate rules, set by the EU, into its domestic food system. It is hence suggested that Sweden has established a national regime, regardless. According to Friedmann (2005 see McMichael, 2009) the new rules further require an episode of stable conditions, with periods of instability that is shaping the political context. Sweden's current position in the adaptive cycle (cf.

4.1) could indicate such period of stable conditions in domestic agriculture, with economic interruptions in the past years, especially affecting the dairy sector, that shaped the CAP's reforms for recalibrated the regulative frame. The European Single Market can represent the new food circuit that is known from the global regimes and supporting dominant power structure of state and market (cf. McMichael, 2009). The restricted control of national authorities and the dominant market-orientation of Common Agricultural Policy, might be another sign of this new order. It could be related to the notion of ongoing privatization of the state (McMichael, 2009). In this context, managing food security is the task of the private sector and no longer the state's responsibility. This would reflect McMichael's (2009) corporate food regime that is rooting in the previous regime, but politically restructured to institutionalize economic liberalism (McMichael, 2009). The argument of globalization thereby legitimizes accumulation by dispossession, including alternative agricultural systems (McMichael, 2009).

Sweden's meat and dairy sector is currently in its conversation stage and hence vulnerable to sudden disturbances that may trigger a crisis situation. It, however, also gives opportunities for change, and intended transformation can prevent uncontrollable destruction of the system. *Ecological Leftovers* emphasizes more substantial changes to achieve resilience and incorporates the concept of sustainable resource use (cf. 4.4). Tendall et al. (2015) consider the two concepts, resilience and sustainability, as being complementary over time. Resilience provides a system with the capacity to cope with occurring disturbances and sustainability, to maintain its functioning in the future (Tendall et al., 2015 p.18). I this context, *Economic Sustainability* and *PLANT* could be seen as measures for maintaining a functioning system during disturbances, while aiming for the long-term objective of sustainable management in the subsequent food regime. The process of sustainable transition was also discussed by Friedmann (2017), who observed sequences of smaller changes that can lead to bigger transformations in a system. To understand the mechanisms involved, the current state must be understood, its structure and the history, but also relevant actors and their goals (Friedmann, 2017). As a suggested option in the paper, this transformative process can start with an objective analytical approach for assessing the current situation, which is then reformulated for practical application in a managerial approach (Hornborg, 2011 see Friedmann, 2017). When comparing this method with this research, the historical analysis and system's conceptualization can represent the analytical approach, which is then translated into potential strategies for the livestock sector by incorporating already available and sophisticated research. The three strategies could be understood as part of a series of individual changes towards a more sustainable and resilient state and are thus combined in the process of transition. To better grasp this idea, Friedmann compared such

processes with a moving train. To prevent a crisis situation, this train needs to be slowed down at first, by using fewer resources (cf. *Economic Sustainability*), but because it is still running in the same direction, new types of transportation need to be found (cf. *PLANT*), to eventually reach to destination of sustainability (cf. *Ecological Leftovers*).

An approach of assessing Sweden's resilience, and also related to sustainability, was conducted by Camilla Eriksson (2018) and is related to the issues addressed in this thesis' research. Eriksson investigated the resilience of Sweden's agriculture and thus its ability to produce food during crisis, based on qualitative interviews. The research shows that vulnerabilities in the supply chain have increased in the past decades, due to the high import dependency, domestic deficits in basic foodstuffs and on-demand production and delivery (Eriksson, 2018). When asking farmers about their options to adapt in crisis situations, differences in the sectors become obvious (ibid.). Pig and poultry farms would not be able to sustain their production. For cattle farming, some milk output could be continued but it is considered more vulnerable than systems with grazing beef cattle (ibid.). This is related to higher feed demands of dairy cows, required energy in the production and missing storage capacities for milk (ibid.). Possible changes at the farm that could maintain production would involve: replacing pig and poultry with crop cultivation, extensification of cattle farming through natural grazing, flexibilities in the rules for environmental protection and animal welfare, higher shares of horticulture, lower quality standards of foods and reintroducing subsistence framing (ibid.). When aiming for higher shares of food crops, shortages of fuel would be the biggest challenge, but also a lack of knowledge concerning cultivation was further expressed (ibid.). Other agricultural inputs may further limit possibilities in production, especially in conventional farming which is more dependent on imports (ibid.). Alternatives for fossil fuel and fertilizers could help increase self-sufficiency, while keeping current mechanized farming systems, to a certain extent (ibid.). A more circular production system is discussed which requires appropriate land use management, with possibility prioritizing plan-based food production (ibid.). An early transition in agriculture that improves preparedness for wartime is desired by farmers (ibid.). Large-scale organic farming is considered as possible solution, as well as higher self-sufficiency in energy and inputs, and on-farm processing and sales (ibid.). It is suggested that including sustainable agriculture in civil defence strategies can help realize resilience and self-sufficiency in agriculture (ibid.). Sustainable transformation is therefore considered important to overcome vulnerabilities in Sweden's agri-food system, which is also indicated in this research's discussion above. The objectives of the derived strategies conform with some of the suggested changes of the stated research. Examples are more plant-based food production, extensification with

grazing of natural pastures, farm diversity, changes in land use, bio-energy and more localized and closed production system. This indicates that the proposed strategies could contribute to farmers' adaptive capacity in wartime. Higher vulnerability is further connected to market dependencies in agriculture in both research, which could make self-sufficiency levels the core entry point for improving resilience in Sweden. Challenges related to fuel supply could have been emphasised and discussed more in the long-term strategy of this thesis, as it is a major concern for maintaining production in the future and thus for resilience. With the low chances of maintaining pig and poultry farming in crises, the strategy of reducing livestock should maybe be kept in connection with these types of production. The overall aim of reducing meat production might therefore be better exchanged with the idea of sustainable transition.

For achieving higher flexibility in the system and thus increase resilience is especially related to redundancy of land resources in this research (cf. *Economic Sustainability*). Resource redundancy is also the main factor for resilience in food production of the indicator framework presented by Seekell et al. (2017). It provides a quantitative approach of national-level resilience in the food system, from 1992 to 2011 (cf. Seekell et al., 2017). Its *Biophysical Capacity Index* includes uncultivated land, suitable for food production, available freshwater resources and a country's potential of closing the yield gap (cf. Fader et al., 2016; Seekell et al., 2017). These factors give information about a food systems' capacity to increase production, either through extensification (using land and water resources) or intensification (decreasing the yield gap). Values for the biophysical index is decreasing for the study period for northern and western parts of Europe and went from high to limited for Sweden (Seekell et al., 2017). High yields result in low resilience for the country and thus presents the critical factor for redundancy, which is explained by limited transformative capacity of producing food in intensive agricultural systems (Seekell et al., 2017). Availability of land resources is, however, sufficient (Fader et al., 2016) at current times and could challenge the relevance of discussing issues related to land resources in this research. Nevertheless, productivity and hence yields may be lower during a crisis and Sweden's population continues to grow (cf. Statistics Sweden, 2018), which potentially increases the pressure on national resources in the future. The results also indicate that extensification is the key factor for transformations and backs management suggestions for grazing animals in the scenarios.

The final comparison of the results relates to recommendations for future CAP reforms. It is currently proposed to keep the two pillars of the policy, regulating direct payments and rural development support (James, 2018). To adjust programs to local conditions, more flexibility in implementation will be given to the Member States

(ibid.). A ‘CAP strategy plan’ would be created in each country that determines the funding in both pillars (ibid.). Greening should also become more flexible but also more targeted at once, presenting options of compulsory and voluntary measures (ibid.). A defined priority is generational renewal in agriculture, which involves supporting young farmers and also promoting agricultural investments (ibid.). Targeted direct payments should be ensured through capping, degressive and redistributive payments and farming requirements for potential recipients (ibid.). To ensure effectiveness, farming consultancy and risk management should be involved in the strategic plans (ibid.). Results and recommendation of the AGRI Committee on post-2020 reforms are, however, partly differing. They suggest a more profound restructuring of the CAP, which would present a one-pillar system that includes five different tiers for payments, building on each other (Ragonnaud, 2016). Greening-related payments are divided into shallow and higher-level environmental payments, which are building on each other (ibid.). Support for young farmers and investments is covered in payments that support competitiveness in the sector (ibid.). More targeting shall be achieved by phasing out decoupled direct payments and introducing an Income Stabilisation scheme that is related to risk management (ibid.). The Committee assessed that capping, degressivity and redistribution of payments was not successful in the past CAP period and concerned only minor amounts of the support (ibid.). A new approach that would phase out basic direct payments is thus considered, by the author, as a better option for future reforms. It has the potential to prevent untargeted areal support, which is the source of problems with land capitalization. This could contribute to more effectiveness of additional payments related for rural development (e.g. support for young farmers). Also coupled support may not be granted to the most productive regions in a country and is thus targeting farms in marginal areas. A lack of information on how greening payments will be targeted and how risk management could look like (cf. James, 2018), further creates uncertainties in the current CAP proposal. The AGRI approach could hence help in addressing the identified challenges of the current schemes but involves major modifications in the policy. Everchanging conditions in the CAP does create uncertainties that can affect a farmer’s decision on continuing farming in the future (Anna Hessle, pers. comm.). Potential farm exiting could therefore be a negative effect of such structural change and thus be an argument to disregard or postpone maybe more effective policy ideas. It should further be considered that ensuring targeted payments may not be related to even more rules and administrative burden for farmers, as created with environmental support programs in the past (Eksvärd & Marquardt, 2017). Higher flexibility for implementing environmental and climate measures can be integrated in the program. An example is a menu-driven approach that allows Member States to create individual equitant objectives as greening requirements (Ragonnaud, 2016). Combined with the idea of conditional greening,

effectiveness of environmental measures could be ensured (cf. Ragonnaud, 2016). Farmers are hereby compensated for their costs and income losses related to the applied greening measures (Ragonnaud, 2016). The aim of creating more resilient farming system should be considered when implementing different ideas for regulatory measures. It is thereby stressed to apply resilience thinking, and thus adaptability, not only to production activities but also into the policy-making process and thereby adjust them to the needs of farm management.

5.4 The state of food systems approach and reflection on own methodology

The European Commission started a new program on European Research and Innovation for Food and Nutritional Security (cf. European Commission, 2018a) that is aiming for a food systems approach that ensures food and nutrition security in the future. Policy developments include priorities of nutritional diets, climate-smart food systems, circular economies and innovation (European Commission, 2018a). With the range of priorities which are defined for EU research and innovation (cf. ibid.), in this context, gives an idea of the extended scope of this new approach. It involves a variety of EU and international policies, including the Common Agricultural Policy (cf. ibid.), which need to be coordinated. This attempt seems challenging, but the author recognizes chances for more holistic and innovative policy measures. It might even provide an opportunity to find solutions for food security and crisis management outside of the agricultural sphere, with innovative research on alternatives for food, feed and energy production or supply.

Due to the complexity of food systems, currently available research approaches are mostly based on qualitative research, primarily for understanding structures, relations and dynamics related to food security (e.g. Ericksen, 2008; Darnhofer et al., 2010b; Cabel & Oelofse, 2012). A more quantitative comprehensive analysis is not yet established, but work on improving scenario analyses on global systems is in progress (e.g. Forsight4Food Initiative). The framework (cf. Ericksen, 2008) used in this research is recognized as comprehensive approach to analyse food systems. It suggests more holistic assessments that are not focusing on only one element of food security (Ericksen, 2008). Future research concerning Sweden's food system could therefore consider activities relating to utilisation or access of food, as new entry point to the analysis. When looking at the presented results, reducing domestic meat consumption and the role of the Swedish welfare state in today's food security may be relevant in this regard. Further resilience analyses could start from these viewpoints, away from the production perspectives.

This research presents an attempt of creating a qualitative framework, specifically tailored to answer the stated research questions and is therefore an assemble of five approaches, for different steps in the analysis. It is combining the food regime theory with the adaptive cycle of the Swedish food system and conceptualizes the involved activities to derive lessons from history. Furthermore, an assessment on the contribution of already existing research for agricultural resilience is created and on the comparability of management goals on national and EU level. This methodology was selected to grasp the complexity of Sweden's agri-food system and to create a framework to structure the analysis. Working with complex systems always implies a substantial degree of uncertainty, which is recognized by the author. Literature on the applied theories that is used in the discussion should help strengthen the approach. The materials used is another combined attempt to synthesize existing research on Sweden's livestock sector of one national institution (SLU). The selected scenarios should legitimize the strategies derived, which could show new openings for further research in return. Language barriers are considered the main weakness of the research, especially in the historical analysis, which covers a relatively small number of literature sources. A dialogue with the main contributing researcher was incorporated in the research to minimize potential deficiencies in this regard.

6 Conclusion

Food systems involve dynamic, complex and heterogenic processes and thus require a comprehensive analytical approach which is tailored to the specific research objectives. A framework was created that comprises different entry points to the analysis and considers the importance of historical events and the political economy. The results revealed patterns and structures at different points in the system. Some conclusions have been derived on ideas for more resilient production systems in Sweden's agriculture, which can cope with potential future disturbances but also challenges the current regulatory context within the EU. The main outcomes are presented in a short and clear form in the following paragraphs.

- A historical analysis showed different political, economic and social conditions in the three periods of the national Swedish food regimes and positions Sweden's food system into a highly vulnerable current state. It can thus be easily affected by disturbances but provides opportunities for positive transformation as well.

- Comparing past developments and crisis situations helps in explaining changing conditions for agricultural production and decision making and can lead to potential recommendations for future risk and resource management that improves national preparedness in agriculture.

- Existing research on Sweden's food and agricultural systems provide promising options for more resilient livestock production and can be used for creating national strategies in Swedish cattle management. Strategies could improve the adaptive capacity in farming, when aiming for higher redundancy of arable land and thus flexibility in its use (*Economic Sustainability*), through innovative ideas for less resource intensive production systems that can generate new knowledge (*PLANT*) or by structural transformations towards more localized and circular farming systems with high degree of diversity (*Ecological Leftovers*).

- A combined implementation of the three stated strategies for Sweden's livestock sector are suggested, to realize the highest degree of resilience and facilitate sustainable transition of Sweden's food and agricultural system
- The EU Common Agricultural Policy has the potential to promote such national approaches for domestic production systems but is currently showing insufficiency, related to poorly targeted payments. Reforming conditions and extent of CAP's support programs could improve the effectiveness of payments and counteract progressing land capitalization.

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