Sample for the Dutch FADN 2019

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 2019. De nadruk in dit rapport ligt op de evaluatie van het selectie plan.

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 2019. The emphasis in this report is on the evaluation of the selection plan.

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

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Preface

The Centre for Economic Information (in Dutch, *Centrum voor Economische Informatievoorziening*, CEI) is one of the programme units for Statutory Research Tasks and is concerned with the efficient and effective collection, processing, recording and management of databases and presentation of statistical data on various activities of players in the agricultural sector and rural areas in the Netherlands and abroad. One of the statutory research tasks is to yearly send data relating to a sample of 1,500 farms to the European Commission annually as its contribution to the European Farm Accountancy Data Network (FADN). This statutory research task is carried out by Wageningen Economic Research on behalf of CEI. This report describes all phases of the Dutch FADN sample for the accounting year 2019 - 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 2019 - from the determination of the selection plan and the recruitment of farms to the quality control of the final sample. Central in this report is the evaluation of the Dutch FADN sample for the year 2019, which includes the following statistical quality aspects: coverage (Chapter 2), representativeness (Chapter 3) and reliability (Chapter 4).

The farms included in the Dutch FADN are a sample of agricultural and horticultural holdings from the Dutch Agricultural Census. The sampling frame fits well with the total population and the coverage of the sampling frame is therefore good (Chapter 2).

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 (Chapter 3). The Dutch Agricultural Census was used as the source for determining the sampling frame.

The determination of the selection plan for the Dutch FADN consists of the following steps:
1. Determination of the farm types
2. Determination of the number of farms per farm type
3. Determination of the stratification scheme, depending on the number of farms per farm type in the target population
4. Distribution of sample farms per farm type over the size classes

For the selection plan of 2019, it was investigated whether it makes sense to keep the starch potatoes as a separate farm type. In addition, it was analysed whether the current division of horticulture companies into the subsectors sweet pepper, tomato, cucumber and other horticulture is still possible It was further analysed how it can be ensured that the number of sample farms for the farm type consumption eggs can be maintained at sufficient size. In the end it was decided to maintain the current distinction of farm types. Compared to the selection plan of 2018, there are small changes in the number of sample farms for the farm types starch potato (-5), tree nursery (+5), eggs for consumption (+5) and other intensive livestock (-5).

A recurring point of attention is the response rate among companies. The response rate among companies that were approached to take part in the FADN is around 19%. This is higher than in previous years. The sample has been evaluated using three quality criteria: response level, statistical reliability and representativeness (Chapter 4). We conclude that the resulting sample meets all evaluation criteria.

Samenvatting

Dit rapport beschrijft de samenstelling van de steekproef van het Nederlandse Farm Accountancy Data Network (FADN) voor het boekjaar 2019 - van de vaststelling van het selectieplan, de werving van bedrijven tot de kwaliteitscontrole van de uiteindelijke steekproef. Het FADN is een Europees instrument voor de evaluatie van het inkomen van landbouwbedrijven en de effecten van het gemeenschappelijk landbouwbeleid. Centraal in dit rapport staat de evaluatie van de Nederlandse FADN-steekproef voor het jaar 2019, waarin de volgende statistische kwaliteitsaspecten zijn meegenomen: dekking (hoofdstuk 2), representativiteit (hoofdstuk 3) en betrouwbaarheid (hoofdstuk 4).

De bedrijven die zijn opgenomen in het Nederlandse FADN zijn een steekproef van land- en tuinbouwbedrijven uit de Landbouwtelling. Het steekproefkader sluit goed aan bij de totale populatie en de dekking van het steekproefkader is daarom goed (hoofdstuk 2).

Er wordt een selectieplan opgesteld om te garanderen dat de steekproef een goede afspiegeling is van de verschillende bedrijfstypen en grootteklassen in Nederland (hoofdstuk 3). De Nederlandse Landbouwtelling is gebruikt als bron voor het vaststellen van het steekproefkader.

Het vaststellen van het selectieplan voor het FADN bestaat uit de volgende stappen:
1. Bepaling van de bedrijfstypes
2. Bepaling van het aantal bedrijven per bedrijfstype
3. Bepaling van het stratificatieschema, afhankelijk van het aantal bedrijven per bedrijfstype in de doelpopulatie
4. Verdeling steekproefbedrijven per bedrijfstype over de grootteklassen

Voor het selectieplan van 2019 is onderzocht of het zin heeft om de zetmeelaardappelen als apart bedrijfstype te behouden. Daarnaast is geanalyseerd of de huidige opdeling van tuinbouwbedrijven in de deelsectoren paprika, tomaat, komkommer en overige tuinbouw nog mogelijk is. Verder is geanalyseerd hoe ervoor kan worden gezorgd dat het aantal steekproefbedrijven voor het bedrijfstype consumptie-eieren voldoende groot worden gehouden. Uiteindelijk is besloten om het huidige onderscheid in bedrijfstypes te handhaven. Ten opzichte van het selectieplan van 2018 zijn er kleine wijzigingen in het aantal bedrijven voor de bedrijfstypes zetmeelaardappel (-5), boomkwekerij (+5), consumptie-eieren (+5) en overig staldierbedrijven (-5).

Een terugkerend punt van aandacht is de respons van bedrijven. De respons onder bedrijven die zijn benaderd om deel te nemen aan het Bedrijveninformatienet ligt rond de 19%. Dit is hoger dan in voorgaande jaren. De steekproef is beoordeeld aan de hand van drie kwaliteitscriteria: responsniveau, statistische betrouwbaarheid en representativiteit (hoofdstuk 4). We concluderen dat de resulterende steekproef aan alle evaluatiecriteria voldoet.

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. On a yearly basis financial, economic, physical and structural data from farms are collected, 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*, abbreviated as CEI).

The Netherlands are required to provide information of at least 1,500 farms to the European Commission as its contribution to the FADN. In addition to the number of farms, there are other requirements as well, e.g. the EC has requirements on the sampling process. Hence, the quality must be guaranteed. This research therefore focuses on the following research question: what is the quality of the Dutch FADN Sample for the year 2019? The following statistical quality aspects were included in the evaluation: coverage of the sampling frame (Chapter 2), representativeness (Chapter 3), and reliability (Chapter 4). In addition, there is an appendix with background information. 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 Good coverage of the sampling frame

2.1 Introduction

All agricultural companies together form the agricultural population. For the Dutch FADN, the Agricultural Census is used to select farms for FADN. Section 2.2 explains the background of the Agricultural Census and Section 2.3 describes the quality of this Census.

2.2 Overview

Based on the trade register of the Chamber of Commerce, companies are approached for the Agricultural Census and other administrative purposes, where additional information on the agricultural activities is collected to describe the structure of the Dutch agricultural sector (data on farms, livestock, crops and special topics). Theoretically, all agricultural companies in the Netherlands are registered in this trade register. The Agricultural Census is the data source upon which the FADN sample is based. Ideally, 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. The number of farms included in this sampling frame can differ from the number in the target population due to non-response in the agricultural census and errors in the specification of the farm.

When recruiting 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, this implies that only after approaching the farms it can be determined whether the farms meet the criteria or not, since the defined criteria cannot be applied to the Agricultural Census.

[2] 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.

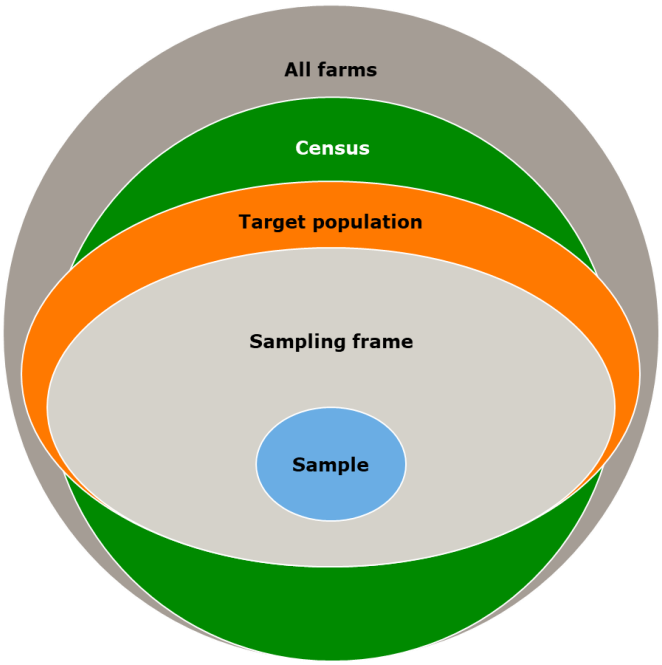

Figure 2.1 *Relationship between target population, sampling frame and sample*

2.3 Coverage

For the Dutch FADN, a minimum economic size of €25,000 SO has been applied according to EU legislation (see EU Regulation 2015/220), for the definition of the target population. In 2019, 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). This is different compared to 2010; when 19,993 farms of the census were not part of the target population of FADN, which was 1.1% of the total production capacity expressed in SO (van der Veen et al., 2012).

Table 2.1 *Number of farms and their relative economic importance (measured in total SO) in the 2019 Agricultural Census compared to the target population*

	Number of farms	Percentage of farms (%)	Percentage of SO (%)
All farms in the Agricultural Census (a)	53,233	100	100
Farms with less than €25,000 SO (b)	8,812	16.55	0.48
Farms above minimum threshold (a) – (b)	44,421	83.45	99.52

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. After years of increase, a decreasing number of sample farms included in the FADN are not included in the Agricultural Census compared to previous year.

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

Accounting year	Number of farms missing
2014	6
2015	38
2016	53
2017	67
2018	73
2019	52

3 The selection plan covers all farm types and size classes

3.1 Introduction

According to the EU directive on sample selection, the selection plan is a key document which specifies how the selection activities are organised, initiated and conducted in accordance with the regulations of the EU including requirements on the sampling process and the quality of the sample. 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 in the target population (Section 3.4)
4. Distribution of sample farms per farm type 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 because of their relevance for policy makers (such as starch potatoes). 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 2019, it was investigated whether it makes sense to keep the starch potatoes as a separate farm type because of the reduced policy importance by phasing out the single farm payment to the hectare payment that will be the same for all farms from 2019 onwards. Due to the introduction of the flat rate, the allowances of the starch potato farms converged towards the level of the other arable farms. The flat rate was fully implemented in 2019. To be able to continue to monitor the effect on business development and sustainability indicators, it is proposed to continue to maintain the starch potato companies as a separate group (for at least) up to and including 2020. However, no new starch potato companies will be recruited, which means that the number of sample companies might decrease.

In the Dutch FADN, the following subsectors are distinguished in the horticulture sector: tomatoes, cucumbers, sweet peppers and other horticulture (including combinations of the above). For reliable analyses of these subsectors it is necessary that a sufficient number of companies per subsector are included in the Dutch FADN. However, the number of horticulture companies in the Agricultural Census is declining as a result of economies of scale. In addition, not all horticulture companies are registered in the Agricultural Census. This raises the question of whether it is still possible and useful to continue to distinguish the subsectors.

Researchers from Wageningen Economic Research indicated that it is important to maintain the subsectors for analysing developments in horticulture cultivation. For example, for energy consumption, it makes a big difference whether it concerns a tomato company or a radish company. It is therefore proposed to continue to distinguish the sub-sectors in the sampling plan. If the number of companies in a subsector drops below 20 for several years, a new assessment will be made as to whether it is possible to maintain the individual subsectors. Actions are also being taken to increase the success rate of the recruitment of companies from the Agricultural Census. For example, interviews were conducted about the underlying reasons why approached companies do not want to participate.

In 2019 it was known that from 2024, the keeping of fur animals would be banned in the Netherlands (in the meantime a ban has already been implemented). In the Netherlands, in practice this only concerns companies with mink. The mink farms in the Dutch sampling plan fall under other intensive livestock. The group of other intensive livestock farms is a very diverse group, which is not reported about separately. The group of other intensive livestock farms is, however, relevant when reporting on agriculture and horticulture as a whole. About a quarter of the type of other intensive livestock farms consists of mink farms. It was therefore decided to stop recruiting mink farms, resulting in a short decrease in the number of farms.

In addition, the number of farms with eggs for consumption has been increased, so that the reporting group is sufficiently large. Finally, additional farms have been added to tree nurseries, because the EU companies are used in the research for this specialised farm 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) and or variety of crops within a farm type. The selection plan largely matches the numbers of farms that would be expected based on the criteria of economic importance, heterogeneity and number of farms. The distribution differs, depending on which criteria are applied. 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). Compared to the selection plan of 2018, there are small changes in the number of sample farms for starch potato (-5), tree nursery (+5), eggs for consumption (+5) and other intensive livestock (-5). The considerations for these changes have already been discussed in the previous section.

3.4 Stratification scheme

EU Regulation 2015/220 specifies the size classes and puts restrictions on the clustering of size classes. The variance of the size (in SO) of each clustering scheme, is calculated and used to determine the optimum clustering scheme (Appendix 1) per farm type. 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. For the 2019 selection plan, there have been no changes in the optimum clustering scheme. Table 3.1 shows the optimum clustering scheme for each type of farming for the 2019 target population.

Table 3.1 *Clustering scheme 2019 (size classes in a single colour in one row represent one stratum)*

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

The clustering scheme is primarily based on the method of Neyman Allocation (Neyman, 1934). The result of 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 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 for that type has been increased.

3.5 Sample farms per stratum

Table 3.2 presents the optimum selection plan for 2019, 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 (according to the agricultural census). Given that the maximum number of sample farms is limited to 10% of the population, this leads to fewer sample farms within that stratum. This applies for example to other horticulture farms.

Table 3.2 *Selection plan per stratum 2019*

Lower threshold (€ 1,000 SO)	**25**	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**	**Total**
Upper threshold (€ 1,000 SO)	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**	**infinity**	
Type of farm										
Field crop farms										
- Starch potatoes	2		10	6	7					25
- Organic crops	4		9	12	5					30
- Other field crops	25		37	35	38		15			150
Horticulture										
Vegetables under glass	2		27		25		17	33	26	130
Flowers under glass	4		26		29		20	23	16	118
Plants under glass	2		11		6		10	15	21	65
Field vegetables	4		28		11		12			55
Fruit	2		7	13	10		6			38
Tree nursery	3		32		21		19			75
Flower bulbs	2		9		11		15			37
Other horticulture	2		9		7		27			45
Grazing livestock										
Dairy (organic)	1		6	15	8					30
Dairy (non-organic)	4		34	128	65	25	44			300
Calf fattening	2		9		2	7	20			40
Goats	2		3	9	12		4			30
Other grazing livestock	5	13	4	4	7					33
Intensive livestock										
Pig rearing	1		2	9	13		23			48
Pig fattening	1		5	5	7		30			48
Combined pig rearing and fattening	1		1	3	6		27			38
Eggs for consumption	2		4		8		21			35
Broilers	1		4		5		20			30
Other intensive livestock	1		4		6		14			25
Combined	3		7	14	28		23			75
Total										1,500

The sampling fractions, the ratio of the size of the sample to that of the population (Cochran, 1977), 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 The sample meets the evaluation standards

The evaluation of the sample is based on the level of response, statistical reliability and representativeness. These criteria are discussed in separate paragraphs in this chapter.

4.1 Level of 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. It also happens that farms stop or no longer want to participate, and therefore new farms have to be recruited. To meet the required number of farms for delivery to the European Commission, a successful recruitment process is important.

For agricultural and rural surveys, response rates are widely considered to be an essential measure of the quality of the population sample (Zahl-Thanem et al., 2021). The decline in response rates over the last decades has raised concerns about both the representativeness of samples and the potential non-response bias (Coon et al., 2019). Stedman et al. (2019) found an annual decline in response rates of 0.76% between 1971 and 2017 (R^2 = 0.60). Low response rates provide the potential for biased sample returns and, consequently, attention needs to be paid to identifying means of maintaining or enhancing the response rate. However, response rates reveal nothing about the extent to which bias is present, in which population subgroups bias might be occurring, and/or which parts are subject to bias (Stedman et al., 2019). This means that a relatively low response rate requires attention.

Farms are selected in the sample from the Agricultural Census. Addresses for the selected farms are requested from the Netherlands Enterprise Agency. The farms are then approached to ask if they would be interested in taking part in the Farm Accountancy Data Network. Almost 500 farms were approached for the sample for 2019. Some of these farms (16%) were unsuitable for inclusion in the sample, for example because the entrepreneur stopped the farm operations or will stop 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 enterprise. Ultimately, almost 80 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 10% and 25% for several years. The response rate is rising for the second year in a row. The efforts to increase the response rate therefore seem to be working. More details about the response rate can be found in Appendix 5.

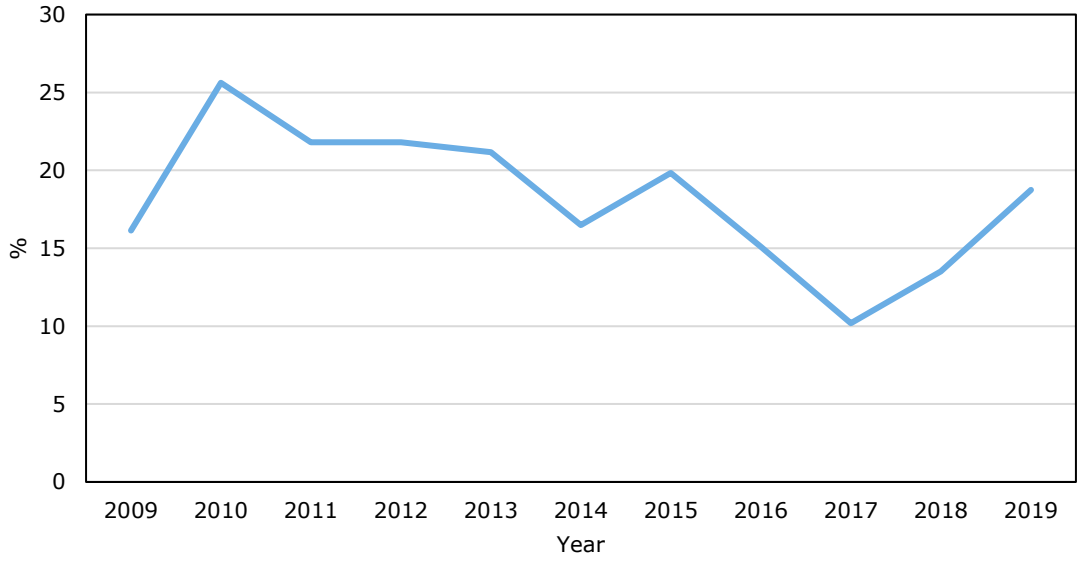

Figure 4.1 *Response rates, 2009-2019*

4.2 Statistical reliability

Reliability is about the consistency 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 of the true population value, given a particular 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 7,120 for field crop farms signals that the average farm income on such farms can vary within the confidence interval; average +/- 1.96 * 7,120 (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 relative standard error 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 a) variant (2019)*

Type of farming	**Goal variable**			
	Farm income, €	**Total revenues, €**	**Profitability b)**	**Total income, €**
Field crops	5,436	11,778	1.9	6,478
	0.11	*0.04*	*0.02*	*0.10*
Vegetables under glass	41,716	288,479	1.7	41,730
	0.10	*0.11*	*0.02*	*0.10*
Cut flowers under glass	47,357	205,135	2.4	47,324
	0.17	*0.11*	*0.02*	*0.17*
Pigs	21,748	63,368	1.4	21,963
	0.06	*0.05*	*0.01*	*0.06*
Poultry	24,397	118,984	2.0	25,141
	0.19	*0.10*	*0.02*	*0.18*
Grazing livestock	3,668	18,052	1.3	3,697
	0.05	*0.05*	*0.02*	*0.05*
All farms	3,446	18,614	0.8	3,519
	0.03	0.03	0.01	0.03

a) Corporate Social Performance (CSP) 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; b) 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 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 (Section 3.3).

4.3 Representativeness

The representativeness (interpreted as the absence of 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 none of the main farm types, there is a significant difference in the acreage per farm and the SO per farm between the sample and the target population. Compared to 2018, no changes are observed.

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	223,551	239,734	NS a)	56.1	61.6	NS
Horticulture under glass	2,157,791	1,907,847	NS	5.1	5.5	NS
Horticulture open air	511,545	591,564	NS	19.7	22.5	NS
Dairy farms	425,209	433,235	NS	56.3	58.1	NS
Poultry farms	1,094,885	1,035,982	NS	-	-	-
Pig farms	989,787	938,399	NS	-	-	-

a) NS = nonsignificant.

The sampling plan is based on farm types (e.g. open-air vegetable growers) and not on the underlying crops or animals present on the farm (e.g. cauliflower). This can result in certain crops or animals being under- 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 for the other categories do arise, they are in general not significant because of a large dispersion.

5 Conclusions

This report describes the sample of the Dutch FADN for the accounting year 2019 - from the determination of the selection plan and the recruitment of farms to the quality control of the final sample. This research assessed the quality of the Dutch FADN Sample for the year 2019. The following statistical quality aspects were included in the evaluation: coverage of the sampling frame (Chapter 2), representativeness (Chapter 3), and reliability (Chapter 4). The coverage of the sampling frame turned out to be good. In addition, it is shown that the sample is a good representation of the different farming types and farm sizes in the Netherlands. Lastly, it is concluded that the sample meets the evaluation standards. Hence, the quality of the sample of the Dutch FADN for accounting year 2019 is good. Recommendations for future research include the increase of the response rate and to document reasons for non-response to learn from that and to further increase the response rate.

Sources and literature

Australian Bureau of Statistics (2017). What is a Standard Error and Relative Standard Error, Reliability of estimates for Labour Force data: https://www.abs.gov.au/websitedbs/d3310114.nsf/Home/What+is+a+Standard+Error+and+Relative+Standard+Error,+Reliability+of+estimates+for+Labour+Force+data

Bethlehem, J. (2008). Wegen als correctie voor non-respons. Centraal Bureau voor de Statistiek (CBS). Statistische methoden (08005), Voorburg/Heerlen, Nederland.

Cochran, W.G. (1977). Sampling Techniques. New York: John Wiley & Sons.

Coon, J.J., C.J. van Riper, L.W. Morton and J.R. Miller (2019). Evaluating nonresponse bias in survey research conducted in the rural midwest. *Soc. Nat. Resour*. https://doi.org/10.1080/08941920.2019.1705950.

Eurostat (2019). Statistics explained: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Standard_output_(SO).

Everitt, B. S. (2003). *The Cambridge Dictionary of Statistics*. CUP. ISBN 978-0-521-81099-9.

FADN: https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/farms-farming-and-innovation/structures-and-economics/economics/fadn_en

Ge, L., R.W. van der Meer, H.B. van der Veen and H.C.J. Vrolijk (2017). Design principles and quality of the sample of agricultural and horticultural holdings. Report 2017-016 Wageningen Economic Research 2017.

Ge, L., and H.B. van der Veen (2018). 'Notitie vernieuwing van het steekproefplan voor het Bedrijven-Informatienet 2016' (Dutch). Internal Note Wageningen Economic Research.

Kruskal, W. and F. Mosteller (1979a). Representative sampling, I: Nonscientific literature. International Statistical Review, 47, 13–24.

Kruskal, W. and F. Mosteller (1979b). Representative sampling, II: Scientific literature, excluding statistics. International Statistical Review, 47, 113–127.

Kruskal, W. and F. Mosteller (1979c). Representative sampling, III: the current statistical literature. International Statistical Review, 47, 245–265.

Kruskal, W. and F. Mosteller (1980). Representative sampling, IV: the history of the concept in statistics, 1895 - 1939. International Statistical Review, 48, 169–195.

Neyman, J. (1934). On the two different aspects of the representative method: The method of stratified sampling and the method of purposive selection. *Jour. Roy. Stat. Soc.,* 97, 558-606.

Stedman, R.C., N.A. Connelly, T.A. Heberlein, D.J. Decker and S.B. Allred (2019). The end of the (research) world as we know it? Understanding and coping with declining response rates to mail surveys. *Soc. Nat. Resour.*, 32(10), 1139–1154.

Veen, H.B. van der, I. Bezlepkina, P. de Hek, R. van der Meer and H.C.J. Vrolijk (2012). Sample of Dutch FADN 2009-2010. Design principles and quality of agricultural and horticultural holdings. LEI-report 2012-061 November 2012, LEI Wageningen UR, The Hague.

Veen, H.B. van der, L. Ge, R. van der Meer and H.C.J. Vrolijk (2014). Sample of Dutch FADN 2012. Design principles and quality of agricultural and horticultural holdings. LEI-report 2014-027 December 2014, LEI Wageningen UR, The Hague.

Vrolijk, H.C.J. and K. Lodder (2002). Voorstel tot vernieuwing van het steekproefplan voor het Bedrijven-Informatienet. Report 1.02.02. LEI, The Hague, 2002.

Vrolijk, H.C.J. and G. Cotteleer (2005). Non-respons en rotatie in het Bedrijven-Informatienet. Kwantitatieve en kwalitatieve analyse van de effecten. Report 1.05.01 LEI, The Hague, 2005.

Zahl-Thanem, A., R.J. Burton and J. Vik (2021). Should we use email for farm surveys? A comparative study of email and postal survey response rate and non-response bias. *Journal of Rural Studies*, 87, 352-360.

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).

An 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 2019*

Lower threshold (€ 1,000 SO)	**25**	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**	**Total**
Upper threshold (€ 1,000 SO)	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**	**infinity**	
Type of farm										
Field crop farms										
- Starch potatoes	214		311	170	75					770
- Organic crops	119		137	78	60					394
- Other field crops	2,896		1,980	1,089	540		165			6,670
Horticulture										
Vegetables under glass	35		174		148		101	184	172	814
Flowers under glass	44		279		183		69	145	129	849
Plants under glass	18		108		95		62	138	186	607
Field vegetables	227		352		113		92			784
Fruit	286		410	392	172		66			1,326
Tree nursery	466		729		195		168			1,558
Flower bulbs	56		238		106		160			560
Other horticulture	278		597		219		263			1,357
Grazing livestock										
Dairy (organic)	6		128	257	98					489
Dairy (non-organic)	356		2,788	7,418	2,583	739	510			14,954
Calf fattening	89		476		233	188	297			1,283
Goats	32		44	83	157		70			386
Other grazing livestock	2,547	1,660	705	156	88					5,003
Intensive livestock										
Pig rearing	15		48	124	246		250			683
Pig fattening	179		341	291	312		348			1,471
Combined pig rearing and fattening	6		23	62	180		332			603
Eggs for consumption	20		238		174		215			647
Broilers	6		95		127		275			503
Other intensive livestock	11		159		154		184			508
Other										
Combined	737		634	571	528		292			2,762
Total										44,421

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 2019 Agricultural Census by stratum*

Lower threshold (€ 1,000 SO)	**25**	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**
Upper threshold (€ 1,000 SO)	**50**	**100**	**250**	**500**	**750**	**1,000**	**1,500**	**3,000**	**infinity**
Type of farm									
Field crops									
- Starch potatoes	0.01		0.03	0.04	0.09				
- Organic crops	0.03		0.07	0.15	0.08				
- Other field crops	0.01		0.02	0.03	0.07		0.09		
Horticulture									
Vegetables under glass	0.06		0.16		0.17		0.17	0.18	0.15
Flowers under glass	0.05		0.04		0.03		0.14	0.10	0.16
Plants under glass	0.22		0.24		0.31		0.32	0.17	0.09
Field vegetables	0.02		0.08		0.10		0.13		
Fruit	0.01		0.02	0.03	0.06		0.09		
Tree nursery	0.01		0.04		0.11		0.11		
Flower bulbs	0.04		0.04		0.10		0.09		
Other horticulture	0.01		0.02		0.03		0.10		
Grazing livestock									
Dairy (organic)	0.17		0.05	0.06	0.08				
Dairy (non-organic)	0.01		0.01	0.02	0.03	0.03	0.09		
Calf fattening	0.02		0.02		0.01	0.04	0.07		
Goats	0.06		0.20	0.14	0.00		0.06		
Other grazing livestock	0.00	0.01	0.01	0.03	0.08				
Intensive livestock									
Pig rearing	0.07		0.04	0.07	0.05		0.09		
Pig fattening	0.01		0.01	0.02	0.02		0.09		
Combined pig rearing and fattening	0.17		0.04	0.05	0.03		0.08		
Eggs for consumption	0.10		0.02		0.05		0.10		
Broilers	0.17		0.04		0.04		0.07		
Other intensive livestock	0.09		0.03		0.04		0.08		
Other									
Combined	0.00		0.01	0.02	0.05		0.08		

Appendix 5 Response rate by type of farm

Table A5.1 *Response rate in different types of farm, recruitment for CSP variant, 2018*

Farming types a)	Total farms approached	Unsuitable farms (%)	Response rate (%)
Field crops			
Organic crops	10	30	43
Other field crops	46	13	28
Horticulture			
Vegetables under glass			
- Sweet pepper	4	0	50
- Cucumber	25	4	25
- Other vegetable under glass	42	12	3
Flowers under glass	44	25	9
Plants under glass	42	26	13
Field vegetables	66	20	9
Tree nursery	36	14	6
Fruit growing	22	9	20
Grazing livestock			
Dairy	54	4	25
Calf fattening	15	0	20
Intensive livestock			
Pig rearing	22	36	29
Pig fattening	54	24	32
Combined pig rearing and fattening	7	14	0
Eggs for consumption	8	0	50
Total	497	16	19

a) Only farm types with recruiting activities are displayed.

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