Responding to change: Farming system resilience in a liberalized and volatile European dairy market

Authors:
Martin Thorsøe, AU - *Aarhus University, Denmark*
Egon Noe, SDU - *University of Southern Denmark*
Damian Maye, *CCRI – University of Gloucestershire, United Kingdom*
Mauro Vigani, *CCRI – University of Gloucestershire, United Kingdom*
James Kirwan, *CCRI – University of Gloucestershire, United Kingdom*
Hannah Chiswell, *CCRI – University of Gloucestershire, United Kingdom*,
Mikelis Grivins, *BSC – Baltic Studies Centre, Latvia*
Anda Adamsone-Fiskovica, *BSC – Baltic Studies Centre, Latvia*
Talis Tisenkopfs, *BSC – Baltic Studies Centre, Latvia*
Emi Tsakalou, *AUA – Agricultural University of Athens, Greece*
Pierre-Marie Aubert, *IDDRI – Institut du développement durable et des relations internationales, France*
William Loveluck, *IDDRI – Institut du développement durable et des relations internationales, France*

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Highlights:

1. Market liberalization and price volatility drive changes in all farming systems.
2. Price volatility results in poor adaptive capacity of dairy farms.
3. Strategies for dairy farming systems are conditioned by strategies of processors.
4. Systems respond with different strategies despite comparable regulatory framework.
5. Dairy market trends may have long-term impact on land use.

Abstract: For more than two decades market conditions for European producers have changed significantly due to liberalization and increasing price volatility**.** The objective of this article is to analyze how farming systems in five European countries (Denmark, Greece, France, Latvia, and the United Kingdom) have reacted to the emerging instability of the milk market. Dairy production is an ideal setting to study how different farming systems respond to changing conditions as a number of policy changes have altered market conditions for producers. Empirically, the analysis draws on statistical data on dairy production and farm structure, and qualitative and quantitative data from case studies in the five countries. During the period under study, dairy farming systems have operated under the same overarching EU regulation, but dairy sectors at the national level followed specific pathways. We found different strategies and institutional arrangements deployed to address price volatility at the national levels. We argue that divergence in the strategies developed to address this disturbance reflects different configurations of value chain organization (particularly dairies), production factors (production facilities and biophysical conditions), and market orientation. Increasing market volatility implies that succession planning and attracting investments is difficult for farming systems across all countries, and thereby to formulate strategies for resilience.

Keywords: Milk quota; farming systems; food system governance; dairy sector; farmer strategies; market liberalization

1. Introduction

In order to support sustainable agri-food futures it is important to understand the foundations for farming system resilience. This is increasingly relevant because market, policy, and environmental conditions continuously evolve, becoming less predictable and more interconnected globally (Biggs et al., 2011; Freibauer et al., 2011; Veerman et al., 2016). Furthermore, changing conditions have had profound impacts on farming practices and therefore also on the resulting land use and activities in rural areas (Dervillé and Allaire, 2014; Huettel and Jongeneel, 2011; Mills et al., 2017).

Faced with unpredictability farming systems must adopt strategies that increase tolerance to uncertainty and surprise (Biggs et al., 2011; Darnhofer, 2014). Therefore, farming systems must develop resilience, understood as "*the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedbacks, and therefore identity, that is, the capacity to change in order to maintain the same identity*" (Walker et al., 2004: 5). Recent Europe-wide disturbances include the 2008 food crisis (Rosin et al., 2012), liberalization of agricultural commodity

markets (Dervillé and Allaire, 2014), accelerating climate change and extreme weather events (Nelson et al., 2009), as well as diversifying consumer preferences (Thorsøe, 2015).

Hence, it is important to understand what disturbs farming system resilience and to identify strategies to ensure resilience in the light of such disturbance (Darnhofer et al., 2016; Dedieu, 2009; Holling, 2001). The objective of this article is to analyze how farming systems in five European countries (Denmark, Greece, France, Latvia, and the United Kingdom) have responded to liberalization and the emerging volatility of the milk market and to discuss the implications of this development for farming system resilience. The article is based on a comparative case study of the dairy farming systems in the five different countries.

Dairy production is an ideal setting to study how farming systems respond to a disturbance as a number of recent policy changes have profoundly changed conditions for primary producers. Moreover, milk is produced in every European country and dairy farming is particularly important in many disadvantaged regions (e.g. areas in danger of abandonment and less-favored areas) (EC, 2014). The size and importance of the dairy sector varies considerably across regions, but dairy is the single most important commodity sector in terms of output value as dairy products accounted for 13.8 % of total agricultural production in the European Union (EU) in 2017 equaling nearly EUR 60 billion (EU, 2018). Generally, dairy products are consumed in local markets while the extent of international trade in dairy products is limited, representing just 7 % of global dairy production (EU, 2018).

The article is based on a farming system theoretical perspective. We understand farming systems as socio-technical systems that are assembled by social as well as material factors and organized with a particular purpose in mind (Noe and Alrøe, 2012). A central idea in farming system theory is the distinction between internal factors (such as the farmer, farm workers, and machinery) and external factors that function as the surrounding environment to the system (such as regulation, markets, and processors) (Darnhofer et al., 2012; Ison, 2012). In dairy farming, a combination of factors are mobilized in production, such as pastures, cows, farmers, farm workers, dairies, milking parlors, mortgage providers, etc, thus, each individual farming system is made up of these components.

We distinguish between different analytical levels, with farming systems being the lowest and all farms at national level constitute the dairy sector. Furthermore, individual farming systems are part of a value chain along with processors and retailers downstream that are responsible for processing and sale of dairy products. Furthermore, all dairy farming systems as well as related industries within a country comprise the dairy sector. Farming systems are organized around a particular operating logic (Noe and Alrøe, 2012). They not only differ in terms of structure, level of mechanization and size, but also in terms of the strategy for value capture (Porter, 2008). This strategy expresses a choice concerning how to modify parameters such as product quality, business size, marketing, research and development, contracts, etc. The strategy leads to a distinct performance that can be observed in economic, social, or ecological terms.

European farming systems are very heterogeneous and differ substantially in size, organization, and the use of technology, thus responding differently to changing conditions (Dedieu, 2009). Besides, a dairy farming system is a multi-layered organization spanning several spatial scales that are subject to their own complex dynamics, and when conditions change all actors have to adjust their position in the system (Darnhofer et al., 2010; Noe and Alrøe, 2006). This also implies that farming systems through their strategic decisions respond differently to changes in their environment (biophysical, economic, social, and institutional) and that the development path of the particular social, structural, and material configuration of the farming

system is important for understanding these strategic responses (Noe and Halberg, 2002). In this perspective, resilience of a farming system is understood as the dynamic process of the system to observe crucial changes in its environment and to strategically react accordingly to sustain itself; in other words, resilience is a dynamic feature of the system.

The analysis is organized as follows. Firstly, we outline the methodology used in the study (section 2). Secondly, we unfold the changing market and policy conditions in the dairy sector at a European level (section 3). Thirdly, we examine how dairy farming systems in the five countries have reacted to changing dairy policies and the resulting volatile market conditions (section 4). Finally, we discuss the strategic responses by the farming systems observed and the wider implications of the findings in terms of the regional configuration of dairy farming (section 5).

2. Data sources and methods

Dairy farming systems in five European countries[1] were analyzed using in a mixed-method research framework (Creswell, 2014). More specifically, different methodologies were employed, including quantitative and qualitative data, in the context of the EU H2020-funded SUFISA[2] project (2015-2019). This combination of methods provided different types of information, offering a rich picture of the dairy farming system in each of the five countries.

We focus the analysis on the changing European regulatory conditions as these regulations have profoundly altered market conditions for dairy producers (Veerman et al., 2016). To highlight the context of the strategies adopted by the farming systems we initially characterize the European policies that influenced the dairy price since the early 1980s, when milk production quotas were introduced. This characterization was based on a review of European policy documents and academic literature pertaining to the milk market and regulatory interventions.

The strategic responses to these changes were then observed at the individual farming system level, the value chain level, and at national level. At the value chain level we uncovered the strategic positions of dairies, while on the farm level we examined how farming systems observed and reacted to these changes. The strategic response of dairy farming systems and value chains was initially observed by comparing the development of dairy prices and production volumes across the EU Member States, as this illustrates the direct effects of the changes. For this characterization we used descriptive statistics, extracted from the EUROSTAT and FAOSTAT databases, as data are collected according to a standardized methodology. These data characterize the performance of the farming systems in the five countries on an aggregate level.

Subsequently we used qualitative and quantitative data acquired in the SUFISA project to explore the configuration of the farming systems in the five national settings and the strategic responses of these in more detail. The farm level was our entry point for data collection, but we also included the perspectives of associated stakeholder groups, as these are important to understand interdependencies in relation to food chain governance and institutional arrangements (Martino et al., 2017). The authors of this article were all

[1] The Greek case study concerned goat milk for Feta production, hence, the results of some of the Greek data is not fully comparable to the other cases.

[2] Sustainable Finance for Sustainable Agriculture and Fisheries.

part of the national teams that conducted the analysis and hold intimate knowledge regarding the configuration of the national dairy farming systems.

A number of data sources were used to analyze the five case studies (for a full description see Maye et al. (2018a)). For the description of the strategies for resilience applied in this paper we have focused on two sets of data that describe the farming systems and associated value chains. First, a qualitative inquiry containing 20-30 key informant interviews per country with a range of different stakeholders, including policymakers, farmers, NGOs, and representatives from the value chain and supporting industries was carried out. This work was completed in 2016. Following an initial analysis of these data, two or three focus groups were held in 2017 with dairy farmers in one selected region in each of the five countries. The focus groups and interviews were audio-recorded, transcribed verbatim, open coded, with the meaning condensed according to a grounded research methodology (Corbin, 1998). These data were used to unfold the strategic considerations at farming system level (section 4.3). Second, we conducted a phone or face-to-face survey among farmers in the case study regions during the winter of 2017. The number of respondents ranged between 82-200 (for further information on the survey see Vigani et al., 2018). These data are used to characterize the structure and organization of the farming systems and strategic considerations (sections 4.1 and 4.3).

All country-level data were synthesized in individual national case study reports that were presented and discussed with stakeholders for verification. The qualitative and quantitative data were collected and analyzed in an iterative process, hence, the qualitative data obtained in the workshops were used to deepen the interpretation of the results from the survey. A detailed account of the methodology adopted in the SUFISA project and the full dataset on which this article is based can be found in the five national case study reports (Aubert et al., 2018; Grivins et al., 2018; Maye et al., 2018b; Thorsøe and Noe, 2018; Tsakalou and Vlahos, 2018).

3. European regulatory and market conditions

European institutions have a profound impact on dairy price formation and are therefore a highly relevant actor for the dairy sector. It is also important to note that dairy farming systems are the result of a long strategic adaptation process. Therefore, to understand current strategies and structuring of dairy farming systems, we briefly introduce the evolution of the regulatory framework and market conditions that shape the surrounding environment of European dairy farming, particularly regulatory conditions introduced by the EU.

Historically, the most important instruments in EU dairy policy have included production quotas, direct payments, intervention storage, export refunds, and import duties (see Table 1). The Common Agricultural Policy (CAP) was developed to improve agricultural production, but the early 1980s marked the beginning of a reform era that eventually liberalized commodity markets (Ackrill, 2000). The CAP was reformed in 1984, when milk quotas were introduced to control production, and in 1988 when an expenditure ceiling was imposed by the European Council (EC). A more extensive reform of the CAP took place in 1992, with the MacSharry reform beginning a process of liberalization by decoupling income support from production subsidies (although initially not for the dairy sector), thereby setting the direction for further CAP reforms.

Table 1 Overview of policy instruments applied to regulate conditions on the European dairy market, developed based on (Jongeneel et al., 2011; MMO, 2019).

Instruments (2000-2019)	**Description**
Dairy quotas	National quotas for production were in place between 1984 and 2015.
Income support	Dairy premium introduced after reform in 2003, paid per holding and calendar year. Since 2008 implemented in the SFP scheme.
Public and private intervention storage	Developed to balance the milk market and stabilise market price from seasonal fluctuations. As a result of the 2003 reform, butter and SMP intervention prices were reduced step by step over a four-year period, beginning on 1 July 2004. Butter and SMP intervention prices were reduced by 25% and 18% respectively (2004-08).
Export refunds	Developed to enable EU to discharge some of the structural surpluses on the world market where dairy prices were lower. In 2009 export refunds were reintroduced to help support EU market prices in the wake of the sharp decline in world market prices, however, the refund rates and quantities were considerably lower than previously. Since 2009, exports have been carried out without export refunds.
Import duties	Import duty (tariff) has ensured a price-gap between EU and world market prices for dairy products. Import duties' levels have been only slightly adjusted in the period. However, several trade agreements enable preferential imports at reduced or zero duty, mostly on quota basis.
Stimulation of internal consumption	Various subsidy schemes to stimulate internal consumption of dairy products have been in place, such as school milk scheme, the bakery and ice cream schemes for fat, the casein aid and SMP for feed programmes for protein.

In 1995, dairy market liberalization was again on the agenda, when agriculture became part of the multilateral GATT (General Agreement on Tariffs and Trade) negotiations, as trade partners were discontent with the EU's support of its own agricultural sector (Hansen, 2001). An important policy change occurred with the "Agenda 2000" agreement in 1999 and the "Fischler reform" in 2003 (IPTS, 2009; Swinbank, 2008). In relation to the dairy sector, prices for market interventions (buying into storage) for butter and skimmed milk powder (SMP) were lowered in favor of direct support. These instruments were previously important stabilizing mechanisms of the milk price within the EU that guaranteed producers a minimum milk price – in effect, the gap between the European and world market prices gradually decreased (EC, 2018). While in the EU milk prices were 91 % higher than those on the world market in the period 1997-2003, they decreased to 52 % in 2004-2006, and again in 2007-2008 to just 13 % (Jongeneel et al., 2011). Milk prices became increasingly volatile, particularly after 2006, due to a production boom on world markets.

The CAP Health Check review in 2008 resulted in a decision to abolish milk quotas in 2015, thus further liberalizing milk production across Europe (EC, 2008). To ease the transition the EC decided to gradually increase quotas by 1 % annually in the period 2009-2013. In addition, the "Milk Package" was developed in 2012 to ease the transition for producers. The Milk Package included provisions to support the collective organization of dairy farmers and improve market transparency. Instruments like contractualization, support for Producer Organizations (POs) and sustaining quality production were also part of the package (EC, 2014, 2016). The quota abolition coincided with a number of other factors that influenced the milk price, including a reduced Chinese SMP market and a trade ban from Russia. To sustain dairy farmers, the

EC took a number of initiatives, for instance, extending periods of public and private storage aid, although with little effect on the milk prices within the EU (EC, 2018; OECD, 2017).

This liberalization of market policies had a direct influence on the dairy market. The period up until 2006 was characterized by a relatively stable commodity price, although with an annual variation (see Figure 1). This was due to the interventionist policies of the CAP (Jongeneel et al., 2011). However, the gradual liberalization of the dairy market was quite evident in the subsequent years, where prices were considerably more volatile. Prices were generally high in the years 2007-2008 and 2013-2014, while they were low in 2009-2010 and 2015-2016. However, there were also remarkable regional variations in the volatility. For instance, the amplitude of milk price cycles ranged between 10-20 EUR per 100 kg of milk reflecting about 50 % of the average commodity price (2006-2018), highest in Latvia (EUR 17-20) and lowest in Greece (EUR 10). However, it is important to note that the EU intervention policies still had an effect in these periods, therefore variations do not reflect an undistorted market.

Each of the five countries analyzed has a different history and relationship with the EU. France was one of the founding members of the community and member since 1957, whereas the United Kingdom and Denmark both joined in 1973, and Greece followed in 1981, hence these countries have all experienced the process of policy transformation of the productivist European agricultural policies. The UK has since exited the EU (January 2020), but the regulatory environment for the period of analysis was set by the EU. Latvia is again somewhat different, as it became a Member State of the EU in 2004 along with nine other East European countries, but have followed a comparable trajectory to other European countries since accession. Furthermore, the countries all have different socio-economic and political development trajectories, institutions, and varying biophysical conditions that have given rise to somewhat different dairy farming systems.

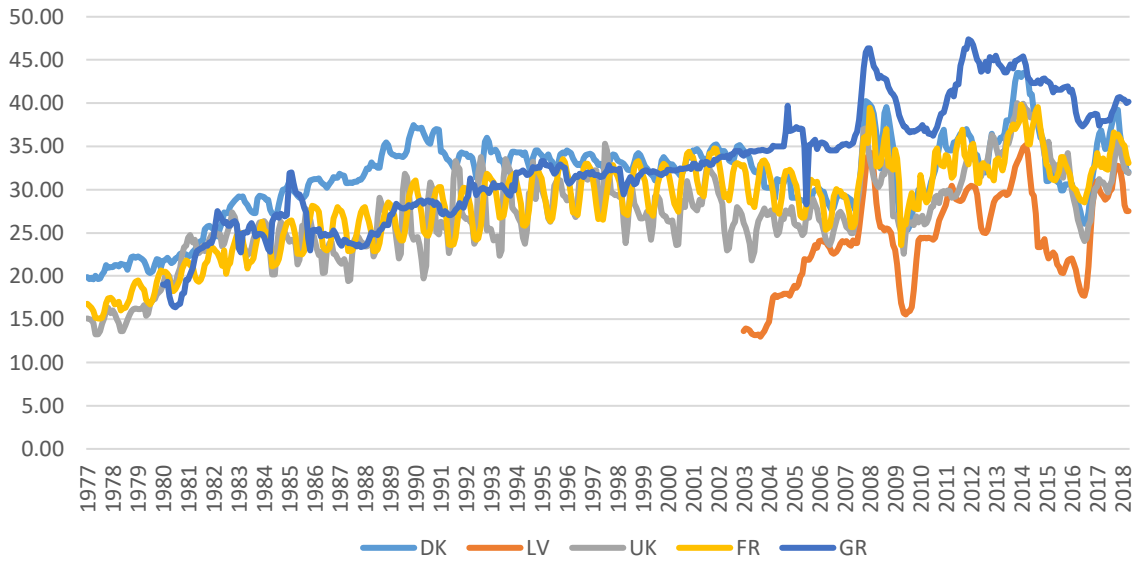


Figure 1 Monthly development in milk price (EUROSTAT, 2019).

In sum, the CAP regime has changed from a production-oriented policy underpinned by price support to a 'multifunctional' policy emphasizing environmental protection and rural development. Policy interventions to sustain milk prices have been reduced in favor of provisions to ensure better collective organization of

dairy farming systems, quality labelling, and increasing market transparency. This process has gradually destabilized the agricultural commodity prices increasingly exposing European producers to world price volatility.

4. Results

In this section, we compare the strategic responses adopted by farming systems and dairy sectors to market liberalization and increased price volatility in the five European countries. Initially we describe the structural characteristics of the dairy sector at the national level. Afterwards we present the effect of the strategies as reflected in the price levels and production volumes, and examine the strategies that farming systems and dairies have developed to manage changing market conditions.

4.1 Structure and organization of the dairy sector

The dairy sectors in the five countries have experienced different developmental pathways in terms of structure and organization of milk production (see Figure 2). Key differences include characteristics of dairy farming systems, contractual relationships in the value chain (see Table 2), and the temporality of these relations.

The orientation of the dairy sector varied considerably, – countries like Denmark and France had a large export share of dairy products, Latvia had a slight dominance of export over import, while Greece and the United Kingdom were net importers (see Figure 2). The structure of dairy farming systems also differed notably between the five countries, but there were also variations within each of the countries (see Figure 2). Denmark had the most homogeneous and intensive dairy farming systems, as majority of farms had more than 100 cows; the Latvian dairy sector was by far dominated by small-scale dairy farming systems with less than 10 cows, but was also home to large-scale and industrialized production facilities. Furthermore, there were considerable inter-country variations in the share of organic production ranging between 2-12 %.

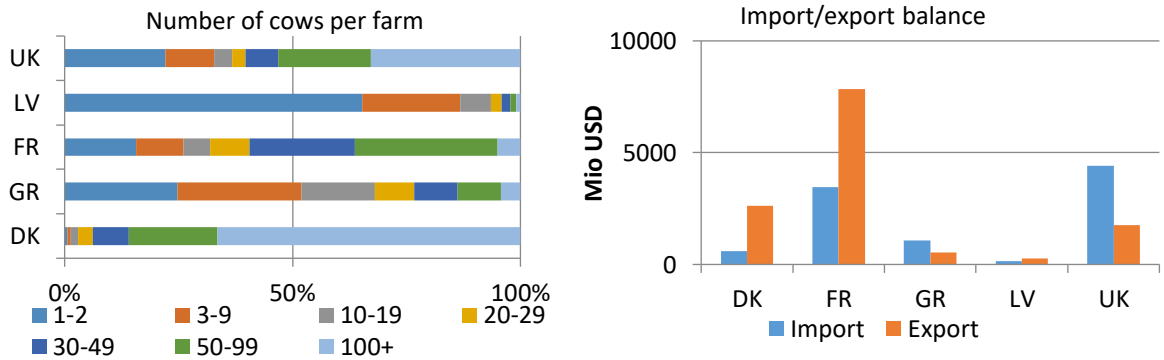


Figure 2 Left: Number of dairy cows per farm in the five countries (EUROSTAT, 2019). Right: Market characteristics, balance between import and export in the five countries (FAOSTAT, 2019).

Table 2 General characteristics of the survey participants (Source: SUFISA survey data).

	Number of respondents	Collective agreement	Individual agreement	Size (ha)	Herd size (Cows)	Yield (Ton/year)	Productivity (Ton/cow)
Denmark	82	79	3	203,7	259,9	2543,2	9,8
United Kingdom	200	83	117	183,7	237,6	1855,7	7,8
France	100	84	16	98,5	70,9	524	7,4
Greece	150	25	125	16,3	182,9[i3]	31,9	0,2
Latvia	142	65	77	303,2	102,8	709	6,9

The SUFISA survey explored the relationship between dairy farming systems and processors in one region in each of the countries. These data show that dairy farming systems in Denmark and France are primarily arranged into collective organizations, such as cooperatives that are responsible for processing and selling products. Dairy farming systems in Greece are primarily associated with processors based on individual sales contracts. In the United Kingdom and Latvia there is an almost equal split between individual and collective sales agreements.

In cooperatives the added value of milk processing is transferred back to individual farming systems. However, private processors may offer better prices, particularly in periods with high demand for dairy products. The duration of a contract between primary producers and processors is important, as long-term investments are required to establish dairy production. Generally, dairy farming systems in Denmark, France, and the United Kingdom have quite long running contracts, typically lasting for more than a year (see Figure 3). This is in contrast to dairy farming systems in Greece that have shorter contract durations, typically less than a year. Dairy farming systems in Latvia are again very heterogeneous, as about 50 % of primary producers have contracts with a duration of less than a year and another 50 % have contracts of more than two years. However, it is important to note that unlike the restricted number of processors in France, Denmark, and the UK, producers in Greece and Latvia have access to a wider range of different processors allowing for more flexibility in choosing bulk buyers of their raw milk.

[3] Note: the case study for Greece explored sheep and goat milk production

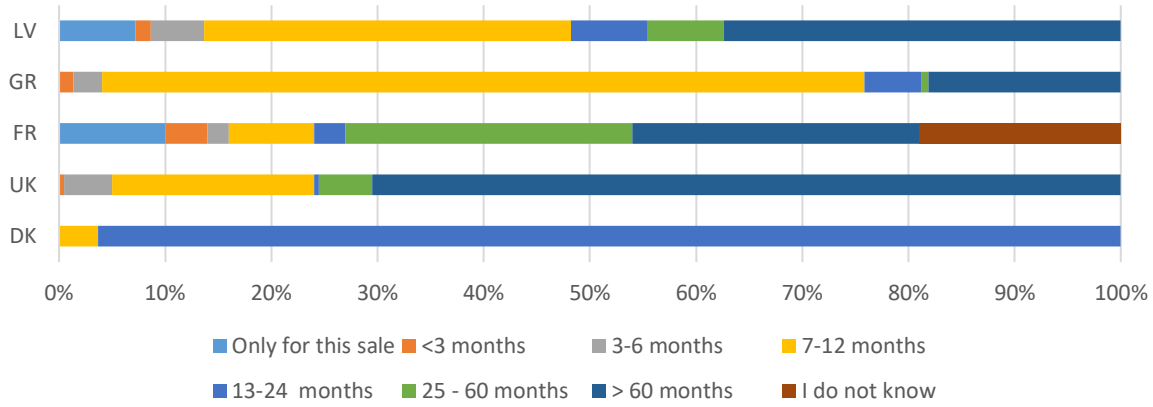


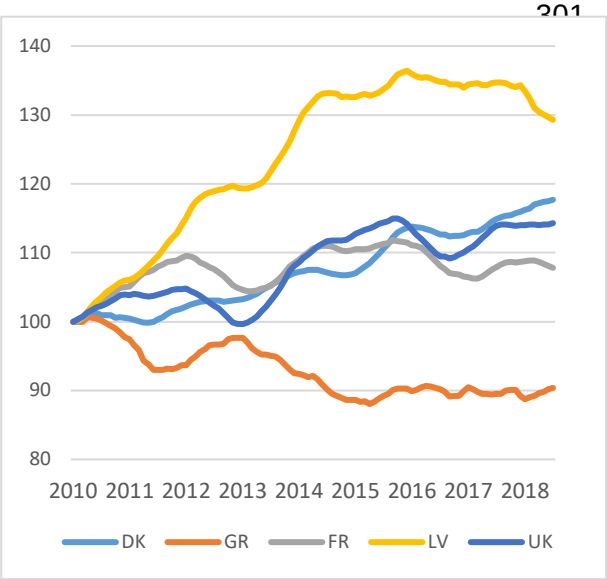
Figure 3 Contract duration of dairy farmers in the five countries. Replies to the question: "What is the duration of this sale agreement or membership in a collective organization?" (Source: SUFISA survey data).

4.2 Development of production and price

Although the dairy market was gradually liberalized, there was considerable fluctuations in the prices that dairies offered to producers in the five countries (see Figure 1). In the expert interviews and focus groups, differences in dairy prices across countries can be explained as variations in the local markets, products, and degrees of integration in the world market. Besides, there are country-specific variations, as farming systems in Latvia received prices below world market price, while farming systems in Greece received high and relatively stable prices. An explanation for this development is Latvia's stronger reliance on the Russian food market and therefore a higher market sensitivity to the Russian trade embargo, as well as power asymmetry in the value chain, where processors have a strong position. In contrast, dairies in Greece are more focused on the lucrative fresh milk market within Greece, and dairies are therefore less sensitive to global price volatility. Interestingly, we observed a convergence of the milk prices in all the five countries since 2010, likely reflecting the increasing world market integration of European dairy farming systems following the gradual market liberalization.

Milk price levels and production volumes have continuously changed in the last decade both on an annual basis and in a longer-term perspective (see Figure 4). The annual variation is particularly due to changes in fodder composition, the timing of calving, and access to grazing in the summer period. However, there were variations across countries as, for instance, farming systems in all the examined countries maintained continuous production throughout the year, except for Latvia where production varied by about 15 % points annually. In the long-term perspective, we observed an annual production increase in all countries since 2010, except for Greece. This increase has been most significant in Denmark and Latvia, although Latvia came from a low starting point in terms of productivity. Interestingly, the development since the beginning of 2015 also marks a period of change in the dairy sector, the trends in Greece, Latvia have come to a halt, and instead we have seen a rapid production increase in Denmark and a slightly declining production in France. The Greek case is a bit of an outlier because Greek farmers focus on Feta production based on goat milk, which is generally less volatile because markets are not exposed to international competition and volatility due to a focus on quality and uniqueness.

Expert interviews and focus groups identified three explanations for this development. Firstly, Denmark was constrained by milk quota, as high productivity and increasing production were seen as an important objective at both processors' and farming systems' levels. Accordingly, when the quotas were abolished milk production increased, which was also encouraged by local dairies. Furthermore, the removal of quotas



	Total production (1000 tons)			Development in production
	2010	2018		2010-2018
DK	4.818	5.615		16,56 %
GR	688	620		-9,82 %
FR	23.375	24.583		5,17 %
LV	625	780		24,85 %
UK	13.584	15.180		11,75 %

Figure 4 Left: Raw milk collected at dairies, monthly data, and 12 month running average; normalized based on 2010 (MMO, 2014). Right: Total dairy production and production development in selected European countries in 2010-2018 (EUROSTAT, 2019).

influenced the wider milk pool and opened the market, particularly at a European level. Secondly, dairies in France have had no interest in expanding production in times of low prices and have deliberately not purchased more milk than what they could sell. Therefore, the strategic response by farming systems was strongly conditioned by the strategic response of the dairies that they supplied. Thirdly, in Latvia the last decade was also characterized by an internal restructuring of farming systems, as farm sizes, productivity, and number of cows per farm have increased considerably.

4.3 Strategic considerations of the farming systems

The development of dairy price and production was quite different across the case study countries. Nevertheless, we observed the same structural tendencies. Farms keep getting bigger and there was a tendency for all farming systems to improve the efficiency of their production because of the market situation (see Table 3). However, the efficiency improvements also reflected an extension of the strategic orientation at individual farming systems level and the fact that different strategic opportunities were available due to diverse backgrounds in each country. Based on the case studies it is also clear that it is challenging for farming systems to formulate resilient strategies, which may lead to a fundamental restructuring of the European dairy sector.

Within each country, farming systems undergo a continuous structural development, but we also see an emerging regional concentration of dairy production at European level, in Denmark (as well as other

countries in North-Western Europe), where conditions for dairy production are favorable and where the milk quota previously limited production. In all countries, we observed increasing farmer age and issues with the reproduction of farming systems. Succession is increasingly problematic following market liberalization as it is difficult for young farmers to see a future as dairy farmers and to attract sufficient capital for succession due to the increasingly volatile and low-income milk market.

In the survey we also explored how farmers observed the disturbances and their views of the future. The data show little overall variation between the countries regarding the expected strategic response of the dairy farming systems in the present situation (see Appendix 1). Many dairy farming systems faced income problems and were left with few strategic options. For instance, a majority (ranging from 50-60 %) of the survey respondents across the five countries indicated that they planned to "maintain the existing scale of operation" (see Figure 5). Only a minority of respondents (20-35 %) indicated that they planned to "expand the existing scale of operation", most pronounced in Greece, Latvia, and the United Kingdom. Lastly, a minority of less than 20 % of respondents indicated that they intended to either "abandon farming" or "reduce the existing scale of operation", most pronounced in France and Denmark. For the Danish case study, this may be due to the fact that a large number of dairy farms had already expanded their operations prior to the quota abolition and because there were a number of older farmers who intend to retire once property prices increase.

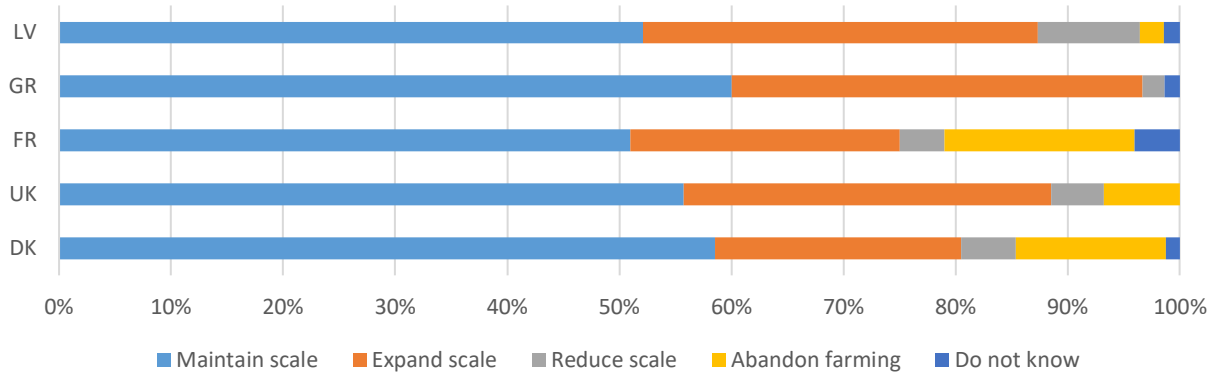


Figure 5 Farmers' strategies. Replies to the question: „What are your strategies for the development of dairy farming within the context of your farm business in the coming 5 years?" (Source: SUFISA survey data).

A number of local issues, such as value chain configuration, market dependence, and local market characteristics influenced farming systems and their ability to endure in times of crisis. Whereas the farming systems in the United Kingdom, Greece, and to some extent Latvia were more embedded in local markets and the production of fresh products, other countries like France and Denmark were more dependent on export markets, hence, they were more influenced by world market dynamics (see Figure 2). In effect, we observed that countries like Denmark expanded production whereas other countries, especially pronounced in Greece, but also Latvia, focused on added-value production like organic production or engaged in various subsidy schemes to support their economy.

To explore the changes farming systems intend to implement to meet their strategic ambitions the survey included a question addressing the expected changes to the farming system in the coming five years (see Appendix 1). Between 35-60 % of respondents indicated a plan to invest in production facilities, most

pronounced in Greece and Latvia. An ambition to specialize their production further was indicated by 20-40 %, most pronounced in France. However, there were also major points of divergence across the countries. For instance, around 50 % of respondents expected to insure against crop or livestock losses in Denmark and Latvia, which was substantially higher than the other countries. 70 % of respondents in Denmark indicated a plan to add value, for instance, by converting to organic production (where prices for organic milk were substantially higher for a long period), which is about 50 percentage points higher than other countries. Furthermore, 45-50 % of respondents in Latvia expected to secure income and develop new partnerships, which is 20 percentage point higher than other countries. Therefore, the strategic response of the farming systems to the changing conditions on the dairy market were associated with the commodity type (and therefore general across the countries) as well as specific and deeply embedded in local contextual features.

Survey participants were also asked to indicate what influences their decisions regarding production and farming strategies. A number of factors were highlighted as important drivers across the different cases – particularly, changes of regulations, consumer preferences and behavior, and access to loans and credit (see Appendix 2). Adverse climatic conditions were also highlighted as important drivers, particularly in France and Latvia, but the importance differ across cases. This suggests that the five case studies are influenced by different environmental and biophysical factors influencing milk production.

We also examined farming and marketing strategies based on qualitative data obtained in interviews, focus groups, and workshops. Here we observed a pronounced difference in the strategic response of farming systems, on the one hand, and processors, on the other. The strategic response of the processors varied quite a lot across countries, due to many different factors such as their market orientation, size, product output, and technical setup. Each individual processor adopted its own strategic response depending on the market conditions, i. e., the nature of their contracts with specific supermarkets, the market of the specific products they produce, and the processing capacity in the dairies' system. This implies that the strategic opportunities available for the farming systems should also be understood in relation to the corporate strategies in the value chain.

Although the different farming systems were vulnerable to price volatility, the specific impacts of this disturbance varied. In countries like Greece, Latvia, the United Kingdom, and France, much of the milk production takes place in relatively old production facilities. Likewise, farming systems are more self-sufficient and have lower debt levels, compared to the Danish case. Hence, when prices are low, farmers are able to either abandon dairy farming altogether or accept a period with low wages or overdraft. In a country like Denmark where dairy production primarily takes place in modern high-tech production facilities the challenge is different. These production facilities demand large investments, implying a high share of fixed costs, and require production at full capacity to service loans. Accordingly, when prices fluctuate these facilities will run with a deficit in some periods (and in some cases quite a large one). Therefore, to endure, different farming systems have adopted different strategies to manage volatility. In Denmark production was expanded to full capacity thereby reducing marginal costs per unit of produce, whereas in France farming systems were restricted by a voluntary quota system coordinated by the dairies, and in the United Kingdom production contracts dominated.

394 *Table 3 The strategic response of farming systems following market liberalization and increasing*
395 *price volatility (Aubert et al., 2018; Grivins et al., 2018; Maye et al., 2018; Thorsøe and Noe, 2018;*
396 *Tsakalou and Vlahos, 2018).*

	Configuration of milk production	**Strategic response of the processors**	**Strategic response of the farming systems**
Denmark	Large-scale and industrialized production facilities. Milk is processed by several cooperatives (Arla is by far the largest). Historically the Danish dairy industry is very export-oriented as 2/3 of production is exported Denmark.	Gradual increase in production, particularly after the quota abolition. A strategy dominated by an ambition to conquer market shares on the global market.	Crisis response has primarily been to lower production costs per kg of milk, by locally expanding production or converting to organic production to get price premium.
France	Great regional differences in production systems. Two main market channels, either cooperatives or private dairies, each of these have approximately the same size. Most milk is sold as standard milk for processing at the dairies.	Deliberate capacity restrictions in the processing sector to ensure stable production in an attempt to not destroy the local market.	Two strategies are prominent, either extensification via pasture-based production or intensification.
Greece	Small-scale and fragmented dairy sector with few international enterprises. Produce around half of the Greek consumption of cow milk products. 60 % of the Greek dairy sector produce goat and sheep milk.	Producer cooperatives are a dominating institution to ensure competition.	Lacking credit access imply difficulties to formulate a strategic response in the current situation of low prices.
Latvia	High share of small scale farming systems with low productivity and uncoordinated processing system. Traditionally, milk is wholesaled at spot market, hence, no long-term contracts for farmers who have a weak position in the value chain.	Initially low milk prices and reliance on the Russian market. However, the entrance of a few large multi-national companies has increased prices and boosted production.	Emphasis on productivity improvement, implying increasing production. Initially the milk price crisis implied that farmers were forced to sell their milk below the costs of production. Several strategies are, however, available, including selling at spot markets to the highest bidder, surviving on subsidies or including new revenue streams.
United Kingdom	Fragmented dairy sector, a number of different market arrangements exist, both cooperative and private. Supermarkets dominate, particularly the liquid milk market. About 65 % of dairy production in the United Kingdom is sold as liquid milk, with only 25 % turned into cheese and 10 % into powders and butter.	Contracts have become an increasingly important feature of dairy supply chains. A range of different actors employing different strategies dominate the milk market. Some processors have introduced an A and B pricing regime to control supply.	Low milk price is an existential concern, but price stability (stable market) is also essential; farmers receive different prices based on the nature of their contract. However, the crisis has implied an increasing contractualization, diversification of revenue streams and conversion to organic production.

397

Thus, dairies also act in a highly competitive market and formulate their own strategic response ensuring the perseverance of their companies, sometimes at the expense of individual farmers. During the period of milk quotas and stable market prices, volatility had not been considered by dairies because prices and production volumes were relatively constant. However, when this changed new institutions were developed to ensure stability for the dairies, but often these meant less flexibility for producers. For instance, in the case of Denmark higher entrance fees to cooperatives were adopted to ensure that farmers do not exit if offered better prices at another dairy. French dairies, in turn, have adopted voluntary production ceilings. Hence, the emerging price volatility was transferred directly onto primary producers.

5. Discussion

As documented in this article, liberalization and the volatile nature of the dairy market has had a profound impact on the conditions of milk producers in Europe. In the following, we discuss the effects of the strategic response of the farming systems with respect to the resilience of the European dairy sector.

5.1 Dairy production in a volatile market

In response to market liberalization the dairy market has become highly volatile in contrast to previously stable dairy market conditions (Veerman et al., 2016). Price stabilization was an important feature of the European dairy market assuring the viability of small-scale farming systems in marginal areas that may not have endured in the absence of market protection (Dervillé et al., 2017; Dillon et al., 2005; McDonald and Macken-Walsh, 2016). European farming systems were adjusted to these market conditions and they were therefore challenged when this protection was abolished.

An important effect of liberalization was an increase in the production of milk in the EU, despite low or volatile prices. For the single farmer it was rational to increase production to endure, but for the European dairy sector as a whole it was problematic, because increasing production further lowered the milk price. Consequently, there is a trade-off between the rationality of individual farming systems and of the dairy sector as a whole. On a more aggregate scale, market liberalization has also changed the structural dynamics of land use and milk production within the EU. Milk production is therefore expected to further concentrate in regions with temperate climate and high grass growth as these have a comparative advantage, whereas quotas previously restricted this structural adjustment (Boere et al., 2015; Huettel and Jongeneel, 2011; Läpple and Sirr, 2019). Thus, liberalization threatens dairy farming systems in other regions, particularly in areas with low production density and a low degree of quality differentiation (Dervillé et al., 2017).

Like the individual dairy farming systems, the dairy processing sector in most European countries has also experienced pronounced consolidation in the last two decades resulting in a number of multinational companies (Grau et al., 2015). This has implied a strategic reorientation of these companies emphasizing economies of scale, and they have become increasingly distanced from primary producers, although the largest processors are still cooperatives (Juliá-Igual et al., 2012).

Today, economic forces encourage more efficient milk production in the EU and further adjustment is expected (Nehring et al., 2016). In this article we have also observed that the changing conditions have accelerated the competition between dairy farming systems within Europe. Particularly, in North-Western

Member States' production increases while it stagnates or declines in other regions, as farming in these regions currently is unable to maintain production under the new market conditions. However, the adjustment is gradual as dairy farming systems are slow to adjust to changing conditions due to a high share of sunk costs in the production facilities and because of the strong cultural importance of dairy production. Besides, local policies to reduce manure production is a barrier for this development in regions that already have a high livestock density (Grinsven and Bleeker, 2017).

Currently we observe a transition to more extensive and value-based production in some areas of the five countries (mountainous and marginal regions) and his accelerated structural adjustment was also observed in studies from France, Ireland, the Netherlands, and Belgium (see, e. g., Deming et al., 2020; Dervillé and Allaire, 2014; Pinter and Kirner, 2014). Hence, structural adjustment not only concerns individual farming systems, but also the rural areas in which these farming systems are embedded (Darnhofer et al., 2016). This is particularly true for dairy farming because of its historical organization as family farming and a strong cooperative organization in many countries.

5.2 Configuration of risks and resilience

Increasing price volatility is a major disturbance, and it is problematic in dairy farming, particularly for industrial systems because relatively long-term investments and a high specialization is required, which lead to a substantial path-dependency (van der Ploeg, 2016). Although specialization offers advantages in terms of productivity gains, on the downside farm income is tied to a single commodity. Such dependence can become a threat as it increases farmers' vulnerability to market shock. Furthermore, farming systems also rely on the world market in relation to input factors, such as feedstuff or fuel, and prices for these commodities have also become increasingly volatile. Accordingly, volatility incurs an increasing complexity of the surrounding environment to the farming systems and inability to manage this complexity results in a poor adaptive capacity (Alrøe and Noe, 2012; Darnhofer et al., 2016). Managing this complexity requires an increasing attention to the timing of investments and risk management as this determines the profitability of farming. Although milk prices are volatile, production is quite inelastic, and it is difficult to adjust production from one month to the next. Hence, the disturbances currently faced by producers are also the result of past strategic decisions and the production system design at a time when market conditions were different.

Market liberalization has also accelerated an increasing individualization of market-related risks, as foreseen in several studies (Breustedt et al., 2011; IPTS, 2009; Jongeneel et al., 2010). The milk market liberalization ,thus, also reflects a changing power balance in the commodity chain in favor of downstream actors (Jongeneel et al., 2011). However, as documented in this article, even though farming systems are managed by the same regulatory framework, they respond with different strategies when faced with these changes to the basic conditions.

Dairy farming systems are also slow to adjust, therefore stable market conditions are needed, or alternatively a strategy to manage price volatility is needed (EC, 2014, 2016; Jongeneel et al., 2010). As shown in this article, effective institutional arrangements to safeguard individual farming systems were not in place or not sufficiently effective prior to quota abolition and the market disturbance that followed in 2015, which may be an important factor in understanding the current crisis (EC, 2016).

Market liberalization has implied that the European dairy sector is increasingly competing with those in countries outside the EU, thus, changes in these other sectors will inadvertently influence market conditions in Europe and vice versa (Young et al., 2006). The European dairy market liberalization makes it difficult to transfer increasing costs of production to the market in situations of extreme local events, like a drought, as these are decoupled from global market dynamics (Biggs et al., 2011). Positive local externalities such as landscape preservation or employment are potentially difficult to transfer at a global level, as consumers have a higher preference for effects in the local area (Feldmann and Hamm, 2015).

Although produce is sold locally commodity prices are not determined by local dynamics and according to Veerman et al. (2016) this implies that a need to emphasize risk management. Thus, strategies to manage volatility are critical for the resilience of farming systems. However, as shown in this article, dairy farming systems have very few strategic opportunities to cope with this volatility and they for instance cannot easily convert to other commodities like arable farmers. Therefore, the opportunities for risk management are few as the competitive space is restricted because milk is a highly standardized product and the strategic choice primarily relates to how input factors are converted into milk. Milk is also perishable which calls for fast and continuous processing.

A resilient farming system needs to be able to buffer shocks, adapt, or transform, while still maintaining its identity (Darnhofer, 2014). In this article, we show that it is difficult for farming systems to address the challenges they face in the context of liberalization and price volatility; in fact, the cases reported here illustrate different strategies that are not very resilient because they have changed the nature and identity of the systems. For instance, we observe structural development and restricted investments and abandonment that prevents succession on dairy farms. Apparently, dairy farming systems are unable to adopt resilient strategies, as these do not sustain the family-based farming that are typical to European dairy production. Although these problems are not exclusively caused by market liberalization and increasing price volatility these disturbances certainly aggravated them.

5.3 Implications for policymaking

The analysis of the five case studies provides an important comparative perspective on the ongoing changes in the European dairy sector following liberalization and increasing price volatility. The core idea behind the EU policies have been to liberalize market conditions and mitigate the negative effects by income support, rural development initiatives, and by improving collective organization of producers, to promote individual insurance, and to combat unfair trading practices (EC, 2013). This article illustrates the importance of a more holistic focus on the challenges of dairy farming systems in order to sustain resilience by developing sectoral strategies to address systemic issues that these systems face. Farming systems are part of a complex value chain, and resilience cannot be advanced at farm level alone, but should be sustained across the entire value chain.

As also documented in this article, there are considerable differences in the contractual arrangements of different European dairy farming systems, however, the “Milk Package” provisions are insufficient to ensure resilience in the dairy sector. Development of producer organizations does provide dairy farming systems with more bargaining power, particularly in regions with few cooperatives (EC, 2014). However, the volatile market conditions (of milk and input factors) are largely unaffected by the provisions in the “Milk Package”. Strengthening producer organizations to improve producers’ bargaining power has been successful, but many downstream players are large-scale multinational corporations that are powerful and

difficult to challenge. Furthermore, as we have shown in this article, farming systems in countries with a high share of cooperatives do not experience significantly better conditions. An explanation may be that improving the bargaining power of farming systems in relation to processors is ineffective if the latter are also in a disadvantaged position in relation to downstream actors (Clapp, 2014). Moreover, the internationalization of the processors has changed their internal power dynamics reducing the influence of individual farmers and has accentuated their need for a global market orientation (Madelrieux et al., 2018).

6. Conclusion

The aim of this article was to explore how different European farming systems have responded to liberalization of milk markets and resulting price volatility based on a comparative case study of dairy farming systems in five European countries. The article shows that dairy farming systems in all five countries have been challenged by these disturbances, but have adopted different strategic responses. These differences across countries can be explained by diverse strategic options for the farmers due to differences in the strategies of the dairies, production factors (production facilities and biophysical conditions), and market orientation. Nevertheless, no country has successfully formulated strategies sustaining resilience of their farming systems. Hence, the structural changes we have seen so far may continue and imply a longer readjustment of the European dairy sector with an impact on land use when grazing dairy cows disappear or grasslands are converted to other land use, unless new policies mitigating these changes are developed.

We contend that the crisis European dairy farming systems have experienced since the abolition of the milk quota is not the result of unfair trading practices, but rather the effect of a successful European integration in the world market. This is a predicament for policymakers, as it is difficult to effectively address the challenges of this market integration without compromising the underlying idea of liberalization and the resulting price volatility.

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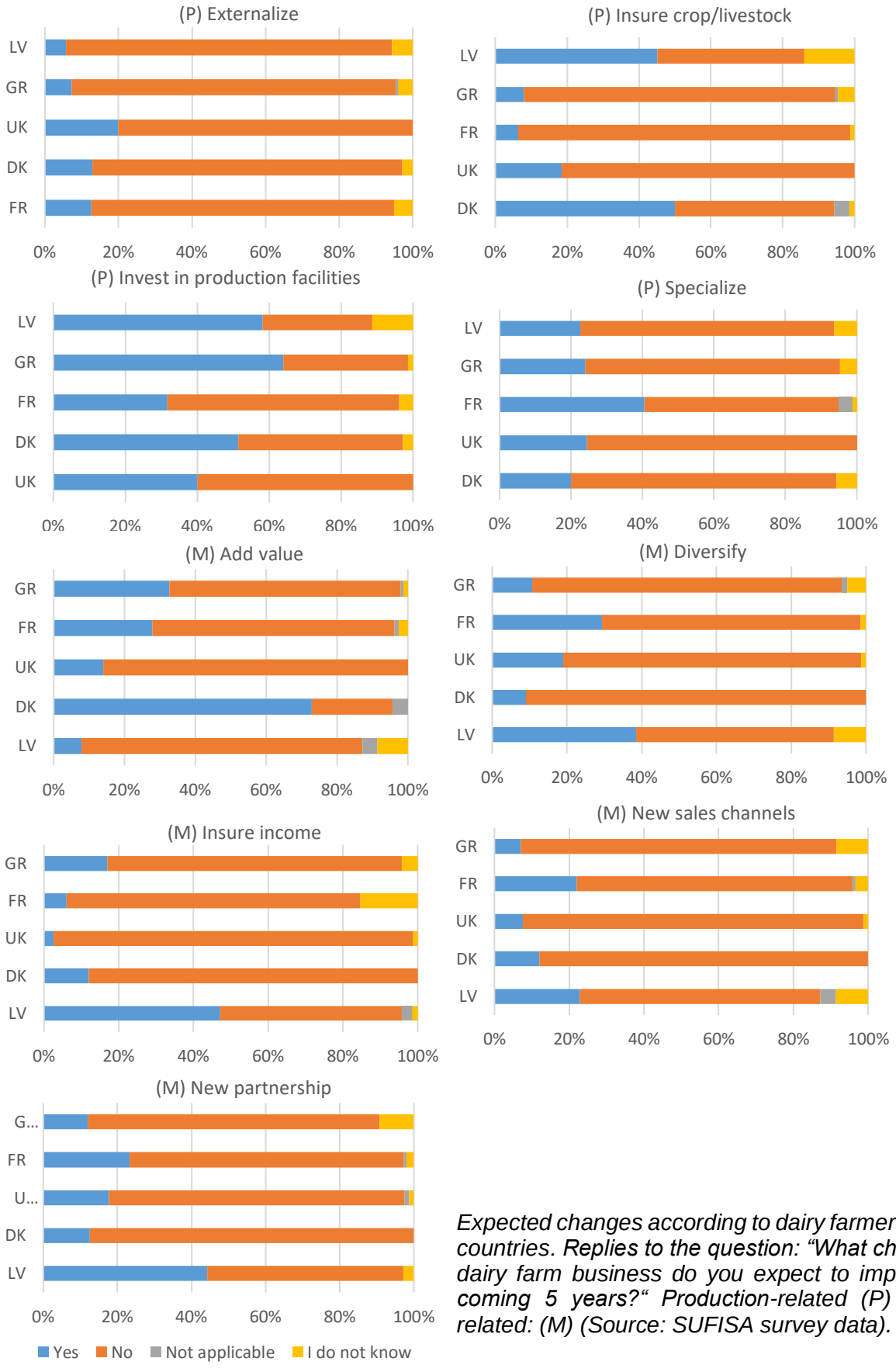
689 **Appendix 1**



Expected changes according to dairy farmers form the five countries. Replies to the question: "What changes to your dairy farm business do you expect to implement in the coming 5 years?" Production-related (P) and market-related: (M) (Source: SUFISA survey data).

Appendix 2

Drivers of farmers' strategies according to dairy farmers from the five countries. Replies to the question: „To what extent might the following factors influence your decisions regarding your production and farming strategies for milk?" (Source: SUFISA survey data).