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Research article

Relationship between farmers' perception of sustainability and future farming strategies: A commodity-level comparison

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Abstract: The environmental challenges have become increasingly integrated into the European Union's Common Agricultural Policy (CAP). The Europe 2020 CAP Framework defines new rules for farmers and targets on innovation, resource efficiency, economic viability, and environmental sustainability. Given the continual evolution of the CAP, it is relevant to focus on sustainable agriculture and which indicators can be employed to aid our understanding of the future farming strategies. This study examines the relationship between perceived sustainability and future farming strategies for three different commodities: sugar beet, dairy, and feta cheese. Survey data collected between 2017–2018 from 191 Belgian sugar beet farmers, 524 dairy farmers (from UK, Denmark, France, and Latvia), and 150 Greek sheep and goat farmers producing milk for feta cheese were analysed using multinomial logistic regressions. Our results show that the farmers' attitude towards sustainability affects intentions to implement specific farming strategies. Belgian sugar beet farmers who perceive their supply chain arrangements (SCAs) environmentally sustainable are less likely to reduce the scale of their farms' operations rather than to maintain them. Dairy farmers are more likely to change the existing scale than to maintain scale if they perceive that production choices affect environmental sustainability to a higher extent. Dairy farmers who perceive their SCAs economically sustainable are less likely to abandon farming. Greek sheep and goat farmers who perceive their SCAs economically sustainable are more likely to expand the existing scale. The observed differences at commodity-level show the importance of well targeted policy measures towards more sustainable farming systems in the European Union.

Keywords: perceived sustainability; future farming strategies; sugar beet; dairy; feta cheese

1. Introduction

To date, much debate about sustainable agriculture has centred on the farm, the farmer and the impact of different land use practices [1–4]. However, sustainability should be seen in terms of the wider agro-food system [4]. Emphasis on sustainable food supply chains is important, because the food supply chain as a whole is the ultimate framework for a scrutiny of sustainability [2]. Supply chain arrangements (SCAs) are becoming more important as a strategic priority for primary producers, since lower policy intervention and unbalanced power are leading to an increased competitive pressure on primary producers and are shaping an emerging role for SCAs. Innovative SCAs are creating new types of relationships between producers and buyers, which have the potential to regulate markets [5].

Some changes are currently shaping supply chains in the EU agri-food sector [6]. Moreover, the progressive reduction of the EU's Common Agricultural Policy (CAP) intervention is making the sector more and more market-oriented and less reliant on the management of markets [7]. In that context, the abolition of milk and sugar quotas is illustrative [5]. Despite the efforts of creating EU-wide minimum standards for SCAs, the differences in the SCAs of different commodity sectors, combined with diverse farming systems structures across the EU, means that similar arrangements may not be a viable solution for all EU situations. Farmers' behaviour is not fully under volitional control, whilst is strongly influenced by external stakeholders such as producers' organizations, food industries, public authorities, etc [8]. Other studies highlighted the aim to identify the level of synergy for integrating sustainability practices into the food chain [4,9–11]. For example, Ilbery and Maye (2005) find that their case study businesses are not particularly sustainable; instead, driven by a strong economic need, they often have to dip into various links associated with more conventional food supply chains [4].

The sustainability objectives have become increasingly integrated into the EU's CAP. The EU's CAP (2014–2020) Framework defines rules for farmers and targets on resource efficiency, economic viability, environmental sustainability, etc. Sustainability is also a requirement to meet consumer expectations and a competitive advantage for firms [8,12]. Given the continuous evolution of the CAP, it is relevant to focus on sustainable agriculture and which indicators can be employed to aid our understanding of the future farming strategies.

Farmers base their agricultural activities and strategies on specific production goals or business plans. In the past such objectives have generally been rather simple ones based almost entirely on profit (or utility) maximization. However, it has been acknowledged that the current situation is more complex. Farmers are faced with growing pressure to become more sustainable from an environmental point of view and with growing market uncertainties that tend to weaken their economic viability. Farmers' perception of the options affects strategic decision making [13]. Farmers must find a balance between profit and non-profit objectives in order to maximize their income levels, without sacrificing the environment or natural ecosystems [14]. Those non-profit objectives are referred to the whole farms' business environment and relate to a wide range of issues such as sustainable agriculture. The process of strategic decision making is of increased importance to balance the various interests and needs [13]. The rapid evolution of new challenges shaping agricultural sustainability and the unpredictability of the driving forces behind them, make it crucial for farmers to find alternative ways to assess their farm systems. Farmers need to take into account considerations related to the environmental, social, and economic impact of their activities. For example, the need to limit production levels in order to not exceed market capacity [12].

Focusing on sustainable agriculture is obvious and justifiable, but sustainability proves a remarkably difficult concept to define and use precisely, because sustainable development is shaped by the different worldviews of people and organizations, which in turn influence how issues are formulated and actions are proposed [15,16]. The main objective of measuring sustainability is to detect opportunities to improve sustainability [15]. Comparing the sustainability of supply chain arrangements can be useful to identify superior strategies and technologies from a sustainable point of view. Empirical applications are still needed, not to obtain a magic number but to identify paths of improvement [15]. There is a need to find out what farmers' perceptions are with regard to sustainable agricultural practices. Therefore, this study intended to measure farmers' perceptions on selected sustainable agricultural practices and their relationship on future economic farming strategies. The new CAP reform can reduce the profitability of the sector with some foreseeable concerns for farmers. Because of its high compliance costs, the new CAP reform will likely affect farmers' decisions (input allocation) and the economic results of farms [8,17]. Farmers should consider possible strategies to face this important economic change in the sector [17]. This study focuses on economic strategies, since farmers are looking for farm development options to support a substantial part of farm income. Economically healthy farms are important for the local economy [13].

This study aims to understand which sustainability perception indicators support what type of future farmers' decisions. We identified 4 basic different strategies (maintain existing scale, expand existing scale, downscale existing scale, and abandon farming) and described in which way each of the perceived sustainability factors—not only for the farm but also for the whole farms' business environment—contributes to the implementation of those strategies. The use of the sustainability concept is tri-dimensional (i.e., environmental, social, and economic) and based on the results of the confirmatory factor analysis (CFA)[1]. This study contributes to the existing research in several ways. First, in this paper we provide a novel perspective on sustainability by focusing on supply chain arrangements. Despite numerous studies examining sustainable agriculture, investigation of farmers' perceptions of sustainable SCAs has only gained little (or no) attention hitherto. Second, the variability in primary producers' conditions across commodities and regions in the EU makes it challenging to identify a set of characteristics common to all SCAs. We contribute to this current knowledge gap by examining SCAs across a diversity of case studies in terms of commodity coverage and geography.

We begin with framing the sustainability concept. Next, we describe the method with a focus on the survey design, the measurement of the variables included in the empirical model, and the explanation of the statistical analysis. Hereafter, the results are presented. Section 5 contains a discussion of the main results, while section 6 concludes and formulates some policy implications.

2. Sustainability concept

During the past fifty years, external inputs like pesticides, inorganic fertilizer, animal feed-stuffs, tractor, and other machinery have been mainly used in order to increase food production. However,

[1] The results of our CFA can be found in Appendix A.

these external inputs have substituted for natural processes and resources, rendering them less powerful [18]. The high productivity of conventional agriculture had been achieved at the cost of massive damage to the natural environment and troublesome social disruptions. In order to reverse the negative consequences of conventional agriculture, different forms of sustainable agricultural systems have been recommended as alternatives for achieving the goal of an economically profitable and environmentally sound agricultural production system [19].

Agricultural sustainability has been defined and described in many ways. The concept of "*sustainable development*[2]" was introduced by the "*Brundtland report*" in 1980 [20]. From then on, the concept of agricultural sustainability has gradually evolved and became increasingly prominent in agricultural policy debates. Therefore stakeholders pay more attention to the issues of monitoring and evaluation of agricultural practices, and raised the question of suitable indicators to measure sustainability aspects of given practices [21]. H Eckert and Breitschuh [22,23] defined sustainable agriculture as "*the management and utilization of the agricultural ecosystem in a way that maintains its biological diversity, productivity, regeneration capacity, vitality, and ability to function, so that it can fulfil—today and in the future—significant ecological, economic, and social functions at the local, national, and global levels and does not harm other ecosystems*". The implementation and evaluation of sustainable agriculture has become a principal challenge for agricultural research, practice, and policy [24].

Sustainability in agriculture is a complex concept and there is no common viewpoint among scholars about its indicators [25]. Moreover, there is no common and universal methodology for assessing sustainability of farms. In practice, sustainability assessment generally involves dividing the individual dimensions/factors into various issues of concern and assessing these objectives using indicators [21]. However, most researchers have classified sustainability in three groups of interdependent and interactive components [12,21,25,26], namely environmental (or ecological), social, and economic indicator sets. Each dimension is often underpinned with sub-themes and the respective indicators [27]. Viewed from the perspective of the farm, we can argue that the choice of these three dimensions is appropriate because the contribution to sustainable agriculture is threefold: (1) the production of goods and services (i.e., economic pillar), (2) the management of natural resources and the provision of environmental public goods (i.e., environmental pillar), and (3) the contribution to rural dynamics (i.e., social pillar) [12]. The harmonious combination of these three interconnected dimensions constitutes the background of sustainable agriculture. To move towards sustainability, it is necessary to progress simultaneously in all three dimensions. Because these three dimensions are linked, the improvement (or maintenance) of the economic performance alone is meaningless if it does not come together with an improvement (or maintenance) of environmental and social performances. For example, the economic profitability of a production system is not sufficient to compensate unbearable ecological and social costs [12].

The *environmental pillar* is connected with the management and conservation of natural resources and fluxes within and between these resources. Natural resources provided by ecosystems include water, air, soil, energy, and biodiversity [24]. The agro-ecosystem has several *social functions*, both at the level of the farming community and at the level of society. The definition of these functions is based on present-day societal values and concerns [24]. *Economic sustainability* is

[2] Sustainable development was defined as an "*economically viable, environmentally sound, and socially acceptable development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [20].

defined as the economic viability of farming systems, which is their ability to be profitable in order to provide prosperity to the farming community [24]. Economic viability can be understood as whether a farming system can survive in the long term in a changing economic context, such as variability in output and input prices, variability in yields, changes in output outlets, and changes in public support and regulation [12].

3. Methods

3.1. Survey design

We applied an observational cross-sectional study design by using a producer survey. This survey is part of the EU-funded Horizon 2020 project SUFISA[3] (Sustainable finance for sustainable agriculture and fisheries). A total of 2299 farmers from 11 EU member states and eight different commodities were interviewed using a common survey. The sampling unit for the survey is the primary producer (farm). Within the supply chain, primary producers are the most exposed to market risks. The target population is defined at case study level, and it is comprised of farmers in a selected region producing the target commodity. The objective of the producer survey was to collect primary data on supply chain arrangements in order to assess the sustainability of given SCAs and identify future drivers of SCAs. The data collected at a microeconomic level (primary producers) during the SUFISA producer survey are rich and innovative in that there are few publicly available data sets concerning SCAs at an EU level [5]. In the case of sheep and goat farmers producing milk for feta cheese, a deliberate effort was made to target younger generation farmers in order to capture the prospective of a Protected Denomination of Origin product [28]. Data are comparable across a large geographical area and across commodity groups. In this paper, we have highlighted three different commodities (sugar beet, dairy, and feta cheese) in six different countries (Belgium, UK, Denmark, France, Latvia, and Greece)[4]. The commodity selection reflects variety: The sugar beet sector is a rather decreasing sector, the dairy sector is a stable and large sector, and feta cheese sector is an increasing sector.

3.2. Measurement

3.2.1. Sustainability

Sustainability across EU regions and commodities is directly captured through analysis of producers' opinions and perceptions of sustainability of SCAs and associated attributes. Farmers were asked to evaluate how much, in their opinion, the current SCA was sustainable [5]. The items identified by the European Commission [29] largely correspond to the elements of an OECD definition of the economic, social, and environmental dimensions of sustainable agriculture.

[3] In this project 22 different case studies in 11 different European countries are studied. The cases are diverse and cover areas such as dairy farming, aquaculture, olive or sugar beet cultivation. The goal of the project is the identification of conditions that farmers face, what strategies they have employed in the past or may employ in the future and how effective these strategies are.

[4] Tables and statistics are organised and presented by commodity group, meaning that case studies sharing the same commodity have been aggregated together to provide an overview of the SCAs at the sectoral level.

Different classifications are possible and indeed defendable. In this study, we selected the most suitable items per dimension to measure sustainability (see Table 1).

According to the theory of reasoned action and the theory of planned behaviour, psychological studies have agreed that intention to perform a particular behaviour is demonstrated to be the best predictor for that specific behaviour. Intentions are assumed to capture the motivational factors that influence a behaviour, and depend on beliefs that link the given behaviour to certain outcomes and on the perceived social pressure to perform the behaviour. It is considered as a general rule that the stronger the intention to engage in a behaviour, the more likely should be its performance [30–32]. Based on the intention models [30–32], we argue that the farmers' perceptions of sustainable SCAs give us essential insights into the underlying process that determines sustainable agricultural behaviour.

Moreover, certain SCAs explicitly require the adoption of farming practices which have lower impacts on the agro-ecological systems. A number of companies in the agri-food sector aim at market segments or niches by differentiating towards products with lower environmental or social impact. This is the case for organic products or for products obtained from conservation agriculture practices, such as integrated pest management and minimum tillage. These practices allow for maintaining biodiversity, reduce soils erosion, improve soils carbon sequestration capacity and ultimately to preserve the environmental resources for longer-term economic exploitation. In order to enter these markets, companies and cooperatives request specific production standards from farmers, often supported by certifications from private standard companies (e.g., GlobalGAP). Other standards aim to improve the social sustainability of the production processes, although these are more frequent in less developed countries rather than in the EU (e.g., FairTrade). As a result, the SCAs indirectly induce the farmer to adopt a more sustainable behaviour.

Different degrees of sustainability were perceived by farmers in each commodity group when asked to distinguish between environmental, social, and economic sustainability. Four components were identified for each dimension of sustainability. For each component the farmer was asked to assign a score from 1 (strongly disagree) to 5 (strongly agree) regarding the potential impact of the sales agreement terms on the various sustainability aspects.

Sustainability of SCAs depended on the farming system characteristics. The average perceived sustainability of SCAs for each commodity group is plotted in Appendix B. The figures show that, according to producers, the most sustainable arrangements can be found in the sugar beet commodity group. On the contrary, the agreements contracted in the case of feta cheese are perceived by producers as the less sustainable. Within each commodity group, the SCAs were perceived by the farmer to have a differentiated impact on the three sustainability dimensions, i.e. – environmental, social, and economic sustainability. As Table 1 shows, the perceived sustainability of SCAs in the sugar beet sector was quite homogeneous, although social sustainability was slightly higher compared to environmental and economic dimensions. Dairy SCAs were viewed as relatively environmentally and economically sustainable but less socially sustainable. Feta cheese SCAs, which were considered the least sustainable by surveyed farmers, had a relatively higher economic sustainability score than environmental and social dimensions.

Table 1. Average sustainability score at commodity-level.

Question	Sugar beet	Dairy	Feta cheese
Environmental			
The production choices I made in relation to my main sale agreement helped me to maintain biodiversity	3.72	2.68	1.72
The production choices I made in relation to my main sale agreement helped me to support animal welfare*	/	3.73	2.40
The production choices I made in relation to my main sale agreement helped me to maintain water quality	3.71	3.41	1.51
The production choices I made in relation to my main sale agreement helped me to maintain soil organic matter	4.01	3.16	1.88
Social			
The production choices I made in relation to my main sale agreement helped me to create a good connection with buyers and input providers	3.78	3.26	1.91
The production choices I made in relation to my main sale agreement helped me to connect with other farmers	3.84	3.45	1.93
The production choices I made in relation to my main sale agreement helped me to achieve societal recognition of my farming activities	4.18	3.19	1.88
The production choices I made in relation to my main sale agreement helped me to secure a successor	3.71	2.67	1.72
Economic			
The production choices I made in relation to my main sale agreement helped me to maintain profitability	4.14	3.28	3.83
The production choices I made in relation to my main sale agreement helped me to invest in the farm business	3.70	3.00	2.88
The production choices I made in relation to my main sale agreement helped me to sell the products in periods of greater difficulty where prices were low	3.22	3.20	2.02
The production choices I made in relation to my main sale agreement helped me to cope with changing market conditions	3.66	3.35	2.09

*Note: We have deleted this indicator of environmental sustainability because animal husbandry is not relevant for sugar beet farmers.

As the confirmatory factor analyses assure unidimensionality and content validity of our perceived sustainability indicator sets, it is allowed to calculate a summated scale by averaging the scores of the four indicators for environmental sustainability dimension (or three in the case of sugar beet[5]), the four indicators for social sustainability dimension, and the four indicators for economic

[5] We have deleted the indicator "the production choices I made in relation to my main sale agreement helped me to support animal welfare" because animal husbandry is not relevant for sugar beet farmers.

sustainability dimension (or two in the case of feta cheese[6]) [34]. Observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability indicators were not used when calculating the *"Environmental"*, *"Social"*, and *"Economic" sustainability* variables.

3.2.2. Future farming strategies

Farmers' decisions to adopt a new agricultural technology depend on complex factors, such as farmers' perceptions [35]. According to Alonge and Martin (1995), farmers' perceptions about the compatibility of sustainable agricultural practices with their farming systems emerged as the best predictors of adopting such practices [19,36].

It is important to understand how sustainability perceptions are linked to future economic strategies. Therefore, we asked the farmers directly about the future economic strategies that they will adopt in their farming activities (*"What are your strategies for the development of your commodity within the context of your farm business in the coming five years"*). The answers can be classified in one of the following four strategies: *"I plan to maintain the existing scale of operations"*, *"I plan to expand the existing scale of operations"*, *"I plan to downscale the existing scale of operations"*, and *"I plan to abandon farming"*. These answer categories were broadly developed based on the qualitative work done within the SUFISA project [37].

In terms of future production and farming strategies, Table 2 shows that the majority of surveyed farmers do not expect any significant changes to their current production and farming business in the next five years. When the farmers are planning to change the existing scale, the sugar beet farmers prefer to downscale instead of expanding, while the dairy farmers and sheep and goat farmers prefer to expand. None of the sheep and goat farmers producing milk for feta cheese reported that they plan to abandon farming in the coming five years. This is not a surprising result, considering our deliberate effort to address younger farmers.

Table 2. Future farming strategies in coming five years at commodity-level.

Strategy	Sugar beet n (%)	Dairy n (%)	Feta cheese n (%)
Maintain existing scale	102 (61.4%)	280 (56.2%)	90 (60.8%)
Expand existing scale	18 (10.8%)	155 (31.1%)	55 (37.2%)
Downscale existing scale	37 (22.3%)	30 (6%)	3 (2%)
Abandon farming	9 (5.4%)	33 (6.6%)	0 (0%)

Primary producers in the EU are facing a series of challenging factors affecting their business and their capacity to generate sufficient income now and in the future. Such factors can be categorised as 'risks' that can be due to the natural environment (such as weather and diseases), the market (such as price volatility), and/or policies (such as policy reforms or changes to regulations).

[6] The CFA shows that not all items at the scale measurement level contribute significantly to their respective latent constructs for the feta cheese case. Fit indices and the overall internal consistency of the sustainability indicator sets were considered inadequate for the sample. Hence, modifications to the survey structure were made. Only the indicators "to sell the products in periods of greater difficulty where prices were low" and "to cope with changing market conditions" are used (see Appendix A).

The survey asked farmers to identify and rate[7] the most challenging risk factors that might influence their production and farming strategies in the future (see Table 3). For surveyed farmers, the most challenging factor was a severe drop in market prices, with prices and their volatility one of the main concerns for EU farmers across a variety of sectors. Changes in input prices can directly affect farms' profitability and therefore their capacity to generate sufficient income, especially if uncertainty on input prices is combined with uncertainties on product prices. However, access to loans for capital investments or credit for consumable inputs were the least worrying challenges, suggesting that, despite the financial crises of the last 10 years, there were more detrimental factors threatening farms' survival than credit access [5].

Table 3. Drivers that influence farming strategies at commodity-level.

Question	Sugar beet	Dairy	Feta cheese
Adverse climatic conditions or pests	3.13	3.36	3.11
Input price volatility	3.43	3.66	3.64
Severe drop in market prices	4.49	4.06	3.93
Changes in consumer behaviour and/or preferences	3.13	3.35	3.47
Access to loans for capital investments	1.97	3.13	2.86
Access to credit for consumable inputs	2.20	2.85	3.18
Change of farming regulations	3.57	3.55	3.16
Changes in the CAP	2.67	3.56	3.51

3.3. Statistical analyses

Multinomial logistic regression was performed, with farmers' perceptions on sustainability as covariates, predicting their future farming strategies. Multinomial logistic regression fits maximum likelihood models with discrete dependent variables when the dependent variable takes on more than two outcomes and the outcomes have no natural ordering. It is possible to use logistic regression to predict membership of more than two categories and this is called multinomial logistic regression. The analysis breaks the outcome variable down into a series of comparisons between two categories [38]. To determine whether or not there is a significant relationship between sustainability perceptions and future farming strategies, multinomial logistic regression (mlogit) was conducted using the software programs STATA (version 12) and SPSS (version 24).

4. Results

Our sample consists of 191 Belgian sugar beet farmers, 524 dairy farmers (from UK, Denmark, France, and Latvia), and 150 Greek sheep and goat farmers producing milk for feta cheese[8]. All those farmers confirmed that sugar beet, dairy or feta cheese production respectively made up at least

[7] From 1 (strongly disagree) to 5 (strongly agree).

[8] The number of respondents is sometimes lower than these numbers, which is due to two reasons: a) farmers were not forced to answer a question resulting in missing values, b) follow-up questions were posed to farmers depending on their previous answer.

part of their farm business during the campaign 2016–2017. The data of the survey were anonymously analysed.

4.1. Descriptive statistics

4.1.1. Sugar beet case

The average score on environmental sustainability is 3.67 (with a minimum of 1 and a maximum of 5). The average score on social sustainability is 3.85 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability is 3.65 (with a minimum of 1 and a maximum of 5). The sample included slightly more Flemish farmers than Walloon farmers (55% n = 92 vs. 45% n = 74). The age is almost equally distributed around the respondents: 51% of the respondents are older than 50 years. More than one third of the respondents hold a college or university degree (38%). On average, 12.89 ha of the total area was cultivated for sugar beet (with a minimum of 2 ha and a maximum of 100 ha). However, the average sugar beet area for the entire Belgian sugar beet sector was 7.89 ha in 2014 [39]. This might implicate that farmers with a high sugar beet area were more interested in filling in the survey. A detailed overview of the control variables is presented in Table 4.

Table 4. Descriptive statistics at commodity-level.

Variable	Sugar beet			Dairy			Feta cheese		
	n	Mean	St. Dev.	n	Mean	St. Dev.	n	Mean	St. Dev.
Environmental	151	3.67	1.10	424	3.28	1.07	131	1.92	0.95
Social	142	3.85	1.09	433	3.15	0.99	119	1.86	1.07
Economic	138	3.65	1.20	443	3.24	1.03	140	2.73	0.87
Farmer age	166	0.51	0.50	496	0.58	0.49	148	0.16	0.36
Farm size	164	12.89	13.69	498	160.61	188.90	148	14.66	8.32
Farmer education	166	0.38	0.49	498	0.23	0.42	/	/	/
Region	166	0.55	0.50	/	/	/	/	/	/
UK	/	/	/	498	0.39	0.49	/	/	/
DK	/	/	/	498	0.16	0.37	/	/	/
FR	/	/	/	498	0.17	0.38	/	/	/
LV	/	/	/	498	0.28	0.45	/	/	/

Note: Farmer age (= 1 if farmer is older than 50 years; = 0 otherwise), Farm size (logarithm of total commodity area in ha), Farmer education (= 1 if farmer has a college or university degree; = 0 otherwise). Region (= 1 if farmer lives in Flanders; = 0 otherwise), UK (= 1 if farmer lives in UK; = 0 otherwise), DK (= 1 if farmer lives in Denmark; = 0 otherwise), FR (= 1 if farmer lives in France; = 0 otherwise), LV (= 1 if farmer lives in Latvia; = 0 otherwise). For the feta cheese case: Farmer education and Region (= 1 if farmer lives in Northern Greece and 0 if farmer lives in Thessaly Central Greece) are not included because there is no variation in those variables (i.e., all respondents live in Thessaly Central Greece).

4.1.2. Dairy case

The average score on environmental sustainability is 3.28 (with a minimum of 1 and a maximum of 5). The average score on social sustainability is 3.15 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability is 3.24 (with a minimum of 1 and a maximum of 5). The sample included 192 UK farmers, 81 Danish farmers, 85 French farmers, and 140 Latvian farmers. The age is almost equally distributed around the respondents: 58% of the respondents are older than 50 years. More than one fifth of the respondents hold a college or university degree (23%). About 60% of all surveyed farmers have a specific agricultural education, and producers in Denmark and Latvia are even above 75% [5]. On average, 160.61 ha of the total area was cultivated for dairy production (with a minimum of 4 ha and a maximum of 1769 ha). A detailed overview of the control variables is presented in Table 4.

4.1.3. Feta cheese case

The average score on environmental sustainability is 1.92 (with a minimum of 1 and a maximum of 5). The average score on social sustainability is 1.86 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability is 2.73 (with a minimum of 1 and a maximum of 5). Feta cheese is perceived by producers as the less sustainable agreements. Only 16% of the respondents are older than 50 years. Due to the rationale behind sample selection, more than half of the feta cheese producers in Greece were below 40 years of age, while this percentage drops below 10% in the dairy cases in UK and Latvia [5]. None of the respondents has a university degree. On average, 14.66 ha per farm was utilised in the production process (with a minimum of 2.36 ha and a maximum of 43.78 ha). A detailed overview of the control variables is presented in Table 4.

4.2. Multinomial logistic regressions

Our case is suitable for multinomial logistic regressions. There is one outcome variable (future farming strategy) with four categories (maintain scale, expand scale, downscale scale, and abandon farming), three predictors[9] (environmental sustainability impact factor, social sustainability impact factor, and economic sustainability impact factor), and four control variables[10] (farmer age, farm size, farmer education, and region). In our case it makes most sense to use the first category (maintain scale) as the baseline category because this category represents no change in strategy while the other three categories represent some form of change (expanding, downscaling or abandoning). Significant parameters tell us which strategy farmers prefer based on sustainability perceptions.

4.2.1. Sugar beet case

Table 5 shows the individual parameter estimates using environmental sustainability. Note that the table is split into three parts because these parameters compare pairs of outcome categories. We specified the first strategy (i.e., maintain the existing scale) as our reference category. Parameters with significant negative coefficients decrease the likelihood of that response category with respect

[9] We run these predictors separately because of high correlation between them.

[10] It is important to understand how farmers' strategic decision making is related to the socio-economic context in which the farm operates [3]. Strategic decision making is not a purely economic driven decision, but is it also influenced by the personal characteristics of the owner-manager [13]. Our control variables can be considered as characteristics of the socio-economic context in which the farm operates. The econometric models generally applied to study farmers' adoption of sustainable agricultural practices employ a range of determinants such as farm and farmer characteristics [8].

to the reference category, while parameters with significant positive coefficients increase the likelihood of that response category in comparison with the reference category.

Whether the farmer puts high value on perceived environmental sustainability significantly predicts whether the farmer is planning to downsize the existing scale or to maintain the existing scale (B = −0.384, $p < 0.05$), ceteris paribus. The Odds Ratio tells us that as this variable increases, so as the farmer's environmental sustainability score shows one more unit, the change in the odds of downscaling scale (rather than maintaining scale) is 0.681, ceteris paribus. In short, the farmers are less likely to downscale scale than to maintain scale if they put a higher value on perceived environmental sustainability, ceteris paribus. In other words, the odds of downscaling scale are significantly lower than the odds of maintaining scale when the farmers' value on perceived environmental sustainability increases by one unit, ceteris paribus.

Table 5. Multinomial logistic regression for environmental sustainability-sugar beet.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−2.115 (1.371)			
Environmental	−0.228 (0.242)	0.496	0.796	1.279
Farmer age	0.053 (0.546)	0.362	1.054	3.072
Farm size	0.528 (0.383)	0.801	1.695	3.590
Farmer education	−0.317 (0.552)	0.247	0.728	2.148
Region	0.317 (0.585)	0.436	1.374	4.323
Maintain scale vs. downscale scale				
Intercept	−0.968 (1.080)			
Environmental	−0.384 (0.190)**	0.469	0.681	0.990
Farmer age	0.235 (0.421)	0.555	1.265	2.886
Farm size	0.463 (0.309)	0.866	1.588	2.913
Farmer education	0.489 (0.455)	0.668	1.630	3.980
Region	−0.432 (0.459)	0.264	0.649	1.595
Maintain scale vs. abandon farming				
Intercept	0.898 (2.032)			
Environmental	−0.520 (0.381)	0.282	0.595	1.256
Farmer age	−0.519 (0.911)	0.100	0.595	3.548
Farm size	−0.785 (0.738)	0.107	0.456	1.938
Farmer education	0.141 (0.919)	0.190	1.151	6.974
Region	−0.246 (0.947)	0.122	0.782	5.004

Note: $R^2 = 0.100$ (Cox & Snell), $R^2 = 0.115$ (Nagelkerke). Model $Chi^2\,(15) = 15.674$, $p > 0.1$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C1 in Appendix C shows no significant estimates for the social sustainability independent variable. Table C2 in Appendix C shows no significant estimates for the economic sustainability independent variable.

4.2.2. Dairy case

Whether the farmer puts high value on perceived environmental sustainability significantly predicts whether the farmer is planning to expand the existing scale or to maintain the existing scale (B = 0.234, $p < 0.05$), ceteris paribus (see Table 6). The Odds Ratio tells us that as this variable increases, so as the farmer's environmental sustainability score shows one more unit, the change in the odds of expanding scale (rather than maintaining scale) is 1.263, ceteris paribus. In short, the farmers are more likely to expand scale than to maintain scale if they put a higher value on perceived environmental sustainability, ceteris paribus. In other words, the odds of expanding scale are significantly higher than the odds of maintaining scale when the farmers' value on perceived environmental sustainability increases by one unit, ceteris paribus.

Table 6. Multinomial logistic regression for environmental sustainability-dairy.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−2.077 (0.975)**			
Environmental	0.234 (0.111)**	1.016	1.263	1.570
Farmer age	0.735 (0.228)***	1.336	2.086	3.259
Farm size	−0.020 (0.137)	0.749	0.980	1.282
Farmer education	−0.535 (0.278)*	0.340	0.586	1.010
DK	0.425 (0.368)	0.743	1.529	3.145
FR	0.674 (0.348)*	0.991	1.962	3.884
LV	−0.067 (0.280)	0.540	0.935	1.619
Maintain scale vs. downscale scale				
Intercept	−2.758 (2.054)			
Environmental	0.429 (0.233)*	0.973	1.536	2.424
Farmer age	−0.523 (0.510)	0.218	0.593	1.612
Farm size	0.072 (0.290)	0.608	1.075	1.899
Farmer education	−0.753 (0.530)	0.167	0.471	1.331
DK	−0.418 (0.737)	0.155	0.658	2.793
FR	0.058 (0.702)	0.268	1.060	4.192
LV	−0.538 (0.575)	0.189	0.584	1.801
Maintain scale vs. abandon farming				
Intercept	−19.326 (1.788)***			
Environmental	0.205 (0.218)	0.800	1.227	1.883
Farmer age	−0.982 (0.532)*	0.132	0.375	1.063
Farm size	−0.086 (0.289)	0.521	0.918	1.618
Farmer education	−0.184 (0.671)	0.223	0.832	3.099
DK	−0.904 (0.507)*	0.150	0.405	1.094
FR	0.245 (0.599)	0.395	1.278	4.135
LV	17.982 (0.000)	/	/	/

*Note: $R^2 = 0.127$ (Cox & Snell), $R^2 = 0.147$ (Nagelkerke). Model $Chi^2\,(21) = 57.368$, $p < 0.01$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. UK is excluded to avoid perfect multicollinearity.

Whether the farmer puts high value on perceived environmental sustainability significantly predicts whether the farmer is planning to downsize the existing scale or to maintain the existing scale (B = 0.429, $p < 0.10$), ceteris paribus. The Odds Ratio tells us that as this variable increases, so as the farmer's environmental sustainability score shows one more unit, the change in the odds of downscaling scale (rather than maintaining scale) is 1.536, ceteris paribus. In short, the farmers are more likely to downscale scale than to maintain scale if they put a higher value on perceived environmental sustainability, ceteris paribus. In other words, the odds of reducing scale are significantly higher than the odds of maintaining scale when the farmers' value on perceived environmental sustainability increases by one unit, ceteris paribus.

Table C3 in Appendix C shows no significant estimates for the social sustainability independent variable.

Table 7 shows the individual parameter estimates using economic sustainability. Whether the farmer puts high value on perceived economic sustainability significantly predicts whether the farmer is planning to abandon farming or to maintain the existing scale (B = −0.542, $p < 0.01$), ceteris paribus. The Odds Ratio tells us that as this variable increases, so as the farmer's economic sustainability score shows one more unit, the change in the odds of abandoning farming (rather than maintaining scale) is 0.582, ceteris paribus. In short, the farmers are less likely to abandon farming than to maintain scale if they put a higher value on perceived economic sustainability, ceteris paribus. In other words, the odds of abandoning farming are significantly lower than the odds of maintaining scale when the farmers' value on perceived economic sustainability increases by one unit, ceteris paribus.

Table 7. Multinomial logistic regression for economic sustainability-dairy.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−1.584 (0.916)*			
Economic	0.113 (0.110)	0.903	1.120	1.389
Farmer age	0.688 (0.221)***	1.289	1.989	3.069
Farm size	0.036 (0.130)	0.903	1.120	1.389
Farmer education	−0.550 (0.269)**	0.340	0.577	0.978
DK	0.269 (0.347)	0.662	1.308	2.585
FR	0.532 (0.371)	0.823	1.703	3.525
LV	−0.155 (0.266)	0.508	0.856	1.442
Maintain scale vs. downscale scale				
Intercept	−1.507 (1.900)			
Economic	−0.011 (0.216)	0.648	0.990	1.510
Farmer age	−0.678 (0.497)	0.192	0.508	1.346
Farm size	0.055 (0.266)	0.628	1.057	1.779
Farmer education	−0.676 (0.510)	0.187	0.509	1.382
DK	−0.069 (0.721)	0.227	0.934	3.838
FR	0.077 (0.744)	0.251	1.081	4.643
LV	−0.539 (0.527)	0.208	0.583	1.639

Continued on next page

	B (SE)	95% CI for Odds Ratio Lower	Odds Ratio	Upper
Maintain scale vs. abandon farming				
Intercept	1.312 (1.832)			
Economic	−0.542 (0.207)***	0.388	0.582	0.873
Farmer age	−0.855 (0.495)*	0.161	0.425	1.122
Farm size	−0.417 (0.257)	0.399	0.659	1.090
Farmer education	−0.676 (0.575)	0.165	0.509	1.571
DK	−0.656 (0.521)	0.187	0.519	1.442
FR	0.617 (0.647)	0.521	1.854	6.594
LV	0.922 (0.687)	0.654	2.515	9.676

Note: $R^2 = 0.109$ (Cox & Snell), $R^2 = 0.125$ (Nagelkerke). Model $Chi^2(21) = 50.953, < 0.01$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. UK is excluded to avoid perfect multicollinearity.

4.2.3. Feta cheese case

Table C4 in Appendix C shows no significant estimates for the environmental sustainability independent variable. Table C5 in Appendix C shows no significant estimates for the social sustainability independent variable.

Table 8 shows the individual parameter estimates using economic sustainability. Whether the farmer puts high value on perceived economic sustainability significantly predicts whether the farmer is planning to expand existing scale or to maintain the existing scale (B = 0.281, p < 0.10), ceteris paribus. The Odds Ratio tells us that as this variable increases, so as the farmer's economic sustainability score shows one more unit, the change in the odds of expanding scale (rather than maintaining scale) is 1.324, ceteris paribus. In short, the farmers are more likely to expand the existing scale than to maintain scale if they put a higher value on perceived economic sustainability, ceteris paribus. In other words, the odds of expanding scale are significantly higher than the odds of maintaining scale when the farmers' value on perceived economic sustainability increases by one unit, ceteris paribus.

Table 8. Multinomial logistic regression for economic sustainability-feta cheese.

	B (SE)	95% CI for Odds Ratio Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−0.859 (0.903)			
Economic	0.281 (0.151)*	0.986	1.324	1.778
Farmer age	0.273 (0.505)	0.488	1.314	3.533
Farm size	−0.160 (0.296)	0.477	0.852	1.522
Maintain scale vs. downscale scale				
Intercept	−21.734 (3.561)***			
Economic	−0.014 (0.678)	0.261	0.986	3.721
Farmer age	17.355 (0.000)	/	/	/
Farm size	0.331 (1.279)	0.114	1.393	17.066

Note: $R^2 = 0.053$ (Cox & Snell), $R^2 = 0.068$ (Nagelkerke). Model Chi^2 (6) = 7.568, $p > 0.1$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Discussions

We find that sugar beet farmers who consider their SCAs environmentally sustainable are less likely to reduce the existing scale of their farms' operations rather than to maintain them, ceteris paribus. The abolition of the quota system exhibits a challenge for the Belgian sugar beet sector. The future of Belgian sugar beet farmers is threatened by plummeting prices after the quota abolition, which could explain the rather risk-averse behaviour of Belgian sugar beet farmers. Moreover, farmers indicate that the most important reasons for their decision to not increase their current sugar beet operations are the facts that they want to wait and see how the market develops, they do not have access to the necessary land, and the crop is unprofitable. The farming sector is continuing to go through a structural change with less, but larger farms. The reduction of farms is often the only possibility for remaining farms to expand their business. Other land for expansion is either not available or too expensive. As farmers have less options to expand, intensification and innovation are the main remaining strategies for farmers to maintain their income. However, intensification may oppose sustainability goals and may thus also be limited [40].

The abolition of the milk quota in 2015 has led to growing instability on the milk market [41]. Our results indicate that dairy farmers who made environmentally sustainable production choices are more likely to change (expand or downscale) the existing scale than to maintain the existing scale, ceteris paribus. The Brexit causes great uncertainty amongst the industry for the British dairy farmers. There is a need for nuanced post-Brexit policy decision-making that takes into account the potentially differentiated impacts of a changing policy context on dairy farmers and their different SCAs [42]. Currently, Danish dairy farming is in a significant financial crisis. It is no option for Danish producers to reduce production in times of poor prices, but the only option available is to increase efficiency, cancel reinvestments, and increase production [43]. In many French cases, dairy production is associated with pig production and/or vegetables production on the same farm, which allows farmers to diversify their sources of income. As in most European countries, the milk crisis has strongly hit most farms and incomes have decreased strongly [41]. While as of today, farmers' margins of manoeuvre to increase the economic resilience and the sustainability of their farms rests on individual decisions—as they don't feel they have enough power to change the broader context in which they operate. A larger scale transition, in which semi-extensive and pasture-based systems would gain prominence, could only happen if collective and territorially-based strategies are implemented and succeeded [41].

We find that dairy farmers who consider their SCAs economically sustainable are less likely to abandon farming than to maintain the existing scale, ceteris paribus. The Latvian dairy sector has gone through significant challenges associated with market and demographic processes and political decisions. Furthermore, the sector itself is going through a substantial restructuring. Latvian dairy farmers are facing a turbulent period. In the turbulent context, leaving the sector is one of the common strategies the small and medium farms choose. However, more often owners of small farms first choose to internalise costs and cover the losses by unpaid work. This strategy can be a productive short-term solution (and as such, it has proven to be quite efficient). Still, in long-term, it might influence the quality of produce, the efficiency of the farm and have considerable impacts on farmer health [44].

Our results show that sheep and goat farmers producing milk for feta cheese who consider their SCAs economically sustainable are more likely to expand the existing scale than to maintain the existing scale, ceteris paribus. These farmers are quite competitive in both the internal and external markets and their exported feta cheese has increased by 60% during 2010–2015 period. The particularity of their product, sheep and goat milk and feta cheese (a Protected Denomination of Origin product) protects them, up to a certain degree, from the high price volatility faced by other dairy systems. Currently, the Greek sheep and goat farmers show some optimism when economic sustainability is concerned [45].

In all cases examined, the social sustainability dimension seems not to have a significant impact on farmers' strategy selection, when compared with the environmental and economic ones. Although, especially in the case of sugar beet, farmers suggest that their decisions affect societal recognition of their activities. One could first suggest that in times of crisis or changes, as it was the case for all farmers examined (abolition of quotas, financial crisis, restructuring of the sector etc.), economic sustainability becomes an imperative. Furthermore, the pressure to farmers in order to comply with a long series of regulations and rules related to the environment is apparent and increasing each time a new version of the CAP is debated. This fact and the perception of farmers that most of the societal demands towards them and farming have to do with exactly their environmental performance, implies strong association of the two sustainability dimensions, environmental and social, at least in the European farmers' perceptions.

This study has attempted to provide a commodity-level comparison of the relationship between farmers' perception of sustainability and future farming strategies. Yet, as with all research, our results should be interpreted with caution. It is possible that the survey formulation, providing examples of strategies mainly based on income, might have limited the spectrum of alternatives to individual farming strategies. Using an extensive survey would also allow to take into account other types of future farming strategies, like eco-innovation, agroecology, organic farming, short food supply chain agriculture, etc. In view of our results, future research is encouraged to more explicitly examine the trade-offs arising between economic and non-economic future farming strategies in relation with sustainability.

Our results suggest the need for nuanced policy decision-making that takes into account the potentially differentiated impacts of a changing policy context for the various commodities. Farmers consider the EU's Common Agricultural Policy as essential for providing subsidies, which used to be very different between sectors and commodities, but since the mid-term review of CAP in 2003, tend to be homogenised. However, there are still parts of the policy that are directly linked to specific sectors and commodities namely coupled payments and the support through the Common Market Organisation. In these cases the results of the study could be of particular importance. Additionally, market and socio-economic conditions are important aspects that affect all sectors to some degree. For example, the abolition of the milk quotas, the Russian import ban, and the Chinese market reduction has led to volatile and uncertain market conditions for dairy farmers. Due to this, the dairy sector experienced a gradual transition to volatile world market prices for milk (effectively liberalising the market for milk). This transition resulted in a downward pressure on prices [37]. In cases where the product was not affected at the same degree by this transition process (e.g., feta cheese), the downward pressure on prices was not manifested and also not perceived as such by farmers, when deciding about their strategy. Another example is the abolition of the sugar beet quotas, which means that there are no restrictions on sugar beet cultivation anymore. This is likely to have a dramatic effect on farmers' decisions whether to continue growing this crop. It is open to speculation which effect this is going to have, because overproduction may lead to a price drop which may make the cultivation of sugar beet unprofitable [37].

6. Conclusions

Farms, ultimately, are businesses, which need profit continuity in order to survive and to remain on the market, and to keep delivering public goods and ecosystem services. The design of alternative, sustainable agricultural systems and technologies is rapidly evolving. Sustainable agriculture implies the necessity for farmers to remain competitive. Therefore, farmers need to innovate continuously in order to adapt to market development and changes in resource quality and availability [12]. Farmers must balance farm objectives that relate to a wide range of issues such as sustainability, in order to maximize income levels. Farmers need to take into account considerations related to the environmental, social, and economic impact of their activities. The farmers' attitudes towards sustainability affect intentions to implement specific farming strategies. We attempted to identify which farmers' perceptions of sustainable SCAs lead farmers to adopt a given decision or strategy. Our results are relevant for policy makers because they consider the relationship between policies and farmer behaviour to develop the most appropriate strategy and intervention to stimulate sustainability. For example, the European Commission and Council recently approved the new legislation on unfair trading practices (UTPs)[11] ensuring that the food supply chain is more economically, socially, and environmentally sustainable. Although many EU member countries already have different national rules on UTPs, in some countries there is no or only ineffective specific protection against UTPs. This new legislation will ensure a standard level of protection across all EU countries [46]. The relationships between producer organisations and the food industry should be strengthened to give response to sustainable issues creating economic conditions to compensate for transaction costs, and to provide technical support for farmers to improve their skills and knowledge to implement sustainable schemes [8].

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Conflict of interest

The authors declare no conflict of interest.

[11] UTPs are business-to-business practices that deviate from good commercial conduct and are contrary to good faith and fair dealing. The food supply chain is vulnerable to UTPs due to stark imbalances between small and large operators. Often farmers and small operators in the food supply chain do not have sufficient bargaining power to defend against UTPs [46].

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Appendix A. Confirmatory factor analysis (CFA)

This Appendix examines the measurement of the perceived sustainability of the sales agreement using confirmatory factor analysis in order to develop sustainability impact indicators, consisting of environmental factors, social factors, and economic factors. These individual perceived sustainability dimensions will be used in our multinomial logistic regressions.

Sustainability was evaluated in terms of environmental, social, and economic sustainability of SCAs. Four indicators were identified for each dimension of sustainability. Prior literature assumes that the sustainability construct consists of three underlying sub-constructs and each sub-construct is measured using a certain number of indicators in a survey. To determine whether or not the sub-constructs measure one latent construct, structural equation modelling was conducted. We performed a second order confirmatory factor analysis, in which the main construct perceived sustainability will become second order construct and the three sub-constructs (environmental, social, and economic) will become first order constructs.

1. Results sugar beet

The items that are indicators of a specific construct should converge or share a high proportion of variance in common, known as convergent validity. Several ways are available to estimate the relative amount of convergent validity among indicator measures. JF Hair, WC Black, BJ Babin and RE Anderson [34] list some rules of thumb for assessing the construct validity (see Table A1). First, the standard factor loading estimates should be at least 0.5, or ideally above 0.7. Second, construct reliability (CR) is used in measuring the degree to which an underlying variable of a construct and its indicators are represented in structural equation modelling. All CR's should be above the 0.7 cut-off value. Third, the average variance extracted (AVE) should be at least 0.5 or higher, suggesting adequate convergence (i.e., the variance explained by the latent factor structure imposed on the measure is larger than the remaining error in the items).

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices (see Table A2) achieved with the threshold suggested by BM Byrne [47] and JB Schreiber, A Nora, FK Stage, EA Barlow and J King [48]. It is concluded that the overall assessment of the criteria for model fit was acceptable for the 11 indicators measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

Table A1. Construct validity-sugar beet.

Construct	Factor Loading	CR (> 0.7)	AVE (> 0.5)
Sustainability			
Environmental	0.71		
Social	1.05	0.9	0.8
Economic	0.91		
Environmental			
The production choices I made in relation to my main sale agreement helped me to maintain biodiversity	0.76		
The production choices I made in relation to my main sale agreement helped me to support animal welfare*	/	0.8	0.7
The production choices I made in relation to my main sale agreement helped me to maintain water quality	0.86		
The production choices I made in relation to my main sale agreement helped me to maintain soil organic matter	0.92		
Social			
The production choices I made in relation to my main sale agreement helped me to create a good connection with buyers and input providers	0.84		
The production choices I made in relation to my main sale agreement helped me to connect with other farmers	0.74	0.8	0.7
The production choices I made in relation to my main sale agreement helped me to achieve societal recognition of my farming activities	0.86		
The production choices I made in relation to my main sale agreement helped me to secure a successor	0.80		
Economic			
The production choices I made in relation to my main sale agreement helped me to maintain profitability	0.90		
The production choices I made in relation to my main sale agreement helped me to invest in the farm business	0.89		
The production choices I made in relation to my main sale agreement helped me to sell the products in periods of greater difficulty where prices were low	0.49	0.8	0.6
The production choices I made in relation to my main sale agreement helped me to cope with changing market conditions	0.79		

Note: We have deleted this indicator of environmental sustainability because animal husbandry is not relevant for sugar beet farmers.

Table A2. Measures of fit-sugar beet.

Measure of fit	Result
Chi^2	136.52
Degrees of freedom	41
Probability level	0.000
RMSEA	0.13
CFI	0.918
TLI	0.89

2. Results dairy

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices (see Table A3 and Table A4) achieved with the threshold suggested by BM Byrne [47] and JB Schreiber, A Nora, FK Stage, EA Barlow and J King [48]. It is concluded that the overall assessment of the criteria for model fit was acceptable for the 12 indicators measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

Table A3. Construct validity-dairy.

Construct	Factor Loading	CR (> 0.7)	AVE (> 0.5)
Sustainability			
Environmental	0.74		
Social	1.02	0.8	0.7
Economic	0.78		
Environmental			
The production choices I made in relation to my main sale agreement helped me to maintain biodiversity	0.57		
The production choices I made in relation to my main sale agreement helped me to support animal welfare	0.76		
The production choices I made in relation to my main sale agreement helped me to maintain water quality	0.88	0.8	0.6
The production choices I made in relation to my main sale agreement helped me to maintain soil organic matter	0.88		
Social			
The production choices I made in relation to my main sale agreement helped me to create a good connection with buyers and input providers	0.73		
The production choices I made in relation to my main sale agreement helped me to connect with other farmers	0.70	0.8	0.5
The production choices I made in relation to my main sale agreement helped me to achieve societal recognition of my farming activities	0.68		
The production choices I made in relation to my main sale agreement helped me to secure a successor	0.65		

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Construct	Factor Loading	CR (> 0.7)	AVE (> 0.5)
Economic			
The production choices I made in relation to my main sale agreement helped me to maintain profitability	0.79		
The production choices I made in relation to my main sale agreement helped me to invest in the farm business	0.72		
The production choices I made in relation to my main sale agreement helped me to sell the products in periods of greater difficulty where prices were low	0.69	0.8	0.6
The production choices I made in relation to my main sale agreement helped me to cope with changing market conditions	0.77		

Table A4. Measures of fit-dairy.

Measure of fit	Result
Chi²	188.63
Degrees of freedom	51
Probability level	0.000
RMSEA	0.084
CFI	0.939
TLI	0.921

3. Results feta cheese

Using CFA not all indicators at the scale measurement level were found to contribute significantly to their respective latent constructs. The standardized path loadings ranged from 0.59 to 0.79 for environmental, social ranged from 0.76 to 0.85, and economic ranged from 0.13 to 0.85. Fit indices and the overall internal consistency of the sustainability impact scale were considered inadequate for the sample. Hence, modifications to the survey structure were made. The factor economic sustainability impact was modified by removing the indicators "*maintain profitability*" and "*invest in farm business*". According to the analysis of the new survey structure, the fit indices and the overall internal consistency of the sustainability impact scale were considered adequate for the sample.

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices (see Table A5 and Table A6) achieved with the threshold suggested by BM Byrne [47] and JB Schreiber, A Nora, FK Stage, et al. [48]. It is concluded that the overall assessment of the criteria for model fit was acceptable for the 10 indicators measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

Table A5. Construct validity-feta cheese.

Construct	Factor Loading	CR (> 0.7)	AVE (> 0.5)
Sustainability			
Environmental	0.83		
Social	1.05	0.7	0.7
Economic	0.56		
Environmental			
The production choices I made in relation to my main sale agreement helped me to maintain biodiversity	0.79		
The production choices I made in relation to my main sale agreement helped me to support animal welfare	0.59	0.8	0.5
The production choices I made in relation to my main sale agreement helped me to maintain water quality	0.77		
The production choices I made in relation to my main sale agreement helped me to maintain soil organic matter	0.70		
Social			
The production choices I made in relation to my main sale agreement helped me to create a good connection with buyers and input providers	0.84		
The production choices I made in relation to my main sale agreement helped me to connect with other farmers	0.79	0.8	0.7
The production choices I made in relation to my main sale agreement helped me to achieve societal recognition of my farming activities	0.85		
The production choices I made in relation to my main sale agreement helped me to secure a successor	0.76		
Economic			
The production choices I made in relation to my main sale agreement helped me to sell the products in periods of greater difficulty where prices were low	0.81	0.7	0.6
The production choices I made in relation to my main sale agreement helped me to cope with changing market conditions	0.75		

Table A6. Measures of fit-feta cheese.

Measure of fit	Result
Chi²	35.194
Degrees of freedom	32
Probability level	0.319
RMSEA	0.031
CFI	0.994
TLI	0.991

4. Conclusions

The CFA findings presented a significant and reliable measure of convergent validity of perceived sustainability to the group of environmental, social, and economic factors. As the tests assure unidimensionality and content validity of our sustainability impact scale, it is allowed to calculate a summated scale by averaging the scores of the four indicators for environmental impact factor (or three in the case of sugar beet), the four indicators for social impact factor, and the four indicators for economic impact factor (or two in the case of feta) [34]. The scale is a self-report, valid and reliable measure of the potential agricultural sustainability impact on the sales agreement.

Appendix B. Plots perceived sustainability at commodity-level.

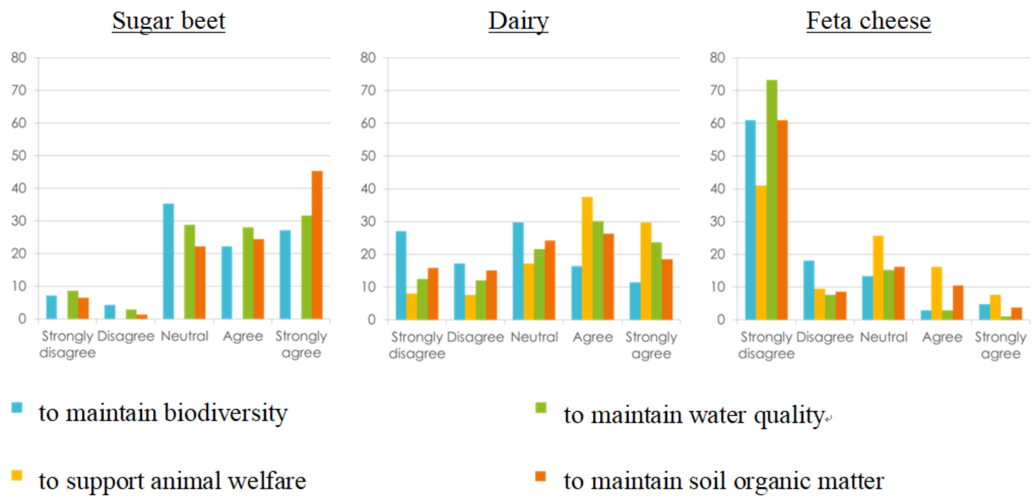

Figure B1. Environmental sustainability (%) at commodity-level.

Figure B2. Social sustainability (%) at commodity-level.

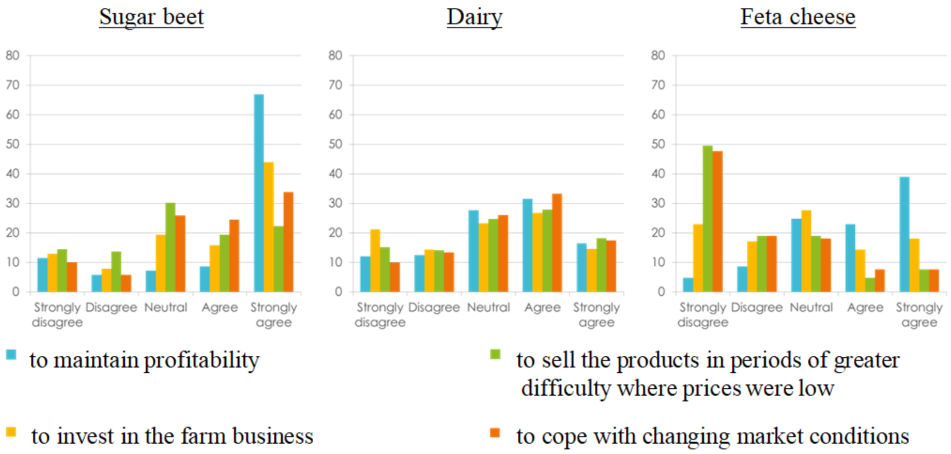

Figure B3. Economic sustainability (%) at commodity-level.

Appendix C. Multinomial logistic regressions.

Table C1. Multinomial logistic regression for social sustainability-sugar beet.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−2.838 (1.602)*			
Social	0.152 (0.289)	0.661	1.164	2.050
Farmer age	−0.247 (0.580)	0.250	0.781	2.435
Farm size	0.350 (0.394)	0.655	1.418	3.070
Farmer education	−0.751 (0.585)	0.150	0.472	1.486
Region	0.555 (0.582)	0.557	1.742	5.448
Maintain scale vs. downscale scale				
Intercept	−1.352 (1.180)			
Social	−0.214 (0.208)	0.537	0.807	1.212
Farmer age	0.161 (0.440)	0.496	1.174	2.780
Farm size	0.408 (0.317)	0.808	1.504	2.802
Farmer education	0.313 (0.489)	0.525	1.368	3.568
Region	−0.350 (0.471)	0.280	0.705	1.775
Maintain scale vs. abandon farming				
Intercept	1.656 (2.209)			
Social	−0.629 (0.390)	0.248	0.533	1.145
Farmer age	−0.647 (0.920)	0.086	0.523	3.173
Farm size	−0.913 (0.758)	0.091	0.401	1.772
Farmer education	0.123 (0.970)	0.169	1.131	7.572
Region	−0.151 (0.962)	0.131	0.860	5.662

Note: $R^2 = 0.091$ (Cox & Snell), $R^2 = 0.106$ (Nagelkerke). Model $Chi^2 (15) = 13.499$, $p > 0.1$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C2. Multinomial logistic regression for economic sustainability-sugar beet.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−2.137 (1.443)			
Economic	−0.079 (0.250)	0.566	0.924	1.509
Farmer age	−0.247 (0.592)	0.245	0.781	2.492
Farm size	0.455 (0.396)	0.726	1.576	3.425
Farmer education	−0.749 (0.593)	0.148	0.473	1.513
Region	0.366 (0.604)	0.441	1.442	4.713
Maintain scale vs. downscale scale				
Intercept	−1.440 (1.105)			
Economic	−0.246 (0.187)	0.542	0.782	1.127
Farmer age	−0.212 (0.453)	0.333	0.809	1.966
Farm size	0.611 (0.314)*	0.995	1.841	3.407
Farmer education	0.247 (0.483)	0.497	1.208	3.297
Region	−0.546 (0.492)	0.221	0.579	1.519
Maintain scale vs. abandon farming				
Intercept	0.287 (2.306)			
Economic	−0.244 (0.418)	0.345	0.783	1.777
Farmer age	−0.254 (0.965)	0.117	0.776	5.141
Farm size	−0.916 (0.862)	0.074	0.400	2.166
Farmer education	−0.256 (0.993)	0.111	0.774	5.418
Region	−0.794 (1.173)	0.045	0.452	4.506

Note: $R^2 = 0.095$ (Cox & Snell), $R^2 = 0.111$ (Nagelkerke). Model $Chi^2\,(15) = 13.601$, $p > 0.1$. $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

Table C3. Multinomial logistic regression for social sustainability-dairy.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−1.462 (0.971)			
Social	0.114 (0.111)	0.901	1.120	1.394
Farmer age	0.632 (0.223)***	1.216	1.882	2.912
Farm size	−0.022 (0.138)	0.747	0.978	1.281
Farmer education	−0.428 (0.271)	0.384	0.652	1.108
DK	0.440 (0.343)	0.793	1.553	3.040
FR	0.478 (0.336)	0.836	1.614	3.116
LV	−0.108 (0.277)	0.522	0.898	1.544
Maintain scale vs. downscale scale				
Intercept	0.986 (1.992)			
Social	−0.289 (0.223)	0.484	0.749	1.161

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		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Farmer age	−0.855 (0.534)	0.149	0.425	1.211
Farm size	−0.171 (0.283)	0.484	0.843	1.468
Farmer education	−0.518 (0.550)	0.203	0.596	1.751
DK	−0.548 (0.675)	0.154	0.578	2.171
FR	−0.193 (0.693)	0.212	0.824	3.204
LV	−0.589 (0.570)	0.182	0.555	1.696
Maintain scale vs. abandon farming				
Intercept	−1.708 (2.142)			
Social	−0.055 (0.226)	0.608	0.947	1.475
Farmer age	−0.850 (0.533)	0.150	0.427	1.214
Farm size	−0.396 (0.278)	0.390	0.673	1.159
Farmer education	−0.159 (0.675)	0.227	0.853	3.201
DK	−0.498 (0.532)	0.214	0.608	1.724
FR	0.581 (0.630)	0.521	1.789	6.144
LV	1.897 (1.065)*	0.827	6.666	53.706

Note: $R^2 = 0.093$ (Cox & Snell), $R^2 = 0.107$ (Nagelkerke). Model Chi^2 (21) $= 41.841$, $p < 0.01$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. UK is excluded to avoid perfect multicollinearity.

Table C4. Multinomial logistic regression for environmental sustainability-feta cheese.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−0.826 (0.965)			
Environmental	0.246 (0.194)	0.874	1.278	1.869
Farmer age	0.201 (0.517)	0.444	1.223	3.370
Farm size	−0.067 (0.304)	0.515	0.935	1.696
Maintain scale vs. downscale scale				
Intercept	−5.584 (3.569)			
Environmental	0.212 (0.667)	0.334	1.236	4.571
Farmer age	−0.855 (1.309)	0.033	0.425	5.531
Farm size	0.976 (1.108)	0.302	2.653	23.271

Note: $R^2 = 0.027$ (Cox & Snell), $R^2 = 0.034$ (Nagelkerke). Model Chi^2 (6) $= 3.570$, $p > 0.1$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C5. Multinomial logistic regression for social sustainability-feta cheese.

		95% CI for Odds Ratio		
	B (SE)	Lower	Odds Ratio	Upper
Maintain scale vs. expand scale				
Intercept	−0.012 (1.078)			
Social	0.045 (0.181)	0.733	1.046	1.492
Farmer age	0.181 (0.605)	0.366	1.198	3.924
Farm size	−0.246 (0.329)	0.410	0.782	1.489
Maintain scale vs. downscale scale				
Intercept	−2.464 (3.997)			
Social	−1.380 (1.729)	0.008	0.252	7.448
Farmer age	−0.750 (1.310)	0.036	0.473	6.158
Farm size	0.671 (1.150)	0.205	1.957	18.637

Note: $R^2 = 0.032$ (Cox & Snell), $R^2 = 0.040$ (Nagelkerke). Model Chi^2 (6) = 3.845, $p > 0.1$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.