Sample for the Dutch FADN 2017

J.L. Roskam, R.W. van der Meer and H.B. van der Veen

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Het Europese FADN (Farm Accountancy Data Network) is een instrument om het agrarische inkomen te monitoren en de invloed van het Europese landbouwbeleid te evalueren. De bedrijven die zijn opgenomen in het Nederlandse FADN vormen een steekproef van land- en tuinbouwbedrijven uit de Landbouwtelling. Dit rapport beschrijft de achtergronden van de steekproef en de ontwikkelingen aangaande de populatie en de steekproef in 2017. Alle stappen van het bepalen van het selectieplan, het werven van bedrijven en de kwaliteit van de steekproef worden beschreven.

The FADN (Farm Accountancy Data Network) is a European instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. The farms included in the Dutch FADN are a sample of agricultural and horticultural companies from the Agricultural Census. This report explains the background of the sample and the developments concerning the population and sample of 2017. All phases - from the determination of the selection plan, the recruitment of farms to the quality control of the final sample - are described in this report.

Key words: FADN, sample, population, agriculture, horticulture

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Preface

The Farm Accountancy Data Network (FADN) is a European system to collect financial, economic, physical and structural data from farms every year. The purpose of the FADN is to monitor the income of agricultural holdings and to evaluate the impact of the Common Agricultural Policy (CAP). The Netherlands is required to send data relating to a sample of 1,500 farms to the European Commission annually as its contribution to the European FADN. This task is carried out by Wageningen Economic Research on behalf of the Centre for Economic Information (in Dutch: *Centrum voor Economische Informatievoorziening*, CEI). This report describes all phases of the Dutch FADN sample for the accounting year 2017 - from the determination of the selection plan and the recruitment of farms to the quality control of the final sample.

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Summary

The Farm Accountancy Data Network (FADN) is a European instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. This report describes the sample of the Dutch FADN for the accounting year 2017 - from the determination of the selection plan and the recruitment of farms to the quality control of the final sample.

The farms included in the Dutch FADN are a sample of agricultural and horticultural holdings from the Dutch Agricultural Census. A selection plan is developed to make sure that the sample is a good representation of the different farming types and farm sizes in the Netherlands. In 2017, the financial and other results of 1,505 companies were delivered to the European Commission for the purposes of the FADN. This implies that the statutory obligation of delivering data for at least 1,500 farms has been met.

The Dutch Agricultural Census was used as the source for determining the sampling frame. Increasing numbers of agricultural and horticultural farms are missing in the Agricultural Census.

For the selection plan, a choice was first made for a distribution of agricultural holdings across different sectors. Within the type, the number of strata is minimised by using several practical preconditions. A selection plan was initially made across strata defined by farm type and farm size to estimate the population mean of the farm size as accurately as possible. Thereafter, the plan was adjusted to reflect the heterogeneity of farms in other aspects such as species grown. Generally, greater heterogeneity of farms results in a larger number of sample farms. For the selection plan of 2017, it was investigated whether there is a reason to no longer treat starch potato farms and goat farms as separate farm types. Both the statistical analysis and the wishes from policy and research argued in favour of continuing to distinguish starch potato farms and goat farms as a separate group in the sample. If the farm types were no longer distinguished separately, there would not be enough farms in the sample for separate analyses for policy research. The statistical reliability is also better when distinguishing the farm types separately, because this increases the number of observations.

The response rate among companies that were approached to take part in the FADN is around 14%. A low response rate combined with a declining number of farms in the population can lead to strata with fewer sample farms available than the optimum according to the selection plan. A lower response rate can result in a selection bias if non-responsive farms systematically differ from the recruited farms. Various actions have therefore been taken to increase the response rate as well as to investigate (potential) reasons for non-response including an update of the recruitment brochure and two studies focused on machine learning and text mining.

Samenvatting

Het Farm Accountancy Data Network (FADN) is een Europees instrument voor de evaluatie van het inkomen van landbouwbedrijven en de effecten van het gemeenschappelijk landbouwbeleid. Dit rapport beschrijft de samenstelling van de steekproef van het Nederlandse FADN voor het boekjaar 2017 - van de vaststelling van het selectieplan, de werving van bedrijven tot de kwaliteitscontrole van de uiteindelijke steekproef.

De bedrijven die zijn opgenomen in het Nederlandse FADN zijn een steekproef van land- en tuinbouwbedrijven uit de Landbouwtelling. Er wordt een selectieplan opgesteld om te garanderen dat de steekproef een goede afspiegeling is van de verschillende bedrijfstypen en grootteklassen in Nederland. In 2017 zijn de financiële en andere kengetallen van 1.505 bedrijven aangeleverd aan de Europese Commissie ten behoeve van het FADN. Dit betekent dat aan de wettelijke verplichting van het aanleveren van minimaal 1.500 bedrijven is voldaan.

De Nederlandse Landbouwtelling is gebruikt als de bron voor het vaststellen van het steekproefkader. Een toenemend aantal bedrijven zijn niet opgenomen in de Landbouwtelling.

Voor het steekproefplan wordt eerst een keuze gemaakt voor een verdeling van bedrijven over sectoren. Binnen het type wordt het aantal strata geminimaliseerd met behulp van een aantal praktische randvoorwaarden. Het steekproefplan wordt gemaakt op basis van strata van bedrijfstype en bedrijfsomvang om het populatiegemiddelde van de bedrijfsomvang zo nauwkeurig mogelijk te schatten. Het plan werd daarna nog aangepast om rekening te houden met de heterogeniteit van de bedrijven op andere gebieden zoals type gewassen. In het algemeen geldt hoe heterogener de bedrijven zijn, hoe groter het aantal steekproefbedrijven. Ten behoeve van het selectieplan 2017 is onderzocht of er aanleiding is om de zetmeelaardappelbedrijven en geitenbedrijven niet meer als afzonderlijke bedrijfstypes te onderscheiden. Echter, zowel de statistische analyse als de wensen vanuit beleid en onderzoek pleiten ervoor om zowel de zetmeelbedrijven als de geitenbedrijven als aparte groep te blijven onderscheiden in de steekproef. Indien de bedrijven niet meer apart worden onderscheiden, zullen er niet voldoende steekproefbedrijven zijn voor afzonderlijke analyses ten behoeve van beleidsonderzoek. Ook is de statistische betrouwbaarheid beter bij het afzonderlijk onderscheiden van de bedrijfstypes, doordat er dan meer steekproefbedrijven zijn.

De respons van bedrijven die worden benaderd om deel te nemen aan het FADN is ongeveer 14%. De respons daalt langzaam. Een lage respons gecombineerd met een afnemend aantal bedrijven in de populatie kan resulteren in strata met minder beschikbare sample bedrijven dan het optimum volgens het selectieplan. Een lagere respons kan resulteren in een vertekening wanneer niet-reagerende bedrijven systematisch verschillen van de gerekruteerde bedrijven. Verschillende acties zijn daarom genomen om de respons te verhogen en om (mogelijke) redenen voor non-respons te onderzoeken, waaronder een update van de wervingsbrochure en twee studies gericht op machine learning en text mining.

1 Introduction

The Farm Accountancy Data Network (FADN) is a European instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy conducted every year to collect financial, economic, physical and structural data from farms, with the aim of monitoring the income and business activities of EU agricultural holdings and to evaluate the impact of the Common Agricultural Policy.[1] In the Netherlands, the data are collected by Wageningen Economic Research on behalf of the Centre for Economic Information (in Dutch: *Centrum voor Economische Informatievoorziening*, CEI). The Netherlands are required to provide information of at least 1,500 farms to the European Commission as its contribution to the FADN.

This report first describes the relationship between the population and the target population in Chapter 2. Chapter 3 presents the selection plan. Chapter 4 describes the developments concerning the recruitment of farms for the FADN and the evaluation of the quality of the sample. Appendix 1 provides an overview of the methodology of sampling used for the FADN. In Appendix 2, the design principles of the FADN are described. Appendices 3-5 comprise more detailed background information tables.

[1] https://ec.europa.eu/agriculture/fadn_en

2 Population of the Dutch FADN

2.1 Overview

All agricultural companies together form the agricultural population. Theoretically, all agricultural companies in the Netherlands are registered in the trade register of the Chamber of Commerce. Based on this register, companies are approached for the Agricultural Census, where additional information on the agricultural activities is collected to, among other things, describe the structure of the Dutch agricultural sector (data on farms, livestock, crops and special topics). The Agricultural Census is the data source upon which the sample will be based. Theoretically, the Agricultural Census includes all Dutch farms with more than €3,000 of total Standard Output (SO).[2] The total SO is used to determine the economic size of a farm. The Standard Output per product is the average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock (Eurostat, 2019).

Not all the farms in the population are represented in the sample (see Figure 2.1). The figure consists of different layers. The outer layer represents all existing farms. Based on FADN regulations, the target population is defined as the farms with more than €25,000 of total SO.

The Agricultural Census is the most comprehensive list of farms and is used to select farms for FADN. For this purpose, farms above €25,000 SO are included in the sampling frame. Farms included in this sampling frame can differ from farms in the target population due to non-response and differences in the specification of the farm.

When selecting a farm, two additional criteria are applied (see Appendix 1 and 2). These criteria are a share of income from primary activities (>25% in total income) and a share of agricultural turnover (50% in total turnover). However, these criteria cannot be applied to the Agricultural Census since only after approaching the farms it can be determined whether the farms meet the criteria or not.

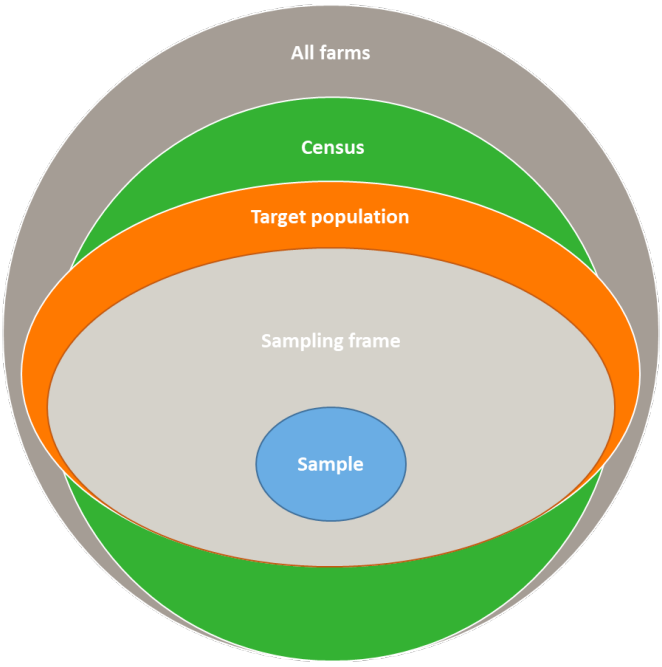

Figure 2.1 *Relationship between target population, sampling frame and sample*

[2] The SO of an agricultural product (crop or livestock) is the average monetary value of the agricultural output at farm gate prices, in euros per hectare or per head of livestock. The sum of all the SOs per hectare of crops and per head of livestock in a farm is a measure of its overall economic size, expressed in euros.

2.2 Coverage

For the Dutch FADN, a minimum economic size of €25,000 SO has been applied for the target population. In 2017, this lower threshold meant that almost 9,000 farms of the census were not part of the target population of FADN. Although this is a large number of farms, they only account for less than 0.5% of the total production capacity expressed in SO (see Table 2.1).

Table 2.1 *Number of farms and their relative economic importance (measured in total SO) in the 2017 Agricultural Census compared to the target population*

	Number of farms	Percentage of farms (%)	Percentage of SO (%)
All farms in the Agricultural Census (a)	54,840	100.00	100.00
Farms with less than €25,000 SO (b)	8,661	15.79	0.47
Farms above minimum threshold (a) - (b)	46,179	84.21	99.53

Source: Agricultural Census, Statistics Netherlands, calculations by Wageningen Economic Research.

Quality of the sampling frame

Although the Agricultural Census is intended to include all Dutch farms, this is not the case in practice. There are several possible explanations for this. On the one hand, not all farms receive an invitation to participate in the Agricultural Census, for instance because the business is registered with the Chamber of Commerce as a trading company rather than as a farming company. On the other hand, there are farms that do not respond to the request, despite it being obligatory. Table 2.2 illustrates the number of farms participating in the FADN sample (see Chapter 3) but missing from the Agricultural Census. An increasing number of sample farms included in the FADN are not included in the Agricultural Census.

Table 2.2 *Number of FADN sample farms not included in the Agricultural Census*

Accounting year	Number of farms missing
2013	0
2014	6
2015	38
2016	53
2017	67

3 Selection plan

3.1 Introduction

A selection plan is a key document which specifies how the selection activities will be organised, initiated and conducted conform the regulations of the EU. The determination of the selection plan for the Dutch FADN consists of the following steps:

1. Determination of the farm types (Section 3.2)
2. Determination of the number of farms per farm type (Section 3.3)
3. Determination of the stratification scheme (depending on the number of farms per farm type (Section 3.4)
4. The sample farms per farm type are distributed over the size classes (Section 3.4)

3.2 Farm types

Dutch FADN farm types differ in some cases from the European FADN (see European classification of farms). Some farm types are not present in Dutch agriculture (e.g. olives, citrus fruit) and some types are further detailed because they are of substantial importance for Dutch agriculture in terms of economic size or their relevance for policy makers (such as starch potatoes within arable farming). For a number of farming types - dairy farms and field crops - a distinction is made between organic farming and non-organic farming (see Vrolijk and Lodder, 2002). The latter consists of organic field crop farms, field vegetables farms and combined crop farms. For the selection plan of 2017, it was investigated whether there is reason to no longer distinguish starch potato farms and goat farms as separate farm types. However, both the statistical analysis and the wishes from policy and research argued in favour of continuing to distinguish starch potato farms and goat farms as separate groups in the sample. If the farm types were no longer distinguished separately, there would not be enough farms in the sample for separate analyses for policy research. The statistical reliability is also better when distinguishing the farm types separately, mainly due to the differences in the number of farms per farm type. Starch potato farms are used to receiving relatively high-income support from Common Agricultural Policy regulations. The income support has been lowered year by year, resulting in a flat rate in 2019 (equal support per hectare for eligible farms). These developments made the starch potato farms an interesting farm type for policy evaluation. Besides this, starch potato farms are in general bigger in area of arable crops than other arable farms. Goat farms are of special interest for policy evaluation because of the relation with human health. In 2007 a Q fever epidemic started, with a maximum number of human patients in 2009. This increased the policy relevance of this sector. The profitability of milking goat farms is in general better than farms belonging to the 'other grazing cattle' type.

3.3 Number of sample farms per farm type

When determining the number of sample farms per type of farm, important considerations are the number of farms in the target population, the economic significance of a type of farm, the amount of land used, and the heterogeneity within a type (the dispersion in size measured in SO). Farm types can be heterogeneous in terms of scale (measured as the SO) or crops. The selection plan largely matches the numbers of farms that would be expected based on the criteria of economic importance, heterogeneity and number. The distribution is different given different criteria. Hence, the selected distribution is a compromise. The total number of farms in one farming type should be at least 30. A lower number of farms would make it very difficult to perform useful analyses on such farm types (Vrolijk and Lodder, 2002). The number of FADN sample farms per farm type in 2017 did not change compared to 2016.

3.4 Stratification scheme

EU Regulation 2015/220 specifies the size classes and puts restrictions on the clustering of size classes. Based on the SO, the variance of strata given different clustering schemes is calculated and used to determine the optimum clustering scheme (Appendix 1 Neyman Allocation). Size classes for the strata vary between the types of farming. This is because the size distribution of farms differs greatly between farm types (Ge et al., 2017). For example, field crop farms are in general much smaller in terms of SO than greenhouse horticulture farms. This is similar to the previous year and therefore there was no reason for changing the optimum clustering scheme. Table 3.1 shows the optimum clustering scheme for each type of farming for the 2017 target population.

Table 3.1 *Clustering scheme 2017 (size classes in a single colour in one row represent one stratum)*

Lower boundary (€'000 SO)	25	50	100	250	500	750	1,000	1,500	3,000
Upper boundary (€'000 SO)	50	100	250	500	750	1,000	1,500	3,000	infinity
Organic crops									
Starch potatoes									
Other field crops									
Vegetables under glass									
Flowers under glass									
Plants under glass									
Field vegetables									
Flower bulbs									
Tree nursery									
Fruit									
Other horticulture									
Dairy (organic)									
Dairy (non-organic)									
Calf fattening									
Goats									
Other grazing livestock									
Pig rearing									
Pig fattening									
Combined pig rearing and fattening									
Broilers									
Eggs for consumption									
Other intensive livestock									
Combined									

3.5 Sample farms per stratum

Table 3.2 presents the optimum selection plan for 2017, based on the design principles described in Appendix 2. The distribution of the sample farms across the size classes has remained broadly the same and is mainly determined by the further increase in the scale of farming activities. However, in some cases, the absolute number of farms in the population in the largest stratum has decreased, implying less sample farms within the stratum. This applies for example to other horticulture farms and goat farms.

Table 3.2 *Selection plan per stratum 2017*

Lower threshold (€'000 SO)	Code	25	50	100	250	500	750	1,000	1,500	3,000	Total
Upper threshold (€'000 SO)		50	100	250	500	750	1,000	1,500	3,000	infinity	
Type of farm											
Field crop farms	*1*										
- Starch potatoes		5		12	8		5				30
- Organic crops		5		10	10		5				30
- Other field crops		29		44	37	29		11			150
Horticulture	*Other 2 + 3*										
Vegetables under glass	2111	2		30		19		19	30	30	130
Plants under glass	2122	2		7		13		10	14	19	65
Flowers under glass	2121	5		25		37		17	24	10	118
Field vegetables	2210	5		28		13		9			55
Fruit	3630	3		7	12	16					38
Tree nursery	2320	6		22		20		22			70
Flower bulbs	2221	3		8		11		15			37
Other horticulture	2131, 2310, 2331, 3500, 3699	4		10		12		19			45
Grazing livestock	*4*										
Dairy	*4500*										
Dairy (organic)		1		13	12	4					30
Dairy (non-organic)		5		48	150	73		24			300
Calf fattening	4611	2		9		16		13			40
Goats	4830	1	2	8	14	5					30
Other grazing livestock	4612, 4810, 4841, 4842, 4843	8	12	5	3	5					33
Intensive livestock	*5*										
Pig rearing	5111	1		4	9	15		19			48
Pig fattening	5121	1		8	8	8		23			48
Combined pig rearing and fattening	5131	1		4	2	6		25			38
Eggs for consumption	5211	2		5		7		16			30
Broilers	5221	1		4		6		19			30
Other intensive livestock	5231, 5301	1		4		10		15			30
Combined	6, 7, 8	6		11	16	25		17			75
Total											1,500

The sampling plan was primarily based on the method of Neyman Allocation. This allocation is adjusted to take the heterogeneity of the farms in other aspects into account. For example: crops are not a stratification variable, but in order to be able to take the great heterogeneity of crops grown on tree nurseries and field vegetable farms into account, the number of sample farms has been increased.

A sampling fraction is the ratio of the size of the sample to that of the population (Cochran, 1977). The sampling fractions differ between strata. This is a result of the disproportionate sampling technique used for the FADN sample. The sampling fraction also gives an indication of the number of farms available for recruitment in a stratum. In strata with a high sampling fraction, only a limited number of farms are available for recruitment. Appendix 3 shows the number of farms per stratum in the target population while Appendix 4 presents an overview of the sampling fractions (number of farms in the sample compared to the number of farms in the target population).

4 Evaluation of the sample

The evaluation of the sample is based on three criteria: recruitment and response, statistical reliability and representativeness. These criteria are discussed separately in the paragraphs below.

4.1 Recruitment and response

Sample farms are retained as much as possible (see Vrolijk and Cotteleer, 2005). Nevertheless, new farms must be recruited every year to compensate for the farms that are lost, due to structural changes in farms or because of changes in the selection plan. To meet the required number of farms for delivery to the European Commission, a successful recruitment process is important. Besides, a high non-response rate could result in a bias.

The Agricultural Census is used to select farms that meet the criteria for inclusion in the sample. Addresses for the selected farms are requested from the Ministry of Agriculture, Nature and Food Quality. The farms are then approached to ask if they would be interested in taking part in the Farm Accountancy Data Network. More than 600 farms were approached for the sample for 2017. Some of these farms (14%) were unsuitable for inclusion in the sample, for example because the entrepreneur has stopped their farm operations or will be stopping soon, or the farm forms part of a larger company without the possibility of making a distinction between the accountancy data of the farm and other parts of the concern. Ultimately, 78 farms were recruited. As can be seen from Figure 4.1, the response rate (number of recruited farms / (number of farms approached – unsuitable farms) * 100) has been between 15% and 25% for several years. The low response rate in recent years is related to the fact that recruitment primarily takes place in sectors with below-average response rates (see Appendix 5). A response rate of 15% in 2017 is not exceptionally low compared to preceding years, although the graph shows that the response rate is slowly declining. A low response rate combined with a declining number of farms in the population can lead to strata with fewer sample farms available than the optimum according to the selection plan. Another problem is that a low response rate can lead to a selection bias if non-responsive farms systematically differ from the recruited farms (see Appendix 1).

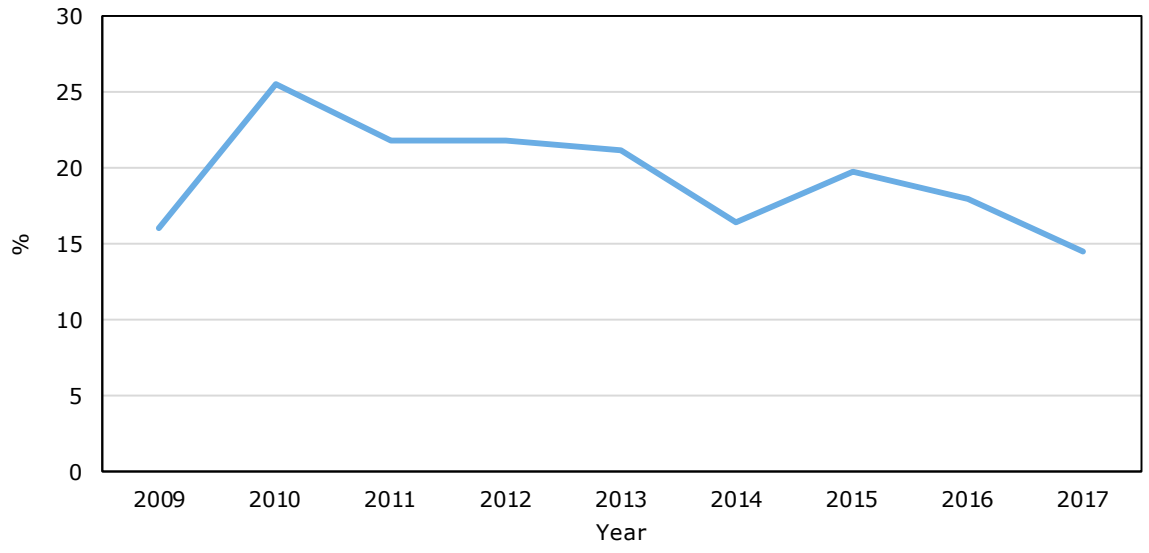

Figure 4.1 *Response rates, 2009-2017*

Various types of actions have been taken to increase the response rate as well as to investigate (potential) reasons for non-response:

- The recruitment brochure was updated, particularly the text and photos within the brochure, in order to stimulate farmers to participate. In addition, the name change from LEI Wageningen UR into Wageningen Economic Research was included in the new brochure.
- Some studies have taken place to investigate possibilities for improving the response rate in the future. These studies focused on *machine learning* and *text mining*. These topics are discussed below.

Machine learning was used to test the presence of a bias, in which algorithms are used to learn complex relations and correlations between features. Structure variables (such as farm type, size, location, age of the farmer, and off-farm income) were used in the analysis. The hypothesis was that if there was such a bias, then a latent set of features would make it possible to predict whether a given farm would accept or decline the FADN invitation. Several machine learning algorithms are used to perform such predictions. It was concluded that there is no evidence that there is a bias in the selection procedure.

A text mining approach was used to find the motives behind invitation refusals of farmers to join the FADN. Topic modelling and more specifically, Latent Dirichlet Allocation (LDA) was used to find these motives. LDA was addressed by Blei et al. (2003). This iterative algorithm considers documents as being generated by a mixture of topics. The purpose of LDA is to compute how much of the document was generated by which topic, i.e. the probability that a specific document was generated by a topic. The dataset that was used accompanies a string with a short description why a potential candidate rejected the invitation. Unfortunately, such a description is not available in case farmers accept the invitation. Reasons of farmers to refuse the invitation to join the FADN include quitting the farming profession, or because they are phasing out. Other reasons are time and heavy administrative loads.

4.2 Statistical reliability

Reliability is about the consistency of a measure, while validity is about the accuracy of a measure. The reliability of estimates can be measured using the standard error of the estimate of a variable to calculate the confidence interval. This confidence interval describes the range between which the true population value will be, given a certain level of certainty. The 95% confidence interval (with a critical t-value of 1.96) ranges from the calculated average minus 1.96 times the standard error to the calculated average plus 1.96 times the standard error. For example, the standard error of 7,630 for field crop farms signals that the average farm income on such farms can vary within the confidence interval 45,298 +/- 1.96 * 7,630, i.e. (€30,343 - €60,253) (Table 4.1). A higher relative standard error (see Appendix 1) implies less reliable estimates, but the value is greatly affected by the absolute value of the average. If the average value approaches zero, the variation can become very large.

Table 4.1 *Reliability of estimates: standard error and relative standard error (in italics) of important goal variables per main type of farm, based on CSP[3] variant (2017)*

Type of farm	Goal variable			
	Farm income, €	Total revenues, €	Profitability a)	Total income, €
Field crops	7,630	58,720	1.8	7,346
	0.17	*0.16*	*0.02*	*0.12*
Vegetables under glass	59,558	267,301	1.6	60,085
	0.13	*0.11*	*0.02*	*0.13*
Flowers under glass	29,188	102,538	2.2	29,256
	0.13	*0.07*	*0.02*	*0.12*
Pigs	9,096	42,787	1.0	9,203
	0.05	*0.04*	*0.01*	*0.05*
Poultry	37,520	77,443	4.1	37,033
	0.26	*0.07*	*0.04*	*0.24*
Grazing livestock	6,312	11,302	3.3	3,803
	0.07	*0.03*	*0.04*	*0.04*
All farms	4,411	18,120	1.7	3,661
	0.04	*0.03*	*0.02*	*0.03*

a) Revenues per €100 in costs.

There are clear differences in the reliability of estimates between different types of farms. The estimates for grazing livestock are among the most reliable estimates (the lowest standard error). This is due to the relatively large number of farms included in the sample, which reflects the importance of the dairy sector in Dutch agriculture, as well as because of the homogeneity of Dutch dairy farms. The field crop farms have a low standard error as well. The European Commission has no requirements regarding the reliability. However, it is one of the factors that is considered when determining the distribution of farms over both the farm types and size classes.

4.3 Comparison sample and target population

The representativeness (interpreted as there being no systematic differences between the sample and the target population, Van der Veen et al., 2014, see also Appendix 1) of certain specialist types of farms are shown in Table 4.2. For most of the main farm types, there are no significant differences in the acreage per farm and the SO per farm between the sample and the total population. Dairy farms were an exception to this rule in 2017; a significant difference can be seen in the average SO per farm. The stratification was adjusted to avoid such differences in the future. It will be monitored if this increases the representativeness.

Table 4.2 *Comparison of farms in the target population and farms in the sample*

	SO/farm population	SO/farm sample	Significant (5%)	Ha/farm population	Ha/farm sample	Significant (5%)
Arable farms	224,546	237,282		55.9	58.7	
Horticulture under glass	1,888,552	1,739,277		4.9	4.3	
Horticulture open air	461,988	452,196		18.7	16.5	
Dairy farms	418,220	433,971	*	52.5	52.8	
Poultry farms	1,222,430	1,128,756		-	-	
Pig farms	930,668	892,056		-	-	

[3] Corporate Social Performance is the variant of data collection in which a wide range of data is collected for EU and national policies. It covers all the topics that are today considered relevant in a report on the sustainability of a farm. About 80% of the farms included in the sample are in the CSP variant.

The sampling plan is based on farm types (e.g. open-air vegetable growers) and not on the underlying crop or animal (e.g. cauliflower or broccoli). This can result in certain crops or animals being underrepresented or overrepresented in the sample, particularly for types that are less common. To obtain an impression of the extent to which this is the case, a comparison was made between the weighted totals in euros of SO for the crops and animals in the sample against the totals from the Agricultural Census. Although the analysis has shown that differences do arise, they are in general not significant (because of a large dispersion).

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Appendix 1 Sampling Theory and Methodology

Concepts and Methods

Population
According to Cochran (1977), the definition of the population is: 'The aggregate from which the sample is chosen.' A population is thus an aggregate of creatures, things, cases, etc.

Target population
Cochran (1977) defined the *target* population as the population about which information is desired. The population to be sampled (the *sampled* population) should coincide with the *target* population.

Sampling frame
The sampling frame is the source material or device from which a sample is drawn. It is a list of all those within a population who can be sampled, and may include individuals, households or institutions.

Sampling
Sampling is a statistical procedure that relates to the selection of the individual sampling units. Sampling helps to make statistical inferences about the population.

Sample
In statistics, a sample refers to a set of observations drawn from a population. A sample is a subset of a population. A sample can be collected either at random or through systematic methods.

Sampling method used for FADN disproportionate stratified sampling
Sampling units from the population that meet certain criteria form the target population. Estimates are made for the target population based on these sample farms. This might raise the question of how conclusions can be drawn for the target population if only a limited number of farms are observed. The answer to this question can be found in sampling techniques such as stratified random sampling (Cochran, 1977). Sampling units that are included in the sample must be representative for the whole target population (no systematic differences between the sample and the population, Van der Veen et al., 2014).

One important issue is how to ensure that the sampling units are representative for the whole target population. This can be achieved through a disproportionate stratified random sample. A *stratified* sample implies that the target population is divided into several groups (strata). Subsequently, the sampling units are randomly selected from each of the groups. The variables that define these groups must be chosen in such a way that the sampling units within any one group are similar (at least in terms of the important aspects). Sampling from each group ensures that the sample includes sampling units from all groups consistently with different characteristics. Stratification ensures that all groups are properly represented, thereby allowing separate estimates for all groups. All groups combined make up the whole target population. This method of sampling allows unbiased estimates to be made for the whole target population of farms.

Disproportionate means that not all farms have the same chance of being included in the sample. Groups that are relatively homogeneous, i.e. containing farms that show a high degree of similarity, will have a lower chance of being included in the sample. In cases of less homogeneous groups, it is important to have a larger number of observations if reliable estimates are to be made.

Random sampling
Random selection is an application of probability sampling in which each unit in the population has an equal chance of being included in the sample (Cochran, 1977). In the case of stratified sampling, each unit in a stratum has the same chance of being included.

Neyman allocation
Optimum allocation refers to a method of sample allocation based on stratified sampling. This allocation is sometimes called *Neyman* allocation, after Neyman (1934). The purpose of Neyman allocation is to maximise survey precision given a fixed sample size. According to Neyman allocation, the 'best' sample size for stratum *h* would be:

$$n_h = \mathrm{n}\frac{N_h\sigma_h}{\sum_{i=1}^{L} N_i\sigma_i}$$

where n_h is the sample size for stratum *h*, n is the total sample size, N_h is the population size for stratum *h*, σ_h is the standard deviation of stratum *h* and *L* represents the number of strata. The denominator (i.e. $\sum_{i=1}^{L} N_i\sigma_i$) corresponds to the sum of the population size times the standard deviation of all strata.

Quality of survey samples

Accuracy
The degree to which a measurement represents the true value of something. The confidence interval indicates the accuracy of a measure. The smaller the confidence interval of a measure, the higher the accuracy of a measure.

Reliability
The overall consistency of a measure, i.e. how dependably an observation is exactly the same when repeated. The stand error can be an indication of the degree of reliability.

Representativeness
Representativeness is a well-known concept in the context of sampling. Nevertheless, depending on the context, there are different definitions and interpretations. Kruskal and Mosteller (1979a, 1979b, 1979c, and 1980) distinguish the following interpretations (among others):
1. Random without a selective mechanism.
2. The sample as a miniature representation of the target population: all subpopulations in the sample are in the same proportions as in the total population.
3. No significant difference between the estimated value of the target value and the actual value of the target population (compare Van der Veen et al., 2014).
4. Inclusion in the sample of certain farm types or farms in certain size classes.

An indication of the representativeness for a random sample without selection (interpretation 1) is the R indicator. This indicator gives an indication of the possible non-response bias (Bethlehem et al., 2008). To be able to calculate the R-indicator, the response chance of a farm is estimated based on several variables available in the Agricultural Census (Appendix 2).

Interpretation 2 is intuitively the most logical and the most used interpretation in survey research. It is of less importance for the FADN because the FADN is a disproportionate stratified sample. To be able to determine whether a sample is representative according to interpretations 3 and 4, it is necessary to indicate which characteristic should be well represented by the sample. This is the target variable for research. Talking about representativeness in broad terms is therefore not very meaningful.

Non-response
Not all farms approached for participation in the FADN are willing to participate, leading to a non-response in the recruitment process. Non-response is the failure to measure some of the units in the selected sample (Cochran, 1977). A low response rate does not necessarily provide incorrect results

(Bethlehem 2008). However, if the non-response is biased, certain groups can be overrepresented or underrepresented.

Standard error

The standard error of a statistic is the standard deviation of the sampling distribution of that statistic. Standard errors are important because they reflect how much sampling fluctuation a statistic will show (Everitt, 2003). In statistics, a sample mean deviates from the actual mean of a population – this deviation is the standard error of the mean.

Relative Standard Error

The relative standard error is the standard error expressed as a fraction of the estimate and is usually shown as a percentage. Estimates with a Relative Standard Error of 25% or greater are subject to high sampling error and should be used with caution (Australian Bureau of Statistics, 2017).

Appendix 2 Design principles and requirements

EU regulations

EU Regulation 2015/220 sets out rules for the target population, such as definitions for farming types and size classes. The regulation prescribes several size classes and options for the clustering of size classes, the threshold (€25,000 SO for the Netherlands) and the minimum number of sample farms for every EU country (1,500 for the Netherlands).

Target population

The EU Regulation describes that, for the Dutch FADN, a minimum economic size of €25,000 SO should be applied to the target population. This minimum was introduced after the introduction of the SO in 2010 and it was required to fit in with the existing EU size classes. Moreover, the coverage of the sample should not become worse (Van der Veen et al., 2012). The minimum economic size exists to be able to select the commercial farms only, which is required by the European Commission.

Sampling frame

For practical and methodological reasons, a limitation on 'other income of the farm' is used for sample farms. A farm should gain at least 25% of its turnover from primary agricultural activities. Furthermore, agricultural activities (in the broadest sense including other gainful activities) should comprise the largest share of the turnover of the farm.

Number of sample farms per farm type

When determining the number of sample farms per type of farm, the number of farms in the target population, the economic significance of a type of farm, the amount of land used, and the heterogeneity within a type (the dispersion in size measured in SO) are important considerations. If the amount of land used were adopted strictly as the criterion, the sample would consist largely of arable and dairy farms. Farm types can be heterogeneous in terms of scale (measured as the SO) or crops. The selection plan largely matches the numbers of farms that would be expected based on the criteria of economic importance, heterogeneity and number. Hence, the selection plan is a compromise between different approaches. A few observations are presented below:

- The number of arable and dairy cattle farms is greater than would be expected based on heterogeneity. This is because these sectors are particularly relevant for policy and because of the number of farms in these sectors.
- There are fewer mixed farms and other grazing livestock farms. These sectors are less important for research and policy, but they are important for reporting several characteristics of the total target population.
- More horticultural companies have been included than would be expected given the number of such farms in the target population. This is primarily due to the wide variation in crops that are cultivated, particularly at tree nurseries and flower bulb farms.
- For most open-field types, there are relatively more farms in the sampling plan than would be optimum given the numbers of companies. This is due to the greater heterogeneity in crops grown on horticultural farms. This also applies to greenhouse horticulture; in addition, these businesses are highly relevant to policy in terms of energy issues in particular.

The total number of farms in one farming type should be at least 30. A lower number of farms would make it very difficult to perform useful analyses on such farm types (Vrolijk and Lodder, 2002).

Stratification scheme and sample farms per stratum

The FADN sample distinguishes groups based on economic size and type of farming. Within a type of farm, the principles of optimum allocation (see Appendix 1) determine both the stratification scheme and the distribution of farms over the size classes. The variance of strata in different clustering schemes (as described in the EU Regulation) is calculated based on the SO. The optimum clustering scheme is chosen based on the standard error. As the number of strata increases, the variance and the standard error of the target variable will gradually decrease. If the reduction in the variance of adding an extra stratum is less than 5%, no more strata are added. For more details, see Vrolijk and Lodder (2002). Given this optimised stratification scheme, more sample farms are assigned to a stratum in the event that farms are shown to be more heterogeneous. In the extreme example that all farms were exactly alike, one observation is sufficient to make reliable estimates.

Besides the abovementioned statistical criteria, the maximum number of farms within a stratum is 10% of the total number of farms of the target population within that stratum. A larger number would lead to problems in recruiting farms.

Weighting system

The purpose of the weighting system is to take account of different sampling fractions for different strata. In the production of FADN results, weighted averages are calculated using these weightings applied to each individual farm recorded in the sample. The individual weighting is equal to the ratio between the numbers of farms of the same classification stratum (type of farming x economic size class) in the population and in the sample. The farms in the target population within a stratum are continually changing. These changes could influence the inclusion probability of farms in one particular stratum at the time of recruitment. In theory, these differences in inclusion probabilities should be considered in the estimation process in order to ensure unbiased estimators. This would lead to a very complicated system with many different substrata with different inclusion probabilities. This procedure is not applied in the FADN. The theoretical assumption of a strictly random sample cannot be validated. However, given the circumstances the current method is justifiable.

Recruitment

Farms are randomly selected from the Agricultural Census based on the selection plan. Farmers from a selected farm are approached and asked whether they would be willing to participate. If the farmer declines, another farm from the same strata will be approached.

Appendix 3 Number of farms per stratum in the target population

Table A3.1 *Number of farms per stratum (target population) in 2017*

Lower threshold (€'000 SO)	25	50	100	250	500	1,000	1,500	3,000	Total
Upper threshold (€'000 SO)	50	100	250	500	1,000	1,500	3,000	infinity	
Type of farm									
Field crop farms									
- Starch potatoes	208		310	183	68				769
- Organic crops	100		117	85	50				352
- Other field crops	2,718		1,985	1,125	563	142			6,533
Horticulture									
Vegetables under glass	42		185		150	117	191	162	847
Flowers under glass	43		315		202	92	154	109	915
Plants under glass	27		122		97	63	116	171	596
Field vegetables	201		402		122	87			812
Fruit	295		420	428	215				1,358
Tree nursery	552		784		194	152			1,682
Flower bulbs	61		261		108	161			591
Other horticulture	282		596		227	264			1,369
Grazing livestock									
Dairy (organic)	10		129	253	88				480
Dairy (non-organic)	475		3,154	7,995	3,617	521			15,762
Calf fattening	68		465		407	245			1,185
Goats	14	23	45	109	186				377
Other grazing livestock	2,485	1,638	676	125	82				5,006
Intensive livestock									
Pig rearing	16		53	165	284	265			783
Pig fattening	180		385	297	319	349			1,530
Combined pig rearing and fattening	8		22	74	210	328			642
Eggs for consumption	17		203		181	229			630
Broilers	5		90		112	255			462
Other intensive livestock	7		154		203	219			583
Other									
Combined	783		656	618	566	292			2,915
Total									46,179

Source: Agricultural Census, Statistics Netherlands, calculations by Wageningen Economic Research.

Appendix 4 Sampling fractions

The sample is a disproportionate stratified sample. The term 'disproportionate' means that the chances of being included can vary between the strata. The chance of being included is calculated as the number of sample farms divided by the total number of farms in the target population. Table A4.1 shows that the sampling fractions are higher for greenhouse horticulture companies than they are for other sectors. Sampling fractions are higher in certain strata because the heterogeneity of farms in a particular stratum are high.

Table A4.1 *Sampling fraction according to the 2017 Agricultural Census by stratum*

lower threshold (€'000 SO)	25	50	100	250	500	1,000	1,500	3,000
upper threshold (€'000 SO)	50	100	250	500	1,000	1,500	3,000	infinity
Type of farm								
Field crops								
- Starch potatoes	0.02		0.04	0.04	0.07			
- Organic crops	0.05		0.09	0.12	0.10			
- Other field crops	0.01		0.02	0.03	0.05	0.10		
Horticulture								
Vegetables under glass	0.05		0.16		0.13	0.16	0.16	0.19
Plants under glass	0.05		0.02		0.06	0.11	0.09	0.17
Flowers under glass	0.19		0.20		0.38	0.27	0.21	0.06
Field vegetables	0.02		0.07		0.11	0.10		
Fruit	0.01		0.02	0.03	0.07			
Tree nursery	0.01		0.03		0.10	0.14		
Flower bulbs	0.05		0.03		0.10	0.09		
Other horticulture	0.01		0.02		0.05	0.07		
Grazing livestock								
Dairy								
- Organic	0.10		0.10	0.05	0.05			
- Non-organic	0.01		0.02	0.02	0.02	0.05		
Calf fattening	0.03		0.02		0.04	0.05		
Goats	0.07	0.09	0.18	0.13	0.03			
Other grazing livestock	0.00	0.01	0.01	0.02	0.06			
Intensive livestock								
Pig rearing	0.06		0.08	0.05	0.05	0.07		
Pig fattening	0.01		0.02	0.03	0.03	0.07		
Combined pig rearing and fattening	0.13		0.18	0.03	0.03	0.08		
Eggs for consumption	0.12		0.02		0.04	0.07		
Broilers	0.20		0.04		0.05	0.07		
Other intensive livestock	0.14		0.03		0.05	0.07		
Other								
Combined	0.01		0.02	0.03	0.04	0.06		

Appendix 5 Response rate by type of farm

Table A5.1 *Response rate in different types of farm, recruitment for CSP variant, 2017*

Farm types a)	Total farms	Unsuitable farms (%)	Response rate (%)
Starch potato	11	0	45
Arable farms	69	14	15
Cucumber	4	25	33
Tomato	35	3	15
Sweet pepper	25	12	9
Other vegetables under glass	73	15	10
Plants under glass	27	11	4
Flowers under glass	59	20	9
Field vegetables	52	15	9
Flower bulbs	28	57	20
Tree nurseries	143	14	7
Fruit growing	4	0	25
Dairy farms	29	0	48
Pig rearing	14	0	29
Pig fattening	24	0	17
Eggs for consumption	17	12	20
Broiler farms	9	0	33
Total	626	14	14

a) Only farm types with recruiting activities are displayed.

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 5,000 employees and 12,000 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.