Deliverable 3.4.

Sustainability Performance Analysis

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Sustainability Performance Analysis

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Sustainable financing for sustainable agriculture (SUFISA) project[2]

1. Meeting the objectives of D3.4.

In this deliverable, a sustainability performance analysis will be carried out. Two objectives have been formulated for D3.4. In the following it is briefly outlined how they were met.

1. Measurement of sustainability

We will develop a sustainability indicator using the SUFISA survey. Survey data –collected between 2017-2018 in the context of the SUFISA project– were analysed using confirmatory factor analysis. We checked our results by performing cross-country comparisons of the sustainability impact scale. More specifically, secondary analyses of survey data from (1) Belgian sugar beet farmers, (2) dairy farmers (from UK, Denmark, France, and Latvia), and (3) feta farmers from Greece were performed and compared.

2. Sustainability and future farming strategies

We aim to examine the relationship between sustainability and future farming strategies. SUFISA survey data were analysed using multinomial logistic regressions. We attempt to identify the sustainability driving factors that lead farmers to adopt a given decision or strategy.

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The responsibility for the information and views set out in this deliverable lies entirely with the authors.

2. Introduction

Deliverable 3.4. is part of Work Package 3 (WP3), which focuses on impact assessment.

It is recommended to develop a useful tool for monitoring and evaluating sustainability issues in agriculture. We aim to measure the perception to what extent production choices and sales agreements hinder or stimulate sustainability using confirmatory factor analysis (CFA). The CFA approach seeks to examine the extent to which a highly constrained a priori factor structure is consistent with the sample data.

The sustainability objectives have become increasingly integrated into the EU's Common Agricultural Policy (CAP). The EU's CAP (2014-2020) Framework defines new rules for farmers and targets on resource efficiency, agricultural (economic) viability, environmental sustainability, etc. Sustainability is also a requirement to meet consumer expectations and a competitive advantage for firms (Diazabakana et al. 2014; Menozzi et al. 2015). 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.

This deliverable is divided into two main sections. The first section examines the measurement of the potential sustainability impact of the sales agreement using confirmatory factor analysis in order to develop sustainability impact indicators, consisting of environmental factors, social factors, and economic factors, using the SUFISA survey. These individual sustainability impact indicators will be used in the second section of this deliverables, where we examine the relationship between sustainability and future farming strategies.

3. Measurement analysis of sustainability: survey data

3.1. Sustainability concept

The concept of *"sustainable development*[3]*"* was introduced by the *"Brundtland report"* in the late 1980s (WCED 1987). 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 (Latruffe et al. 2016). Eckert and Breitschuh (1994) defined[4] 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*

[3] 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"* (WCED 1987).

[4] This definition is translated by Lewandowski et al. (1999).

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 (Van Cauwenbergh et al. 2007).

Sustainability in agriculture is a complex concept and there is no common viewpoint among scholars about its indicators (Hayati et al. 2011). 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 (Latruffe et al. 2016). However, most researchers have classified sustainability in three groups of interdependent and interactive components (e.g., Diazabakana et al. 2014; Hayati et al. 2011; Latruffe et al. 2016; Zhen and Routray 2003), namely environmental (or ecological) indicators, social indicators, and economic indicators. Each dimension is often underpinned with sub-themes and suitable indicators. 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 (i.e., environmental pillar), and (3) the contribution to rural dynamics (i.e., social pillar) (Diazabakana et al. 2014). 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 (Diazabakana et al. 2014).

3.2. Typology of indicators based on the three sustainability pillars

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 are water, air, soil, energy, and biodiversity (Van Cauwenbergh et al. 2007). 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 (Van Cauwenbergh et al. 2007). *Economic sustainability* is defined as the economic viability of farming systems, which is their ability to be profitable in order to provide prosperity to the farming community (Van Cauwenbergh et al. 2007). 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 (Diazabakana et al. 2014).

3.3. Method

Prior literature assumes that the sustainability construct consists of three underlying sub-constructs and each sub-construct is measured using a certain number of items in a questionnaire. To determine whether or not the sub-constructs measure one latent construct (i.e., the potential sustainability impact of sales agreement), structural equation modelling was conducted using the software program AMOS, version 22.

We performed a second order confirmatory factor analysis (CFA), in which the main construct *potential sustainability impact* will become second order construct and the three sub-constructs (i.e., *environmental*, *social*, and *economic*) will become the first order constructs.

We applied an observational cross-sectional study design by using an online survey. This web-based survey is part of a broader European research project, namely the EU-funded Horizon 2020 project SUFISA[5] (Sustainable finance for sustainable agriculture and fisheries).

Sugar beet case. In total, the survey was answered by 241 Belgian sugar beet farmers who confirmed that sugar beet made up at least part of their farm business during the campaign 2016-2017. After deleting observations with illogical answers[6] and observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions, we dispose of a remaining selection of 139 Belgian sugar beet farmers. The data of the survey were anonymously analysed.

In order to measure the potential sustainability impact of the sales agreement, we asked Belgian sugar beet farmers[7] 12 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Table 1 for an overview of the items). In this study several indicators are computed for environmental sustainability impact (such as biodiversity, animal welfare, water quality, and soil organic matter), social sustainability impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession[8]), and economic sustainability impact (such as profitability, investments in the farm, selling products in difficult periods, and changing market conditions). The selection of our indicators meets the three criteria proposed by Lebacq et al. (2013). First, indicators should be few and not redundant (i.e., parsimony). Second, all necessary indicators are in the survey (i.e., consistency). Finally, the indicators are exhaustive in the sense that they embrace all major sustainability objectives (i.e., sufficiency).

[5] 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. To this end several research steps were conducted. We had interviews and focus groups with farmers and workshops with stakeholders of the supply chain. The information of all case studies was collected and compared. This allowed the identification of key aspects that are now further investigated in the survey.

[6] We manually deleted all double records. Double records are two observations that have the same IP address and/or the same email address. When two observations are considered to be the same, we deleted both observations (n=14). Furthermore, we excluded observations for which the total area is less than the total area for sugar beet (n=13) and/or for which the total production sugar beet (in ton) is disproportionate compared to total area and total area for sugar beet (n=44). Finally, we also excluded outliers according to the price for sugar beet (n=3).

[7] Individual farmers take the major decision in land-use including mode of use and choice of technology (Hayati et al. 2011).

[8] It is sometimes difficult to identify the sustainability dimension to which a specific indicator belongs. For example, the suitability of the farm for succession may be related to economic as well as social sustainability (Diazabakana et al. 2014).

TABLE 1: POTENTIAL SUSTAINABILITY IMPACT OF SALES AGREEMENT

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Environmental					
The production choices I made in relation to my main sale agreement helped me to maintain **biodiversity**	10 7.2%	6 4.3%	49 35.3%	37 22.2%	49 27.2%
The production choices I made in relation to my main sale agreement helped me to support **animal welfare**[*]	0 0%	0 0%	0 0%	0 0%	0 0%
The production choices I made in relation to my main sale agreement helped me to maintain **water quality**	12 8.6%	4 2.9%	40 28.8%	39 28.1%	44 31.7%
The production choices I made in relation to my main sale agreement helped me to maintain **soil organic matter**	9 6.5%	2 1.4%	31 22.3%	34 24.5%	63 45.3%
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**	13 9.4%	4 2.9%	36 25.9%	33 23.7%	53 38.1%
The production choices I made in relation to my main sale agreement helped me to **connect with other farmers**	9 6.5%	7 5.0%	36 25.9%	32 23.0%	55 39.6%
The production choices I made in relation to my main sale agreement helped me to achieve **societal recognition** of my farming activities	9 6.5%	5 3.6%	22 15.8%	23 16.5%	80 57.6%
The production choices I made in relation to my main sale agreement helped me to secure a **successor**	17 12.2%	8 5.8%	30 21.6%	28 20.1%	56 40.3%
Economic					
The production choices I made in relation to my main sale agreement helped me to maintain **profitability**	16 11.5%	8 5.8%	10 7.2%	12 8.6%	93 66.9%
The production choices I made in relation to my main sale agreement helped me to **invest** in the farm business	18 12.9%	11 7.9%	27 19.4%	22 15.8%	61 43.9%
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	20 14.4%	19 13.7%	42 30.2%	27 19.4%	31 22.3%
The production choices I made in relation to my main sale agreement helped me to cope with **changing market conditions**	14 10.1%	8 5.8%	36 25.9%	34 24.5%	47 33.8%

[*] We have deleted this item of environmental sustainability because animal husbandry is not relevant for our case of sugar beet farmers.

Indicators for each dimension are aggregated together in order to obtain three indicators per farm. Statements 1, 3, 4 can be qualified as environmental statements (with a Cronbach's alpha of 0.892), statement 5-8 can be defined as societal statements (with a Cronbach's alpha of 0.881), and statement 9-12 (with a Cronbach's alpha of 0.855) can be assigned to economic statements. All those Cronbach's alphas exceed the recommended lower limit of 0.70, indicating a high level of internal consistency for this scale (Hair et al. 2010). The higher the Cronbach's alpha coefficient, the more the items have shared covariance and probably measure the same underlying concept. In conclusion, we found that the internal consistency of this potential sustainability impact factor is high, which is a good measure of reliability.

A large number of the respondents (n=86; 49.4%) reported to either *"agree"* or *"strongly agree"* that the production choices they made in relation to their main sale agreement/membership in collective organization helped them to maintain biodiversity. The responses on the other items of sustainability impact show a similar pattern, except for the eleventh statement (*"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"*). This statement shows less pronounced results. 28.1% of the respondents do not agree with the statement, while 41.7% do agree with the statement.

Dairy case. In total, the survey was answered by 525 dairy farmers (from UK, Denmark, France, and Latvia) who confirmed that dairy production made up at least part of their farm business during the campaign 2016-2017. After deleting observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions, we dispose of a remaining selection of 384 dairy farmers. The data of the survey were anonymously analysed.

In order to measure the potential sustainability impact of the sales agreement, we asked farmers from UK, Denmark, France, and Latvia 12 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Table 2 for an overview of the items). In this study several indicators are computed for environmental sustainability impact (such as biodiversity, animal welfare, water quality, and soil organic matter), social sustainability impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession), and economic sustainability impact (such as profitability, investments in the farm, selling products in difficult periods, and changing market conditions). The selection of our indicators meets the three criteria proposed by Lebacq et al. (2013). First, indicators should be few and not redundant (i.e., parsimony). Second, all necessary indicators are in the survey (i.e., consistency). Finally, the indicators are exhaustive in the sense that they embrace all major sustainability objectives (i.e., sufficiency).

Indicators for each dimension are aggregated together in order to obtain three indicators per farm. Statements 1-4 can be qualified as environmental statements (with a Cronbach's alpha of 0.852), statement 5-8 can be defined as societal statements (with a Cronbach's alpha of 0.781), and statement 9-12 (with a Cronbach's alpha of 0.830) can be assigned to economic statements. All those Cronbach's alphas exceed the recommended lower limit of 0.70, indicating a high level of internal consistency for this scale (Hair et al. 2010). The higher the Cronbach's alpha coefficient, the more the items have shared covariance and probably measure the same underlying concept. In conclusion, we found that the internal consistency of this potential sustainability impact factor is high, which is a good measure of reliability.

TABLE 2: POTENTIAL SUSTAINABILITY IMPACT OF SALES AGREEMENT

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Environmental					
The production choices I made in relation to my main sale agreement helped me to maintain **biodiversity**	104 27.1%	66 17.2%	107 27.9%	63 16.4%	44 11.5%
The production choices I made in relation to my main sale agreement helped me to support **animal welfare**	31 8.1%	29 7.6%	66 17.2%	144 37.5%	114 29.7%
The production choices I made in relation to my main sale agreement helped me to maintain **water quality**	48 12.5%	46 12.0%	83 21.6%	116 30.2%	91 23.7%
The production choices I made in relation to my main sale agreement helped me to maintain **soil organic matter**	61 15.9%	58 15.1%	93 24.2%	101 26.3%	71 18.5%
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**	57 14.8%	40 10.4%	99 25.8%	123 32.0%	65 16.9%
The production choices I made in relation to my main sale agreement helped me to **connect with other farmers**	35 9.1%	53 13.8%	82 21.4%	134 34.9%	80 20.8%
The production choices I made in relation to my main sale agreement helped me to achieve **societal recognition** of my farming activities	55 14.3%	49 12.8%	113 29.4%	103 26.8%	64 16.7%
The production choices I made in relation to my main sale agreement helped me to secure a **successor**	111 28.9%	52 13.5%	113 29.4%	69 18.0%	39 10.2%
Economic					
The production choices I made in relation to my main sale agreement helped me to maintain **profitability**	46 12.0%	48 12.5%	106 27.6%	121 31.5%	63 16.4%
The production choices I made in relation to my main sale agreement helped me to **invest** in the farm business	81 21.1%	55 14.3%	89 23.2%	103 26.8%	56 14.6%
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	58 15.1%	54 14.1%	95 24.7%	107 27.9%	70 18.2%
The production choices I made in relation to my main sale agreement helped me to cope with **changing market conditions**	38 9.9%	51 13.3%	100 26.0%	128 33.3%	67 17.4%

A large number of the respondents (n=258; 67.2%) reported to either *"agree"* or *"strongly agree"* that the production choices they made in relation to their main sale agreement/membership in collective organization helped them to support animal welfare. The responses on the other items of sustainability impact show a similar pattern, except for the first statement (*"The production choices I made in relation to my main sale agreement helped me to maintain biodiversity"*) and the eighth statement (*"The production choices I made in relation to my main sale agreement helped me to secure a successor"*). More than 42% of the respondents does not agree with these statements, while almost 28% does agree with the statements.

Feta case. In total, the survey was answered by 150 farmers who confirmed that feta production made up at least part of their farm business during the campaign 2016-2017. After deleting observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions, we dispose of a remaining selection of 105 farmers producing feta. The data of the survey were anonymously analysed.

In order to measure the potential sustainability impact of the sales agreement, we asked farmers from Greece producing feta 12 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Table 3 for an overview of the items). In this study several indicators are computed for environmental sustainability impact (such as biodiversity, animal welfare, water quality, and soil organic matter), social sustainability impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession), and economic sustainability impact (such as profitability, investments in the farm, selling products in difficult periods, and changing market conditions). The selection of our indicators meets the three criteria proposed by Lebacq et al. (2013). First, indicators should be few and not redundant (i.e., parsimony). Second, all necessary indicators are in the survey (i.e., consistency). Finally, the indicators are exhaustive in the sense that they embrace all major sustainability objectives (i.e., sufficiency).

Indicators for each dimension are aggregated together in order to obtain three indicators per farm. Statements 1-4 can be qualified as environmental statements (with a Cronbach's alpha of 0.783), statement 5-8 can be defined as societal statements (with a Cronbach's alpha of 0.882), and statement 9-12 (with a Cronbach's alpha of 0.595) can be assigned to economic statements. All those Cronbach's alphas exceed the recommended lower limit of 0.70, indicating a high level of internal consistency for this scale (Hair et al. 2010). The higher the Cronbach's alpha coefficient, the more the items have shared covariance and probably measure the same underlying concept. In conclusion, we found that the internal consistency of this potential sustainability impact factor is high, which is a good measure of reliability.

A large number of the respondents (n=83; 79.1%) reported to either *"strongly disagree"* or *"disagree"* that the production choices they made in relation to their main sale agreement/membership in collective organization helped them to support biodiversity. The responses on the other items of sustainability impact show a similar pattern, except for the ninth statement (*"The production choices I made in relation to my main sale agreement helped me to maintain profitability"*) and the tenth statement (*"The production choices I made in relation to my main sale agreement helped me to invest in the farm business"*). More than 61% of the respondents does agree with the ninth statement about profitability, while 13.4% does not agree with this statement. The tenth statement about investments shows less pronounced results. 40% of the respondents does not agree with the statement, while 32.4% does agree with the statement.

TABLE 3: POTENTIAL SUSTAINABILITY IMPACT OF SALES AGREEMENT

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Environmental					
The production choices I made in relation to my main sale agreement helped me to maintain **biodiversity**	64 61.0%	19 18.1%	14 13.3%	3 2.9%	5 4.8%
The production choices I made in relation to my main sale agreement helped me to support **animal welfare**	43 41.0%	10 9.5%	27 25.7%	17 16.2%	8 7.6%
The production choices I made in relation to my main sale agreement helped me to maintain **water quality**	77 73.3%	8 7.6%	16 15.2%	3 2.9%	1 1.0%
The production choices I made in relation to my main sale agreement helped me to maintain **soil organic matter**	64 61.0%	9 8.6%	17 16.2%	11 10.5%	4 3.8%
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**	64 61.0%	12 11.4%	13 12.4%	7 6.7%	9 8.6%
The production choices I made in relation to my main sale agreement helped me to **connect with other farmers**	60 57.1%	15 14.3%	13 12.4%	11 10.5%	6 5.7%
The production choices I made in relation to my main sale agreement helped me to achieve **societal recognition** of my farming activities	58 55.2%	17 16.2%	21 20.0%	3 2.9%	6 5.7%
The production choices I made in relation to my main sale agreement helped me to secure a **successor**	70 66.7%	8 7.6%	17 16.2%	6 5.7%	4 3.8%
Economic					
The production choices I made in relation to my main sale agreement helped me to maintain **profitability**	5 4.8%	9 8.6%	26 24.8%	24 22.9%	41 39.0%
The production choices I made in relation to my main sale agreement helped me to **invest** in the farm business	24 22.9%	18 17.1%	29 27.6%	15 14.3%	19 18.1%
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	52 49.5%	20 19.0%	20 19.0%	5 4.8%	8 7.6%
The production choices I made in relation to my main sale agreement helped me to cope with **changing market conditions**	50 47.6%	20 19.0%	19 18.1%	8 7.6%	8 7.6%

3.4. Results

3.4.1. Sugar beet case

Using confirmatory factor analysis (CFA), all items at the scale measurement level were found to contribute significantly to their respective latent constructs. An overview of the second order CFA is presented in Figure 1.

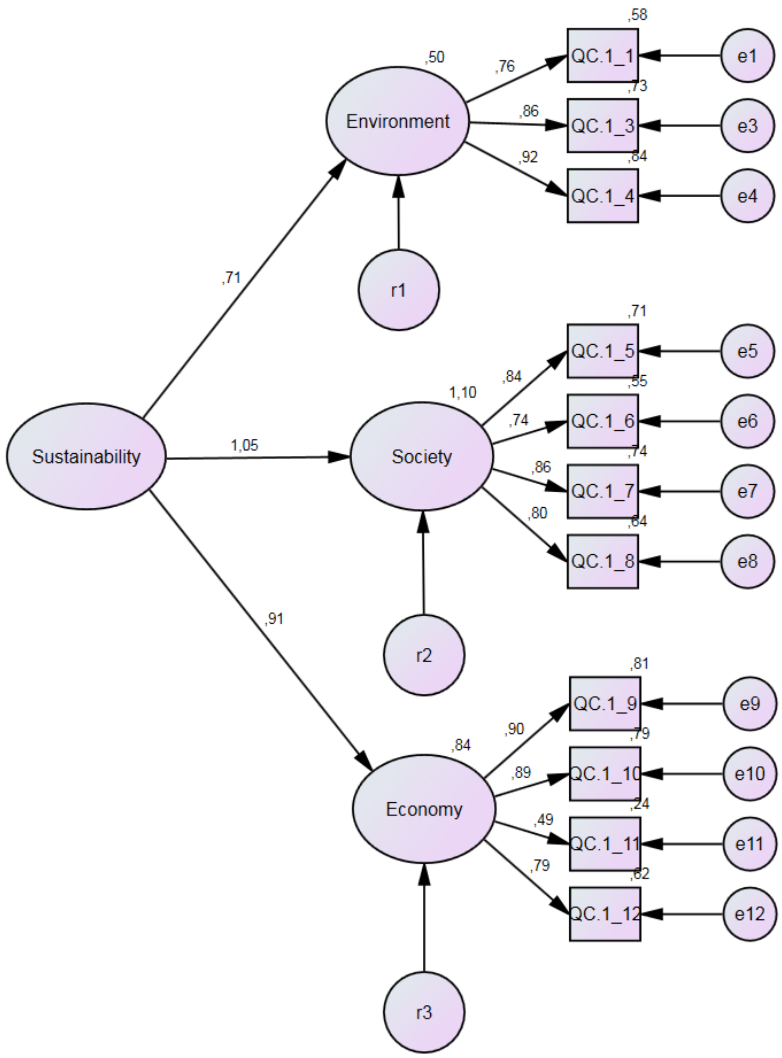

FIGURE 1: SECOND ORDER CFA

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 item measures. Hair et al. (2010) list some rules of thumb for assessing the construct validity (see Table 4).

First, the standard loading estimates should be at least 0.5, or ideally above 0.7. Our results showed that sustainability impact loads well on its three sub-constructs. The factor loadings of sustainability impact on environmental impact, social impact, and economic impact are 0.71, 1.05[9], and 0.91 respectively. The high loadings thus indicate that the three sub-constructs converge on a common point, the latent construct sustainability impact. According to the first order constructs, the standardized parameter loadings ranged

[9] Standardized coefficient can be larger than one. If the factors are correlated, the factor loadings are regression coefficients and not correlations and as such they can be larger than one in magnitude (Jöreskog 1999).

from 0.76 to 0.92 for environmental, social ranged from 0.74 to 0.86, and economic ranged from 0.49 to 0.90, which are all above the 0.50 cut-off value (Hair et al. 2010).

TABLE 4: CR AND AVE FOR THE MAIN CONSTRUCT AND ITS COMPONENTS

Construct	Item	Factor Loading	CR (>0.7)	AVE (>0.5)
Sustainability	Environmental pillar	0.71	0.9	0.8
	Social pillar	1.05		
	Economic pillar	0.91		
Environmental	Maintain biodiversity	0.76	0.8	0.7
	Maintain water quality	0.86		
	Maintain organic matter	0.92		
Social	Create good connection with buyers and input providers	0.84	0.8	0.7
	Connect with other farmers	0.74		
	Achieve social recognition	0.86		
	Secure successor	0.80		
Economic	Maintain profitability	0.90	0.8	0.6
	Invest in farm business	0.89		
	Periods in which there were low prices	0.49		
	Cope with changing market conditions	0.79		

Second, the average variance extracted (AVE) should be at least 0.5 or higher. The AVE value can be calculated as follows:

$$AVE = \frac{\sum_{i=1}^{n} L_i^2}{i}$$

where L_i represents the standardized factor loading and *i* is the number of items (Hair et al. 2010). In our case, all AVE's are above the 0.50 cut-off value (Hair et al. 2010), 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).

Third, construct reliability (CR) is used in measuring the degree to which an underlying variable of a construct and its items are represented in structural equation modelling. The CR value can be calculated as follows:

$$CR = \frac{(\sum_{i=1}^{n} L_i)^2}{(\sum_{i=1}^{n} L_i)^2 + (\sum_{i=1}^{n} e_i)}$$

where L_i represents the standardized factor loadings, *i* is the number of items, and e_i is the error variance term for a construct (Hair et al. 2010). In our results, all CR's are above the 0.70 cut-off value. High construct reliability indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct (Hair et al. 2010).

Discriminant validity is the extent to which a construct is truly distinct from other constructs. High discriminant validity provides evidence that a construct is unique and captures some phenomena other measures do not (Hair et al. 2010). The following fit indices and interpretation recommended by Byrne (2005) were used to assess the model (see Table 5).

TABLE 5: CHI², RMSEA, CFI, TLI

Measure of fit	Result
Chi²	136.52
Degrees of freedom	41
Probability level	0.000
RMSEA	0.13
CFI	0.918
TLI	0.89

According to the Chi-square with an associated *df* and probability, good fit is indicated by a non-significant value (Byrne 2005; Hooper et al. 2008). However, the Chi-square statistic test was significant ($p<0.000$). Nevertheless, it tends to result in a rejection of the model in large samples (over 200 cases) and is therefore sensitive to sample size (Schermelleh-Engel et al. 2003). Model fit was evaluated using Comparative Fit Index (excellent ≥ 0.96; 0.90-0.95 acceptable; < 0.9 inadequate), Tucker-Lewis Index (excellent ≥ 0.95; 0.90-0.94 acceptable; < 0.9 inadequate), and Root Mean Square Error of Approximation (excellent ≤ 0.06; good ≤ 0.08; mediocre 0.08-0.10; inadequate > 0.10) (Byrne 2005; Schreiber et al. 2006). These parameters measure how well the empirical model approaches the theoretical model. However, the RMSEA is less preferable at small sample sizes (Schermelleh-Engel et al. 2003).

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices achieved with the threshold suggested by Byrne (2005) and Schreiber et al. (2006). It is concluded that the overall assessment of the criteria for model fit was acceptable for the 11 items measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

3.4.2. Dairy case

Using confirmatory factor analysis (CFA), all items at the scale measurement level were found to contribute significantly to their respective latent constructs. An overview of the second order CFA is presented in Figure 2.

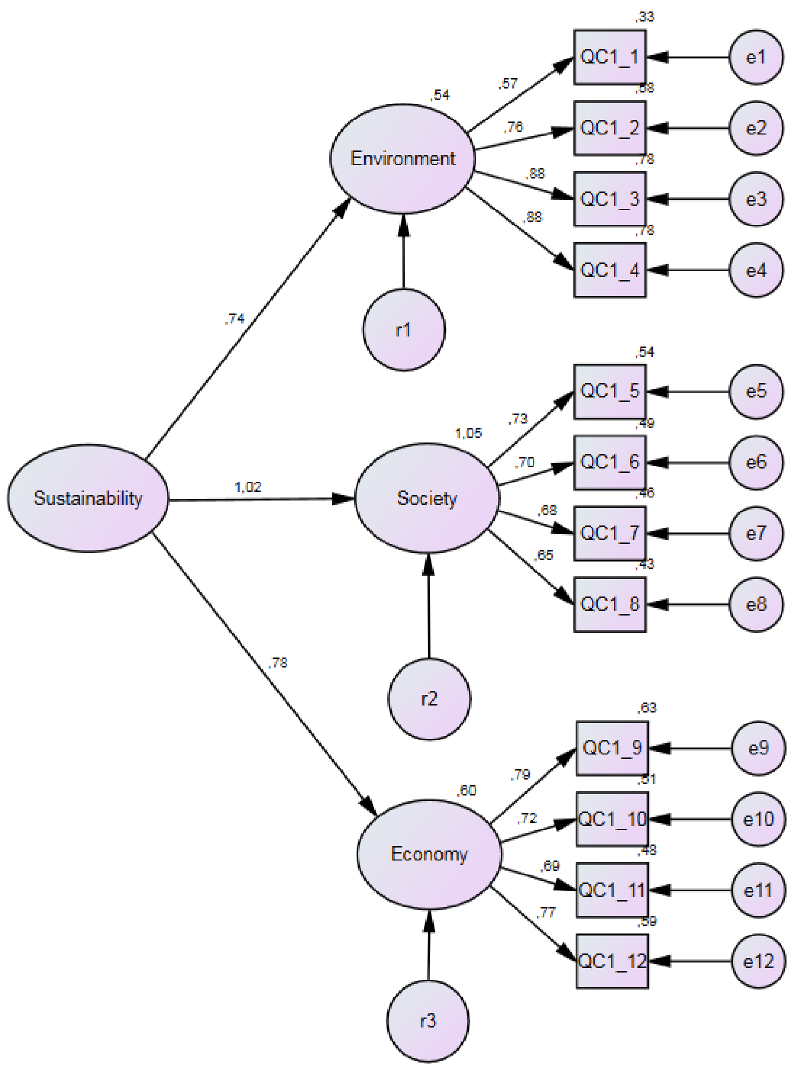

FIGURE 2: SECOND ORDER CFA

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 item measures. Hair et al. (2010) list some rules of thumb for assessing the construct validity (see Table 6).

First, the standard loading estimates should be at least 0.5, or ideally above 0.7. Our results showed that sustainability impact loads well on its three sub-constructs. The factor loadings of sustainability impact on environmental impact, social impact, and economic impact are 0.74, 1.02, and 0.78 respectively. The high loadings thus indicate that the three sub-constructs converge on a common point, the latent construct sustainability impact. According to the first order constructs, the standardized parameter loadings ranged from 0.57 to 0.88 for environmental, social ranged from 0.65 to 0.73, and economic ranged from 0.69 to 0.79, which are all above the 0.50 cut-off value (Hair et al. 2010).

TABLE 6: CR AND AVE FOR THE MAIN CONSTRUCT AND ITS COMPONENTS

Construct	Item	Factor Loading	CR (>0.7)	AVE (>0.5)
Sustainability	Environmental pillar	0.74	0.8	0.7
	Social pillar	1.02		
	Economic pillar	0.78		
Environmental	Maintain biodiversity	0.57	0.8	0.6
	Maintain animal welfare	0.76		
	Maintain water quality	0.88		
	Maintain organic matter	0.88		
Social	Create good connection with buyers and input providers	0.73	0.8	0.5
	Connect with other farmers	0.70		
	Achieve social recognition	0.68		
	Secure successor	0.65		
Economic	Maintain profitability	0.79	0.8	0.6
	Invest in farm business	0.72		
	Periods in which there were low prices	0.69		
	Cope with changing market conditions	0.77		

Second, the average variance extracted (AVE) should be at least 0.5 or higher. In our case, all AVE's are above the 0.50 cut-off value (Hair et al. 2010), 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).

Third, construct reliability (CR) is used in measuring the degree to which an underlying variable of a construct and its items are represented in structural equation modelling. In our results, all CR's are above the 0.70 cut-off value. High construct reliability indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct (Hair et al. 2010).

Discriminant validity is the extent to which a construct is truly distinct from other constructs. High discriminant validity provides evidence that a construct is unique and captures some phenomena other measures do not (Hair et al. 2010).

According to the Chi-square with an associated *df* and probability, good fit is indicated by a non-significant value (Byrne 2005; Hooper et al. 2008). However, the Chi-square statistic test in Table 7 was significant ($p<0.000$). Nevertheless, it tends to result in a rejection of the model in large samples (over 200 cases) and is therefore sensitive to sample size (Schermelleh-Engel et al. 2003). Model fit was evaluated using Comparative Fit Index (excellent ≥ 0.96; 0.90-0.95 acceptable; < 0.9 inadequate), Tucker-Lewis Index (excellent ≥ 0.95; 0.90-0.94 acceptable; < 0.9 inadequate), and Root Mean Square Error of Approximation (excellent ≤ 0.06; good ≤ 0.08; mediocre 0.08-0.10; inadequate > 0.10) (Byrne 2005; Schreiber et al. 2006). These parameters measure how well the empirical model approaches the theoretical model. However, the RMSEA is less preferable at small sample sizes (Schermelleh-Engel et al. 2003).

Table 7: chi², RMSEA, CFI, TLI

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

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices achieved with the threshold suggested by Byrne (2005) and Schreiber et al. (2006). It is concluded that the overall assessment of the criteria for model fit was acceptable for the 12 items measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

3.4.3. Feta case

Using confirmatory factor analysis (CFA), not all items 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 items *"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. An overview of the second order CFA is presented in Figure 3.

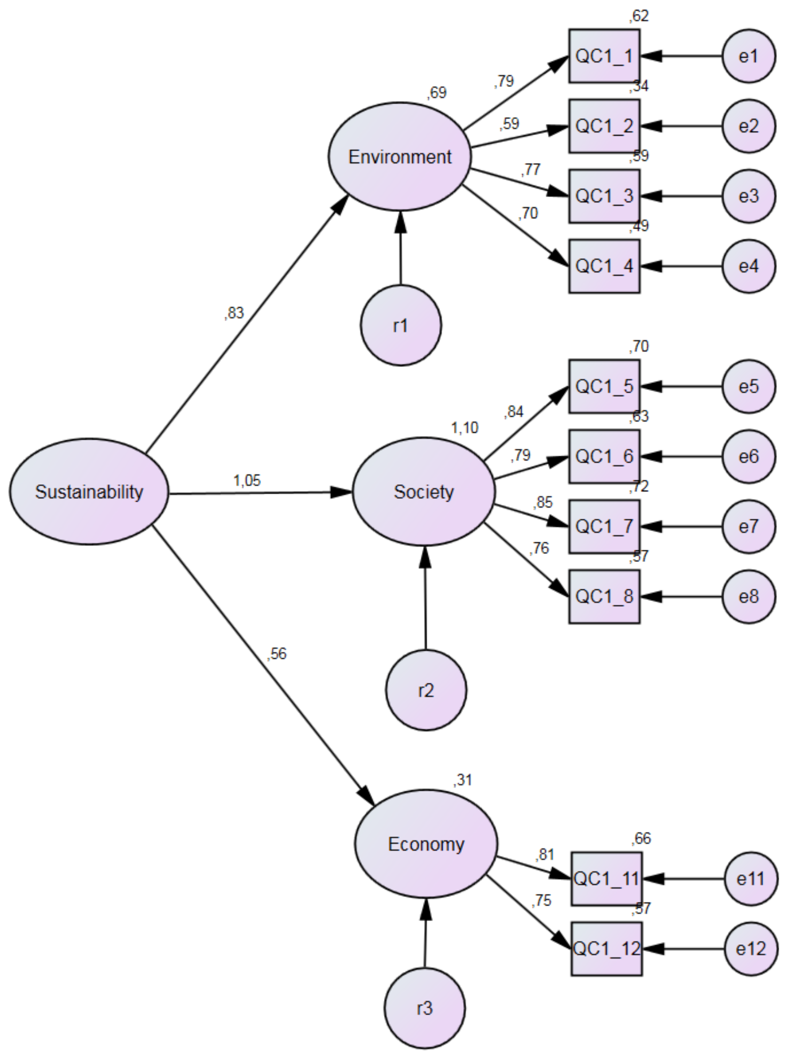

FIGURE 3: SECOND ORDER CFA

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 item measures. Hair et al. (2010) list some rules of thumb for assessing the construct validity (see Table 8).

TABLE 8: CR AND AVE FOR THE MAIN CONSTRUCT AND ITS COMPONENTS

Construct	Item	Factor Loading	CR (>0.7)	AVE (>0.5)
Sustainability	Environmental pillar	0.83	0.7	0.7
	Social pillar	1.05		
	Economic pillar	0.56		
Environmental	Maintain biodiversity	0.79	0.8	0.5
	Maintain animal welfare	0.59		
	Maintain water quality	0.77		
	Maintain organic matter	0.70		
Social	Create good connection with buyers and input providers	0.84	0.8	0.7
	Connect with other farmers	0.79		
	Achieve social recognition	0.85		
	Secure successor	0.76		
Economic	Periods in which there were low prices	0.81	0.7	0.6
	Cope with changing market conditions	0.75		

First, the standard loading estimates should be at least 0.5, or ideally above 0.7. Our results showed that sustainability impact loads well on its three sub-constructs. The factor loadings of sustainability impact on environmental impact, social impact, and economic impact are 0.83, 1.05, and 0.56 respectively. The high loadings thus indicate that the three sub-constructs converge on a common point, the latent construct sustainability impact. According to the first order constructs, the standardized parameter loadings ranged from 0.59 to 0.79 for environmental, social ranged from 0.76 to 0.85, and economic ranged from 0.75 to 0.81, which are all above the 0.50 cut-off value (Hair et al. 2010).

Second, the average variance extracted (AVE) should be at least 0.5 or higher. In our case, all AVE's are above the 0.50 cut-off value (Hair et al. 2010), 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).

Third, construct reliability (CR) is used in measuring the degree to which an underlying variable of a construct and its items are represented in structural equation modelling. In our results, all CR's are above the 0.70 cut-off value. High construct reliability indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct (Hair et al. 2010).

Discriminant validity is the extent to which a construct is truly distinct from other constructs. High discriminant validity provides evidence that a construct is unique and captures some phenomena other measures do not (Hair et al. 2010).

According to the Chi-square with an associated *df* and probability, good fit is indicated by a non-significant value (Byrne 2005; Hooper et al. 2008). The Chi-square statistic test in Table 9 was not significant ($p>0.05$). Model fit was evaluated using Comparative Fit Index (excellent ≥ 0.96; 0.90-0.95 acceptable; < 0.9

inadequate), Tucker-Lewis Index (excellent ≥ 0.95; 0.90-0.94 acceptable; < 0.9 inadequate), and Root Mean Square Error of Approximation (excellent ≤ 0.06; good ≤ 0.08; mediocre 0.08-0.10; inadequate > 0.10) (Byrne 2005; Schreiber et al. 2006). These parameters measure how well the empirical model approaches the theoretical model (Schermelleh-Engel et al. 2003).

TABLE 9: CHI², RMSEA, CFI, TLI

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

The three sub-constructs of sustainability impact were found to have adequate goodness-of-fit indices achieved with the threshold suggested by Byrne (2005) and Schreiber et al. (2006). It is concluded that the overall assessment of the criteria for model fit was acceptable for the 10 items measuring the potential sustainability impact on sales agreement using second order confirmatory factor analysis in its validation.

3.5. Conclusion

In conclusion, the findings presented a significant and reliable measure of convergent validity of potential sustainability impact to the group of environmental, social, and economic factors. The details are shown in Table 4 ,Table 6, and Table 8. As the abovementioned tests assure unidimensionality and content validity (Table 5, Table 7, and Table 9) of our sustainability impact scale, it is allowed to calculate a summated scale by averaging the scores of the four items for environmental impact factor (or three in the case of sugar beet), the four items for social impact factor, and the four items for economic impact factor (or two in the case of feta) (Hair et al. 2010). The scale is a self-report, valid and reliable measure of the potential agricultural sustainability impact on the sales agreement. It provides a useful tool for monitoring, evaluating, and measuring the perception to what extent production choices and sales agreements hinder or stimulate sustainability, and it is recommended for use and further development. Farmers must balance farm objectives that relate to a wide range of issues such as sustainability, in addition to maximizing income levels. Farmers need to take into account considerations related to the environmental, social, and economic impact of their activities. This reliable and valid scale can be used in practice to monitor the potential sustainability impact in agriculture and provide information and guidelines to improve agricultural policies, processes, and strategies.

4. Sustainability and future farming strategies: survey data

4.1. Introduction

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 more recent situation is more complex. Farmers must find a balance between profit and non-profit objectives in order to maximize their income levels. 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 EU's Common Agricultural Policy (CAP) (2014-2020) Framework defines new rules for farmers and targets on innovation, resource efficiency, agricultural (economic) viability, environmental sustainability, etc. 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, farmers need to consider concerns linked with the environmental impact of their activities and the need to limit production levels in order to not exceed market capacity (Diazabakana et al. 2014).

This part aims at examining the relationship between the three sustainability pillars and the future farming strategies farmers can implement. In other words, we are interested in which sustainability indicators support what type of farms' decisions. We identified 4 different strategies (maintain existing scale, expand existing scale, downsize existing scale, and abandon farming) and described in which way sustainability impact –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 threefold and based on the results of the confirmatory factor analysis (CFA)[10]. First, we refer to environmental sustainability impact (= the perception to what extent production choices and sales agreements hinder or stimulate environmental sustainability). Second, we focus on social sustainability impact (= the perception to what extent production choices and sales agreements hinder or stimulate social sustainability). Finally, we take into account economic sustainability impact (= the perception to what extent production choices and sales agreements hinder or stimulate economic sustainability).

4.2. Method

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 (Field 2009). To determine whether or not there is a significant

[10] The CFA shows that it is reliable and valid to measure the sustainability impact factor by using three sub-constructs (environmental, social, and economic). This sustainability impact factor can be used in practice to monitor the perception to what extent production choices and sales agreements hinder or stimulate sustainability in agriculture and provide information and guidelines to improve agricultural policies, processes, and strategies.

relationship between sustainability and future farming strategies, multinomial logistic regression (mlogit) was conducted using the software programs STATA, version 12, and SPSS, version 24.

We applied an observational cross-sectional study design by using an online survey. This web-based survey is part of a broader European research project, namely the EU-funded Horizon 2020 project SUFISA (Sustainable finance for sustainable agriculture and fisheries).

Sugar beet case. In total, the survey was answered by 241 Belgian sugar beet farmers who confirmed that sugar beet made up at least part of their farm business during the campaign 2016-2017. After deleting observations with illogical answers, we dispose of a remaining selection of 191 Belgian sugar beet farmers. The data of the survey were anonymously analysed.

This section presents some descriptive statistics of the future strategies that sugar beet farmers will adopt in their farming activities and their perception of sustainability. Our outcome ("*What are your strategies for the development of sugar beet cultivation within the context of your farm business in the coming 5 years*") resulted in one of the following four events: *"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"*. The results of this question are presented in Table 10. The majority (n=102; 61.4%) answered *"I plan to maintain the existing scale of operations"*. Only 9 farmers reported that they plan to abandon farming in the coming five years.

TABLE 10: STRATEGIES IN THE COMING 5 YEARS

Strategy	n (%)
Maintain existing scale	102 (61.4%)
Expand existing scale	18 (10.8%)
Reduce existing scale	37 (22.3%)
Abandon farming	9 (5.4%)

The farmers' perceptions to what extent production choices and sales agreements hinder or stimulate sustainability were measured by asking them 11 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Tables 12, 13, 14 for an overview of the items). As the confirmatory factor analysis assure unidimensionality and content validity of our sustainability impact factor, it is allowed to calculate the summated scale by averaging the scores of the three items for environmental impact (biodiversity, water quality, and soil organic matter), the four items for social impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession), and the four items for economic impact (profitability, investments in the farm, selling products in difficult periods, and changing market conditions) (Hair et al. 2010). Observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions were not used when calculating the *"Environmental"*, *"Social"*, and *"Economic"* variables. The average score on environmental sustainability impact factor is

3.67 (with a minimum of 1 and a maximum of 5). The average score on social sustainability impact factor is 3.85 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability impact factor is 3.65 (with a minimum of 1 and a maximum of 5). A detailed overview of the independent variables is presented in Table 11.

The sample included slightly more Flemish farmers than Walloon farmers (55%; n=92 vs. 45%; n=74). The age is almost equally distributed among the respondents. 51% of the respondents are older than 50 years, while 49% is younger than 51 years. More than one third of the respondents hold a college or university degree (38%). On average, 12.89 ha of the total farm 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 (Bergen et al. 2015). This might implicate that farmers with a high sugar beet area were more interested in filling in the survey or that there might be some outliers. A detailed overview of the control variables is presented in Table 11.

TABLE 11: DESCRIPTIVE STATISTICS INDEPENDENT AND CONTROL VARIABLES

Variable	n	Mean	St. Dev.
Environmental	151	3.67	1.10
Social	142	3.85	1.09
Economic	138	3.65	1.20
Farmer age (= 1 if farmer is older than 50 years; 0 otherwise)	166	0.51	0.50
Farm size (= natural logarithm of total sugar beet area in ha)	164	0.69	0.75
Farmer education (= 1 if farmer has university degree; 0 otherwise)	166	0.38	0.49
Region (= 1 if farmer lives in Flanders; 0 otherwise)	166	0.55	0.50

Table 12 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on environmental sustainability of sales agreement. The respondents who strongly disagree with the group of environmental sustainability factors have on average a smaller amount of total area of land that they farm (i.e., rented and owned land) and they deliver more to Tiense sugar refinery (Raffinerie Tirlemontoise). Nevertheless, the farmers who strongly agree with the group of environmental sustainability factors have on average less farm area which was cultivated for sugar beet and their average total production of sugar beet in the campaign 2016-2017 is smaller. Moreover, the farmers who strongly agree with the group of environmental sustainability factors are rather older and less educated (i.e., no university degree). This pattern of characteristics is similar for the group of social sustainability factors (see Table 13) and for the group of economic sustainability factors (see Table 14).

Table 12: Characteristics of respondents which strongly disagree vs. strongly agree with the group of environmental sustainability factors

	Strongly disagree (1)	Strongly agree (5)
Maintain biodiversity (QC1_1)	- 31% Flanders - 85% agricultural education - 46% university degree - Smaller farm area - 70% raffinerie Tirlemontoise - n=13 (6.88%)	- 49% Flanders - 75% agricultural education - 29% university degree - Smaller sugar beet area - Lower production - 58% raffinerie Tirlemontoise - n=49 (25.93%)
Maintain water quality (QC1_3)	- 42% Flanders - 41% older farmer (>50 years) - 67% university degree - Smaller farm area - 75% raffinerie Tirlemontoise - n=15 (7.98%)	- 54% Flanders - 51% older farmer (>50 years) - 37% university degree - 54% raffinerie Tirlemontoise - n=54 (28.72%)
Maintain organic matter (QC1_4)	- 44% Flanders - 44% older farmer (>50 years) - 67% agricultural education - 78% university degree - Smaller farm area - 78% raffinerie Tirlemontoise - n=11 (5.88%)	- 66% Flanders - 57% older farmer (>50 years) - 72% agricultural education - 38% university degree - Smaller sugar beet area - Lower production - 53% raffinerie Tirlemontoise - n=79 (42.25%)

Table 13: Characteristics of respondents which strongly disagree vs. strongly agree with the group of social sustainability factors

	Strongly disagree (1)	Strongly agree (5)
Create good connection with buyers and input providers (QC1_5)	- 36% Flanders - 46% older farmer (>50 years) - 73% university degree - Smaller farm area - 82% raffinerie Tirlemontoise - n=16 (8.51%)	- 60% Flanders - 58% older farmer (>50 years) - 31% university degree - Smaller sugar beet area - Lower production - 52% raffinerie Tirlemontoise - n=68 (36.17%)
Connect with other farmers (QC1_6)	- 38% Flanders - 25% older farmer (>50 years) - 86% agricultural education - 75% university degree - Smaller farm area - 75% raffinerie Tirlemontoise - n=10 (5.29%)	- 69% Flanders - 56% older farmer (>50 years) - 74% agricultural education - 29% university degree - Smaller sugar beet area - Lower production - 51% raffinerie Tirlemontoise - n=67 (35.45%)

Achieve social recognition (QC1_7)	- 100% university degree - Smaller farm area - 67% raffinerie Tirlemontoise - n=10 (5.32%)	- 39% university degree - Smaller sugar beet area - Lower production - 54% raffinerie Tirlemontoise - n=99 (52.66%)
Secure successor (QC1_8)	- 20% older farmer (>50 years) - 80% agricultural education - 67% university degree - Smaller farm area - 67% raffinerie Tirlemontoise - n=21 (11.23%)	- 65% older farmer (>50 years) - 68% agricultural education - 33% university degree - Lower production - 56% raffinerie Tirlemontoise - n=69 (36.9%)

TABLE 14: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF ECONOMIC SUSTAINABILITY FACTORS

	Strongly disagree (1)	**Strongly agree (5)**
Maintain profitability (QC1_9)	- 31% older farmer (>50 years) - 77% agricultural education - 69% university degree - Smaller farm area - 62% raffinerie Tirlemontoise - n=19 (10.05%)	- 54% older farmer (>50 years) - 70% agricultural education - 41% university degree - Smaller sugar beet area - Lower production - 54% raffinerie Tirlemontoise - n=121 (64.02%)
Invest in farm business (QC1_10)	- 53% Flanders - 33% older farmer (>50 years) - 73% university degree - Smaller farm area - 67% raffinerie Tirlemontoise - n=21 (11.29%)	- 62% Flanders - 52% older farmer (>50 years) - 40% university degree - Smaller sugar beet area - Lower production - 54% raffinerie Tirlemontoise - n=76 (40.86%)
Periods in which there were low prices (QC1_11)	- 40% Flanders - 40% older farmer (>50 years) - 73% agricultural education - 33% university degree - Smaller farm area - 67% raffinerie Tirlemontoise - n=23 (12.37%)	- 69% Flanders - 66% older farmer (>50 years) - 67% agricultural education - 41% university degree - Smaller sugar beet area - Lower production - 31% raffinerie Tirlemontoise - n=39 (20.97%)
Cope with changing market conditions (QC1_12)	- 42% Flanders - 42% older farmer (>50 years) - 58% university degree - Smaller farm area - 67% raffinerie Tirlemontoise - n=16 (8.6%)	- 64% Flanders - 57% older farmer (>50 years) - 41% university degree - Smaller sugar beet area - Lower production - 55% raffinerie Tirlemontoise - n=64 (34.41%)

Dairy case. This dataset consists of 524 dairy farmers who confirmed that dairy production made up at least part of their farm business during the campaign 2016-2017. The data of the survey were anonymously analysed.

This section presents some descriptive statistics of the future strategies that dairy farmers will adopt in their farming activities and their perception of sustainability. Our outcome ("*What are your strategies for the development of dairy farming within the context of your farm business in the coming 5 years*") resulted in one of the following four events: *"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"*. The results of this question are presented in Table 15. The majority (n=280; 56.2%) answered *"I plan to maintain the existing scale of operations"*. Only 33 farmers reported that they plan to abandon farming in the coming five years.

TABLE 15: STRATEGIES IN THE COMING 5 YEARS

Strategy	n (%)
Maintain existing scale	280 (56.2%)
Expand existing scale	155 (31.1%)
Reduce existing scale	30 (6.0%)
Abandon farming	33 (6.6%)

The farmers' perceptions to what extent production choices and sales agreements hinder or stimulate sustainability were measured by asking them 12 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Tables 17, 18, 19 for an overview of the items). As the confirmatory factor analysis assure unidimensionality and content validity of our sustainability impact factor, it is allowed to calculate the summated scale by averaging the scores of the four items for environmental impact (biodiversity, animal welfare, water quality, and soil organic matter), the four items for social impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession), and the four items for economic impact (profitability, investments in the farm, selling products in difficult periods, and changing market conditions) (Hair et al. 2010). Observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions were not used when calculating the *"Environmental"*, *"Social"*, and *"Economic"* variables. The average score on environmental sustainability impact factor is 3.27 (with a minimum of 1 and a maximum of 5). The average score on social sustainability impact factor is 3.15 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability impact factor is 3.24 (with a minimum of 1 and a maximum of 5). A detailed overview of the independent variables is presented in Table 16.

The sample included 192 UK farmers, 140 Latvian farmers, 85 French farmers, and 81 Danish farmers. The age is almost equally distributed among the respondents. 58% of the respondents are older than 50 years, while 42% of the respondents are younger than 51 years. More than one fifth of the respondents hold a college or university degree (23%). 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 16.

TABLE 16: DESCRIPTIVE STATISTICS INDEPENDENT AND CONTROL VARIABLES

Variable	n	Mean	St. Dev.
Environmental	424	3.27	1.07
Social	433	3.15	0.99
Economic	443	3.24	1.03
Farmer age (= 1 if farmer is older than 50 years; 0 otherwise)	496	0.58	0.49
Farm size (= natural logarithm of total dairy area in ha)	498	4.27	1.07
Farmer education (= 1 if farmer has a university degree; 0 otherwise)	498	0.23	0.42
DK (= 1 if farmer lives in Denmark; 0 otherwise)	498	0.16	0.37
FR (= 1 if farmer lives in France; 0 otherwise)	498	0.17	0.38
LV (= 1 if farmer lives in Latvia; 0 otherwise)	498	0.28	0.45
UK (= 1 if farmer lives in UK; 0 otherwise)	498	0.39	0.49

Table 17 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on environmental sustainability of sales agreement. The respondents who strongly disagree with the group of environmental sustainability factors have on average a larger amount of total area of land that they use for dairy production. Nevertheless, farmers who strongly agree with the group of environmental sustainability factors are rather younger and less educated (i.e., no university degree).

TABLE 17: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF ENVIRONMENTAL SUSTAINABILITY FACTORS

	Strongly disagree (1)	Strongly agree (5)
Maintain biodiversity (QC1_1)	- 53% UK - 15% Denmark - 10% France - 23% Latvia - Larger dairy farm area - n=126 (24.8%)	- 29% UK - 6% Denmark - 33% France - 31% Latvia - Lower production - n=519 (10.04%)
Maintain animal welfare (QC1_2)	- 46% UK - 8% Denmark - 13% France - 33% Latvia - 66% older farmer (>50 years) - 29% university degree - Larger dairy farm area - n=48 (9.25%)	- 50% UK - 9% Denmark - 22% France - 20% Latvia - 56% older farmer (>50 years) - 17% university degree - Higher production - n=149 (28.71%)

Maintain water quality (QC1_3)	- 52% UK - 22% Denmark - 5% France - 21% Latvia - 66% older farmer (>50 years) - Larger dairy farm area - n=63 (12.16%)	- 39% UK - 6% Denmark - 22% France - 33% Latvia - 58% older farmer (>50 years) - Higher production - n=121 (23.36%)
Maintain organic matter (QC1_4)	- 51% UK - 23% Denmark - 8% France - 19% Latvia - 64% older farmer (>50 years) - Larger dairy farm area - n=80 (15.44%)	- 43% UK - 6% Denmark - 23% France - 27% Latvia - 59% older farmer (>50 years) - Higher production - n=95 (18.34%)

Table 18 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on social sustainability of sales agreement. These results are less pronounced and are not similar for all items of social sustainability impact. For example, respondents who strongly agree with the statement *"create good connection with buyers and input providers"* have on average a lower dairy production. Nevertheless, farmers who strongly disagree with this statement are rather older.

TABLE 18: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF SOCIAL SUSTAINABILITY FACTORS

	Strongly disagree (1)	**Strongly agree (5)**
Create good connection with buyers and input providers (QC1_5)	- 66% UK - 5% Denmark - 12% France - 18% Latvia - 62% older farmer (>50 years) - n=67 (13.06%)	- 46% UK - 15% Denmark - 22% France - 17% Latvia - 56% older farmer (>50 years) - Lower production - n=82 (15.98%)
Connect with other farmers (QC1_6)	- 51% UK - 11% Denmark - 13% France - 26% Latvia - 70% older farmer (>50 years) - 23% university degree - Larger dairy farm area - n=47 (9.06%)	- 48% UK - 11% Denmark - 29% France - 13% Latvia - 58% older farmer (>50 years) - 14% university degree - Higher production - n=101 (19.46%)

Achieve social recognition (QC1_7)	- 51% UK - 4% Denmark - 26% France - 19% Latvia - 69% older farmer (>50 years) - 59% agricultural education - Smaller dairy farm area - n=70 (13.54%)	- 44% UK - 22% Denmark - 16% France - 18% Latvia - 60% older farmer (>50 years) - 68% agricultural education - Lower production - n=82 (15.86%)
Secure successor (QC1_8)	- 44% UK - 23% Denmark - 13% France - 20% Latvia - 59% older farmer (>50 years) - Larger dairy farm area - n= 143 (27.77%)	- 48% UK - 6% Denmark - 17% France - 29% Latvia - 65% older farmer (>50 years) - Higher production - n=52 (10.10%)

Table 19 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on economic sustainability of sales agreement. These results are less pronounced and are not similar for all items of economic sustainability impact. For example, respondents who strongly agree with the statement *"maintain profitability"* have on average a smaller amount of total area of land that they use for dairy production. Nevertheless, farmers who strongly agree with this statement are more educated (i.e., university degree and agricultural education) and have on average a lower dairy production.

TABLE 19: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF ECONOMIC SUSTAINABILITY FACTORS

	Strongly disagree (1)	**Strongly agree (5)**
Maintain profitability (QC1_9)	- 52% UK - 9% Denmark - 29% France - 10% Latvia - 17% university degree - 60% agricultural education - Smaller dairy farm area - n=58 (11.20%)	- 48% UK - 10% Denmark - 13% France - 29% Latvia - 25% university degree - 69% agricultural education - Lower production - n=83 (16.02%)
Invest in farm business (QC1_10)	- 36% UK - 36% Denmark - 17% France - 12% Latvia - 15% university degree - Larger dairy farm area - n=109 (21.04%)	- 49% UK - 7% Denmark - 9% France - 36% Latvia - 25% university degree - Higher production - n=76 (14.67%)

Periods in which there were low prices (QC1_11)	-37 % UK - 33% Denmark - 16% France - 13% Latvia - 15% university degree - 73% agricultural education - Smaller dairy farm area - n=75 (14.56%)	- 61% UK - 4% Denmark - 11% France - 26% Latvia - 28% university degree - 65% agricultural education - Higher production - n=86 (16.70%)
Cope with changing market conditions (QC1_12)	- 44% UK - 16% Denmark - 18% France - 22% Latvia - Larger dairy farm area - n=50 (9.69%)	- 58% UK - 11% Denmark - 11% France - 20% Latvia - Lower production - n=80 (15.50%)

Feta case. This dataset consists of 150 farmers who confirmed that feta production made up at least part of their farm business during the campaign 2016-2017. The data of the survey were anonymously analysed.

This section presents some descriptive statistics of the future strategies that farmers will adopt in their farming activities and their perception of sustainability. Our outcome ("*What are your strategies for the development of feta production within the context of your farm business in the coming 5 years*") resulted in one of the following four events: *"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"*. The results of this question are presented in Table 20. The majority (n=90; 60.8%) answered *"I plan to maintain the existing scale of operations"*. None of the farmers reported that they plan to abandon farming in the coming five years.

TABLE 20: STRATEGIES IN THE COMING 5 YEARS

Strategy	n (%)
Maintain existing scale	90 (60.8%)
Expand existing scale	55 (37.2%)
Reduce existing scale	3 (2.0%)
Abandon farming	0 (0%)

The farmers' perceptions to what extent production choices and sales agreements hinder or stimulate sustainability were measured by asking them 12 related questions. The response format of each item consisted of a five-point Likert scale, ranging from *"strongly disagree"* (1) to *"strongly agree"* (5) (see Tables 22, 23, 24 for an overview of the items). As the confirmatory factor analysis assure unidimensionality and content validity of our sustainability impact factor, it is allowed to calculate the summated scale by averaging the scores of the four items for environmental impact (biodiversity, animal welfare, water quality, and soil organic matter), the four items for social impact (good connection with buyers and input providers, connection with other farmers, societal recognition, and succession), and the two items for economic impact (selling products in difficult periods and changing market conditions) (Hair et al. 2010). Observations with missing values (or *"Not applicable"* or *"Do not know"* answers) on the sustainability questions were not used when calculating the *"Environmental"*, *"Social"*, and *"Economic"* variables. The average score on environmental sustainability impact factor is 1.92 (with a minimum of 1 and a maximum of 5). The average score on social sustainability impact factor is 1.86 (with a minimum of 1 and a maximum of 5). The average score on economic sustainability impact factor is 2.08 (with a minimum of 1 and a maximum of 5). A detailed overview of the independent variables is presented in Table 21.

Only 16% of the respondents are older than 50 years, while 84% of the respondents are younger than 51 years. On average, 14.66 ha of the total area was cultivated for the production of feta (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 21.

TABLE 21: DESCRIPTIVE STATISTICS INDEPENDENT AND CONTROL VARIABLES

Variable	n	Mean	St. Dev.
Environmental	131	1.92	0.95
Social	119	1.86	1.07
Economic	140	2.08	1.17
Farmer age (= 1 if farmer is older than 50 years; 0 otherwise)	148	0.16	0.36
Farm size (= natural logarithm of total area for production feta in ha)	148	2.52	0.59

Farmer education (= 1 if farmer has a university degree) 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., none of the respondents has a university degree and all respondents live in Thessaly Central Greece).

Table 22 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on environmental sustainability of sales agreement. The respondents who strongly disagree with the group of environmental sustainability factors have on average a larger amount of total area of land that they farm (i.e., rented and owned land). Nevertheless, farmers who strongly agree with the group of environmental sustainability factors have on average less area which was cultivated for feta production and their average total production of feta in the campaign 2016-2017 is smaller.

TABLE 22: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF ENVIRONMENTAL SUSTAINABILITY FACTORS

	Strongly disagree (1)	Strongly agree (5)
Maintain biodiversity (QC1_1)	- 24% older farmer (>50 years) - 8% agricultural education - Larger farm area - n=80 (53.33%)	- 0% older farmer (>50 years) - 10% agricultural education - Smaller dairy area - Lower production - n=10 (6.67%)

Maintain animal welfare (QC1_2)	- 26% older farmer (>50 years) - 9% agricultural education - n=57 (38%)	- 14% older farmer (>50 years) - 14% agricultural education - Lower production - n=14 (9.33%)
Maintain water quality (QC1_3)	- 19% older farmer (>50 years) - 8% agricultural education - Larger farm area - n=100 (66.67%)	- 25% older farmer (>50 years) - 0% agricultural education - Smaller dairy area - Lower production - n=4 (2.67%)
Maintain organic matter (QC1_4)	- 16% older farmer (>50 years) - 8% agricultural education - Larger farm area - n=84 (56%)	- 11% older farmer (>50 years) - 0% agricultural education - Lower production - n=9 (6%)

Table 23 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on social sustainability of sales agreement. The respondents who strongly disagree with the group of social sustainability factors have on average a larger amount of total area of land that they farm (i.e., rented and owned land) and are on average older. Nevertheless, farmers who strongly agree with the group of social sustainability factors have on average less area which was cultivated for feta production and their average total production of feta in the campaign 2016-2017 is smaller.

TABLE 23: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF SOCIAL SUSTAINABILITY FACTORS

	Strongly disagree (1)	**Strongly agree (5)**
Create good connection with buyers and input providers (QC1_5)	- 22% older farmer (>50 years) - 11% agricultural education - Larger farm area - n=83 (55.33%)	- 6% older farmer (>50 years) - 13% agricultural education - Smaller dairy area - Lower production - n=16 (10.67%)
Connect with other farmers (QC1_6)	- 22% older farmer (>50 years) - 9% agricultural education - Larger farm area - n=79 (52.67%)	- 10% older farmer (>50 years) - 20% agricultural education - Smaller dairy area - Lower production - n=10 (6.67%)
Achieve social recognition (QC1_7)	- 20% older farmer (>50 years) - 1% agricultural education - Larger farm area - n=80 (53.33%)	- 0% older farmer (>50 years) - 22% agricultural education - Smaller dairy area - Lower production - n=9 (6%)
Secure successor (QC1_8)	- 18% older farmer (>50 years) - 9% agricultural education - Larger farm area - n=90 (60%)	- 0% older farmer (>50 years) - 0% agricultural education - Smaller dairy area - Lower production - n=4 (2.67%)

Table 24 provides more insights into the characteristics of the respondents which strongly disagree or strongly agree with the items measuring the potential impact on economic sustainability of sales agreement. These results are less pronounced and are not similar for all items of economic sustainability impact. For example, respondents who strongly agree with the statement *"maintain profitability"* have on average a smaller amount of total area of land that they farm (i.e., rented and owned land). Nevertheless, farmers who strongly agree with this statement are on average older and their average total production of feta in the campaign 2016-2017 is higher.

TABLE 24: CHARACTERISTICS OF RESPONDENTS WHICH STRONGLY DISAGREE VS. STRONGLY AGREE WITH THE GROUP OF ECONOMIC SUSTAINABILITY FACTORS

	Strongly disagree (1)	**Strongly agree (5)**
Maintain profitability (QC1_9)	- 0% older farmer (>50 years) - 20% agricultural education - Smaller farm area - n=5 (3.33%)	- 16% older farmer (>50 years) - 10% agricultural education - Larger dairy area - Higher production - n=58 (38.67%)
Invest in farm business (QC1_10)	- 21% older farmer (>50 years) - 7% agricultural education - Smaller farm area - n=29 (19.33%)	- 15% older farmer (>50 years) - 19% agricultural education - Larger dairy area - Lower production - n=26 (17.33%)
Periods in which there were low prices (QC1_11)	- 27% older farmer (>50 years) - 10% agricultural education - n=68 (45.33%)	- 20% older farmer (>50 years) - 20% agricultural education - Higher production - n=15 (10%)
Cope with changing market conditions (QC1_12)	- 21% older farmer (>50 years) - 7% agricultural education - Smaller farm area - n=71 (47.33%)	- 25% older farmer (>50 years) - 8% agricultural education - Larger dairy area - Higher production - n=12 (8%)

4.3. Results

4.3.1. Sugar beet case

Our case is suitable for multinomial logistic regressions. There is one outcome variable (strategy) with four categories (maintain scale, expand scale, reduce scale, and abandon farming), three predictors[11] (environmental sustainability impact factor, social sustainability impact factor, and economic sustainability impact factor), and four control variables[12] (farmer age, farm size, farmer education, and

[11] We run these predictors separately because of high correlation between them.
[12] The econometric models generally applied to study farmers' adoption of sustainable agricultural practices employ a range of determinants such as farm and farmer characteristics (Menozzi et al. 2015).

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, reducing or abandoning).

Table 25 shows the individual parameter estimates using environmental sustainability impact factor. 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 to the reference category, while parameters with significant positive coefficients increase the likelihood of that response category in comparison with the reference category.

TABLE 25: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR ENVIRONMENTAL SUSTAINABILITY IMPACT FACTOR

		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 (ln)	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. reduce 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 (ln)	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 (ln)	-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: $R^2 = 0.099$ (Cox & Snell), $R^2 = 0.114$ (Nagelkerke). Model $Chi^2(15) = 15.544$, $p > 0.1$. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Whether the farmer perceives that production choices affect environmental sustainability to a higher extent 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 impact shows one more unit, the change in the odds of reducing scale (rather than maintaining scale) is 0.681, ceteris paribus. In short, the farmers are less likely to reduce scale than to maintain scale if they perceive that production choices affect environmental sustainability to a higher extent, ceteris paribus. In other words, the odds of reducing scale are significantly lower than the odds of maintaining scale when the farmers' value on environmental sustainability impact factor increases by one unit, ceteris paribus.

Table 26 shows no significant estimates for the social sustainability impact factor independent variable.

TABLE 26: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR SOCIAL SUSTAINABILITY IMPACT FACTOR

		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 (ln)	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. reduce 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 (ln)	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 (ln)	-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: $R^2 = 0.085$ (Cox & Snell), $R^2 = 0.099$ (Nagelkerke). Model $Chi^2(15) = 12.560$, $p > 0.1$. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 27 shows no significant estimates for the economic sustainability impact factor independent variable.

TABLE 27: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR ECONOMIC SUSTAINABILITY IMPACT FACTOR

		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 (ln)	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. reduce 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 (ln)	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 (ln)	-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: $R^2 = 0.094$ (Cox & Snell), $R^2 = 0.109$ (Nagelkerke). Model $Chi^2(15) = 13.411, p > 0.1$. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.3.2. Dairy case

Our case is suitable for multinomial logistic regressions. There is one outcome variable (strategy) with four categories (maintain scale, expand scale, reduce scale, and abandon farming), three predictors[13] (environmental sustainability impact factor, social sustainability impact factor, and economic sustainability impact factor), and four control variables (farmer age, farm size, farmer education, and country). 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, reducing or abandoning).

Table 28 shows the individual parameter estimates using environmental sustainability impact factor. We specified the first strategy (i.e., maintain the existing scale) as our reference category. Parameters with

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

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

Table 28: Multinomial logistic regression results for environmental sustainability impact factor

		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 (ln)	-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. reduce 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 (ln)	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 (ln)	-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: $R^2 = 0.126$ (Cox & Snell), $R^2 = 0.146$ (Nagelkerke). Model $Chi^2(21) = 56.997$, $p < 0.01$. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
UK is excluded to avoid perfect multicollinearity.

Whether the farmer perceives that production choices affect environmental sustainability to a higher extent 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. The Odds Ratio tells us that as this variable increases, so as the farmer's environmental sustainability impact 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 perceive that production choices affect environmental sustainability to a higher extent, ceteris paribus. In other words, the odds of expanding scale are significantly higher than the odds of maintaining scale when the farmers' value on environmental sustainability impact factor increases by one unit, ceteris paribus.

Whether the farmer perceives that production choices affect environmental sustainability to a higher extent 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 impact shows one more unit, the change in the odds of reducing scale (rather than maintaining scale) is 1.536, ceteris paribus. In short, the farmers are more likely to reduce scale than to maintain scale if they perceive that production choices affect environmental sustainability to a higher extent, ceteris paribus. In other words, the odds of reducing scale are significantly higher than the odds of maintaining scale when the farmers' value on environmental sustainability impact factor increases by one unit, ceteris paribus.

Table 29 shows no significant estimates for the social sustainability impact factor independent variable.

TABLE 29: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR SOCIAL SUSTAINABILITY IMPACT FACTOR

		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 (ln)	-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. reduce scale				
Intercept	0.986 (1.992)			
Social	-0.289 (0.223)	0.484	0.749	1.161
Farmer age	-0.855 (0.534)	0.149	0.425	1.211
Farm size (ln)	-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 (ln)	-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: $R^2 = 0.095$ (Cox & Snell), $R^2 = 0.109$ (Nagelkerke). Model $Chi^2(21) = 42.981$, $p < 0.01$. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
UK is excluded to avoid perfect multicollinearity.

Table 30 shows the individual parameter estimates using economic sustainability impact factor. Whether the farmer perceives that production choices affect economic sustainability to a higher extent 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 impact 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 perceive that production choices affect economic sustainability to a higher extent, ceteris paribus. In other words, the odds of abandoning farming are significantly lower than the odds of maintaining scale when the farmers' value on economic sustainability impact factor increases by one unit, ceteris paribus.

TABLE 30: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR ECONOMIC SUSTAINABILITY IMPACT FACTOR

		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 (ln)	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. reduce 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 (ln)	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
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 (ln)	-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), $R^2 = 0.126$ (Nagelkerke). Model $Chi^2(21) = 51.258, < 0.01$. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
UK is excluded to avoid perfect multicollinearity.

4.3.3. Feta case

Our case is suitable for multinomial logistic regressions. There is one outcome variable (strategy) with three categories (maintain scale, expand scale, and reduce scale), three predictors[14] (environmental

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

sustainability impact factor, social sustainability impact factor, and economic sustainability impact factor), and two control variables (farmer age and farm size). 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 two categories represent some form of change (expanding or reducing).

Table 31 shows the individual parameter estimates using environmental sustainability impact factor. 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 to the reference category, while parameters with significant positive coefficients increase the likelihood of that response category in comparison with the reference category. Table 31 shows no significant estimates for the environmental sustainability impact factor independent variable.

TABLE 31: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR ENVIRONMENTAL SUSTAINABILITY IMPACT FACTOR

		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 (ln)	-0.067 (0.304)	0.515	0.935	1.696
Maintain scale vs. reduce 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 (ln)	0.976 (1.108)	0.302	2.653	23.271

Note: $R^2 = 0.027$ (Cox & Snell), $R^2 = 0.034$ (Nagelkerke). Model $Chi^2(6) = 3.594$, $p > 0.1$. $^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$.

Table 32 shows no significant estimates for the social sustainability impact factor independent variable.

TABLE 32: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR SOCIAL SUSTAINABILITY IMPACT FACTOR

		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 (ln)	-0.246 (0.329)	0.410	0.782	1.489

Maintain scale vs. reduce 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 (ln)	0.671 (1.150)	0.205	1.957	18.637

Note: $R^2 = 0.032$ (Cox & Snell), $R^2 = 0.041$ (Nagelkerke). Model $Chi^2(6) = 3.917, p > 0.1.$ $^{*} p < 0.1,$ $^{**} p < 0.05,$ $^{***} p < 0.01.$

Table 33 shows the individual parameter estimates using economic sustainability impact factor. Whether the farmer perceives that production choices affect economic sustainability to a higher extent 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 impact 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 perceives that production choices affect economic sustainability to a higher extent, ceteris paribus. In other words, the odds of expanding scale are significantly higher than the odds of maintaining scale when the farmers' value on economic sustainability impact factor increases by one unit, ceteris paribus.

TABLE 33: MULTINOMIAL LOGISTIC REGRESSION RESULTS FOR ECONOMIC SUSTAINABILITY IMPACT FACTOR

			95% CI for Odds Ratio	
	B (SE)	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 (ln)	-0.160 (0.296)	0.477	0.852	1.522
Maintain scale vs. reduce 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 (ln)	0.331 (1.279)	0.114	1.393	17.066

Note: $R^2 = 0.035$ (Cox & Snell), $R^2 = 0.046$ (Nagelkerke). Model $Chi^2(6) = 5.081, p > 0.1.$ $^{*} p < 0.1,$ $^{**} p < 0.05,$ $^{***} p < 0.01.$

4.4. Conclusion

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 (Diazabakana et al. 2014). 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' attitude towards sustainability affects intentions to implement specific farming strategies. We attempted to identify the sustainability driving factors that 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.

Sugar beet case. Our results assume that farmers with greater environmental awareness and who feel more responsibilities toward environmental behaviour (i.e., they perceive that production choices affect environmental sustainability to a higher extent) are less likely to downsize the existing scale than to maintain the existing scale, keeping the other variables fixed.

Dairy case. First, our results assume that farmers with greater environmental awareness and who feel more responsibilities toward environmental behaviour (i.e., they perceive that production choices affect environmental sustainability to a higher extent) are more likely to expand the existing scale than to maintain the existing scale, keeping the other variables fixed. Second, farmers with greater environmental awareness and who feel more responsibilities toward environmental behaviour (i.e., they perceive that production choices affect environmental sustainability to a higher extent) are more likely to reduce the existing scale than to maintain the existing scale, keeping the other variables fixed. Third, we show that farmers who perceive that production choices affect economic sustainability to a higher extent higher are less likely to abandon farming than to maintain the existing scale, ceteris paribus.

Feta case. We show that farmers who perceive that production choices affect economic sustainability to a higher extent higher are more likely to expand the existing scale than to maintain the existing scale, ceteris paribus.

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