Sample of Dutch FADN 2012

Design principles and quality of the sample of agricultural and horticultural holdings

H.B. van der Veen, L. Ge, R.W. van der Meer and H.C.J. Vrolijk

LEI WAGENINGEN UR

Sample of Dutch FADN 2012

Design principles and quality of the sample of agricultural and horticultural holdings

H.B. van der Veen, L. Ge, R.W. van der Meer and H.C.J. Vrolijk

This study was carried out by LEI Wageningen UR and was commissioned and financed by the Dutch Ministry of Economic Affairs within the context of the Statutory Research Tasks (WOT-06-001-006).

LEI Wageningen UR
Wageningen, december 2014

REPORT
LEI 2014-027
ISBN 978-90-8615-694-8

H.B. van der Veen, L. Ge, R.W. van der Meer and H.C.J. Vrolijk, 2014. *Sample of Dutch FADN 2012; Design principles and quality of the sample of agricultural and horticultural holdings.* Wageningen, LEI Wageningen UR (University & Research centre), LEI Report 2014-027. 48 pp.; 5 fig.; 23 tab.; 17 ref.

The EU Farm Accountancy Data Network (FADN) requires the Netherlands to yearly send bookkeeping data of 1,500 farms to Brussels. This task is carried out by LEI and CEI. This report explains the background of the farm sample for the year 2012. 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.

Het Europese Bedrijveninformatienet (RICA) vereist dat Nederland jaarlijks de boekhoudkundige gegevens van 1.500 boerderijen naar Brussel stuurt. Deze taak wordt uitgevoerd door het LEI en CEI. Dit rapport geeft toelichting op steekproef voor het jaar 2012. Alle fasen van het vaststellen van het selectie plan, de werving van deelnemers tot de kwaliteitscontrole van de uiteindelijke steekproef worden beschreven in dit rapport.

Key words: FADN, sample , population, evaluation.

This report can be downloaded for free at www.wageningenUR.nl/en/lei (under LEI publications).

P.O. Box 29703, 2502 LS Den Haag, The Netherlands, T +31 (0)70 335 83 30,
E informatie.lei@wur.nl, www.wageningenUR.nl/en/lei. LEI is part of Wageningen UR (University & Research centre).

LEI is ISO 9001:2008 certified.

LEI Report 2014-027

Cover photo: Hans Vrolijk

Contents

Preface

The EU Farm Accountancy Data Network (FADN) requires the Netherlands to yearly send bookkeeping data of 1,500 farms to Brussels. This task is carried out by LEI Wageningen UR and Centre for Economic Information (in Dutch, Centrum voor Economische Informatievoorziening, CEI). This report explains the background of the sample for the year 2012. 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. This report provides essential background information for the European Commission, the Dutch Ministry, researchers and other organisations to fully understand the statistical aspects of the Dutch FADN sample.

Ir. L.C. van Staalduinen
Director General LEI Wageningen UR

Dr. H.C.J. Vrolijk
Head CEI

Summary

S.1 Key results

For the bookkeeping year 2012, 1,521 farm reports have been delivered to the European Commission. The target number of 1,500 farms is reached. Farm data are of major importance in the evaluation of the agricultural policies and the monitoring of the economic developments in the agricultural sector.

In 2012, 68,810 agricultural and horticultural farms operate in The Netherlands. The Dutch FADN aims at farms with a Standard Output (SO) of 25,000 euros or more. This field of observation covers 48,817 farms in 2012. These farms are responsible for 99% of total national production capacity, measured in SO.

Ninety new farms were recruited for the accounting year 2012. The average response rate for farms to be asked to participate in FADN is 22%.

Table S.1 compares the averages in SO per farm of the population and the sample. For most of the variables, the differences are not significant, except for dairy (FADN larger) and horticulture under glass (FADN smaller). The difference for the last sector can be explained by the abolition of the upper threshold in 2010. For the dairy sector, no other explanation than sampling error can be found.

Table S.1
Comparison of farms in the agricultural census and farms in the Dutch FADN.

Variable	Average per farm 2012		
	Census ≥ 25,000 euros SO	FADN	Significant (5%)
Size (Standard Output)			
Total	396,497.18	394,449.63	
Arable crops	38,605.46	39,475.60	
Grassland	10,825.46	10,876.60	
Horticulture open air	49,259.52	51,757.93	
Horticulture under glass	102,762.99	89,475.01	*
Dairy	79,243.76	83,291.78	*
Fattening pigs	27,159.76	28,856.47	
Breeding pigs	22,652.61	23,593.38	
Broilers	9,774.51	9,863.53	
Laying hens	9,887.84	10,680.68	

S.2 Complementary results

An analysis of alternative survey weights shows that no single method is the best on all analysed aspects. The analysed aspects are representativeness, correlation with original weights and standard errors of report variables.

S.3 Background

Member states are obliged to have a network for the collection of accountancy data on the incomes and business operation of agricultural holdings. This task is carried out by LEI Wageningen UR and Centre for Economic Information (in Dutch, Centrum voor Economische Informatievoorziening, CEI). The main purpose of the data network is defined as the annual determination of incomes on agricultural holdings and a business analysis of agricultural holdings. For the Netherlands, The European Commission requires the yearly establishment of a selection plan describing the sample of agricultural and horticultural holdings in the Dutch FADN. The selection plan contributes to the harmonisation of the samples from different countries in the EU.

The agricultural census provides the sampling frame for selecting farms to be included in the FADN. Based on the most recent agricultural census, farms are assigned to strata, which are defined by type of farming and economic size class. Only farms greater than 25,000 euros SO were included in the sampling frame.

For each stratum the number of farms to be included in the Dutch FADN sample is determined. This number is dependent on the economic importance of a sector, the number of farms in a stratum, the policy relevance of a group and the heterogeneity of farms.

Samenvatting

S.1 Belangrijkste uitkomsten

Voor het boekhoudjaar 2012 zijn 1.521 bedrijfsverslagen aan de Europese Commissie geleverd. Het streefgetal van 1.500 bedrijven is dus gehaald. Data van agrarische bedrijven zijn van groot belang bij de evaluatie van landbouwbeleid en het monitoren van de economische ontwikkeling in de agrarische sector.

In 2012 zijn er 68.810 land- en tuinbouwbedrijven actief in Nederland. Het Nederlandse FADN richt zich op bedrijven met een Standaard Output (SO) van 25.000 euro of meer. Deze populatie bestaat uit 48.817 bedrijven in 2012. Deze bedrijven vertegenwoordigen 99% van de nationale productie capaciteit, gemeten in SO.

Negentig nieuwe bedrijven zijn geworven voor het boekjaar 2012. De gemiddelde response voor bedrijven die gevraagd werden deel te nemen is 22%.

Tabel S.1 vergelijkt de gemiddelden in SO per bedrijf van de populatie en de steekproef. Voor de meeste variabelen zijn de verschillen niet significant, behalve voor zuivel (steekproef groter) en glastuinbouw (steekproef kleiner). Het verschil voor de laatste sector kan verklaard worden door de afschaffing van de bovengrens in 2010. Voor de zuivelsector, kan geen andere verklaring dan steekproeffouten worden gevonden.

Table S.1
Vergelijking van de bedrijven in de landbouwtelling versus de bedrijven in de steekproef.

Variabele	Gemiddelde per bedrijf 2012		
	Landbouwtelling ≥ 25,000 euro SO	FADN	Significant (5%)
Omvang (Standard Output)			
Totaal	396,497.18	394,449.63	
Akkerbouw	38,605.46	39,475.60	
Gras	10,825.46	10,876.60	
Tuinbouw open grond	49,259.52	51,757.93	
Glastuinbouw	102,762.99	89,475.01	*
Melkvee	79,243.76	83,291.78	*
Vleesvarkens	27,159.76	28,856.47	
Fokzeugen	22,652.61	23,593.38	
Vleeskuikens	9,774.51	9,863.53	
Leghennen	9,887.84	10,680.68	

S.2 Overige uitkomsten

Uit een analyse van alternatieve wegingsfactoren blijkt dat geen enkele methode de beste is op alle geanalyseerde aspecten. Er is gekeken naar representativiteit, correlatie met originele gewichten en standaardfouten van rapportagevariabelen.

S.3 Achtergrond

Lidstaten zijn verplicht om een netwerk voor het verzamelen van de boekhoudkundige gegevens van landbouwbedrijven te hebben. Deze taak wordt in Nederland uitgevoerd door LEI Wageningen UR en het Centrum voor Economische Informatievoorziening (CEI). De doelen van het netwerk zijn om jaarlijks de inkomens van landbouwbedrijven vast te stellen en bedrijfsanalyses uit te voeren. De Europese Commissie vereist dat jaarlijks een selectieplan wordt opgesteld. Dit selectieplan draagt bij aan de harmonisatie van informatienetten in verschillende EU-landen.

De Landbouwtelling vormt het uitgangspunt voor het vaststellen van de steekproef voor het Bedrijveninformatienet. Op basis van de meest recente Landbouwtelling worden bedrijven ingedeeld in strata, die zijn gevormd op basis van het bedrijfstype en de economische omvang. Alleen bedrijven groter dan 25.000 euro SO vallen binnen het steekproefkader.

Voor elk stratum wordt vastgesteld hoeveel bedrijven in de steekproef moeten worden opgenomen. Dit aantal is afhankelijk van onder andere de economische betekenis van de sector, het aantal bedrijven in de groep, de beleidsrelevantie en de heterogeniteit van de bedrijven.

1 Introduction

1.1 Introduction

In 1965 the European Commission adopted a regulation (nr. 79/65/EEG) in which member states were obliged to set up a network for the collection of accountancy data on the incomes and business operation of agricultural holdings in the European Economic Community. The purpose of the data network is defined as the annual determination of incomes on agricultural holdings and a business analysis of agricultural holdings. The Netherlands were required to provide financial economic information on 1,500 farms to Brussels.
For the management of the system, the EU requires information on the selection of farms that are included in the national FADN system. In particular the regulation prescribes the provision of data on the establishment of a selection plan and the recruitment of farms. With respect to the selection plan the regulation EEG 1859/82 prescribes (article 6):

'Each Member State shall appoint a liaison agency whose duties shall be: …to draw up and submit to the National Committee for its approval, and thereafter to forward to the Commission: the plan for the selection of returning holdings, which plan shall be drawn up on the basis of the most recent statistical data, presented in accordance with the Community typology of agricultural holdings.'

1.2 Objective and structure of the report

This report of the year 2012 provides background information on the population, the selection plan, implementation of the selection plan and quality of the sample of data that is to be provided to Brussels and which forms the basis for a wide range of national and international research projects.

Chapter 2 gives a description of the background of the Dutch FADN system. Chapter 3 describes the agricultural population. This chapter will also consider the demarcation of the population as used in the Dutch FADN. Also the design of the sample of the Dutch FADN system is described. Chapter 4 reports on the selection plan. Chapter 5 provides information on the implementation of the selection plan and the recruitment of new farms. Chapter 6 provides a qualitative and quantitative evaluation of the sample.

2 Statistical background of the Dutch FADN sample

2.1 Introduction

In the Dutch FADN detailed records on 1,500 agricultural and horticultural farms are kept. Besides financial information, a broad set of technical, socio-economic and environmental data are collected. One of the reasons for the Dutch FADN system is the legal obligation to provide information on the financial economic situation of farms to Brussels. However, an even more important use of the data can be found at the national level. Data from the FADN system are used for many national policy evaluations and research projects.

Based on a sample of farms, estimations are made for the whole population. This might raise the question how conclusions can be drawn for the whole population if only a limited number of farms are observed. The answer to this question can be found in the selection of farms that are included in the sample. The same is true for the FADN sample. The farms that are included in the FADN should be representative of the whole population. In this way a sample can provide even better information than a census (in which all units are observed). With a fixed budget it is much easier to collect good data on a limited number of farms instead of collecting information on all farms. With a limited number of farms and thus a limited number of data collectors, it is easier to ensure good procedures and good training to collect reliable data.

An important issue is how to ensure that the farms that are included in the FADN sample are representative for the whole population. To this end, use is made of a disproportional stratified random sample. A *stratified* sample implies that the population is divided into a number of groups. Subsequently farms are selected from each of the groups. The variables that define these groups should be chosen such that the farms within one group are similar (at least with respect to the important aspects). The FADN sample distinguishes groups based on farm size and type of farming. Using stratification, and selecting farms from each group, ensures that farms from all groups and consequently with different characteristics are included in the sample.

Disproportional means that not all farms have the same chance of being included in the sample. Groups which are relatively homogeneous, i.e. farms which show large similarities, will have a lower chance of being included in the sample. After all, if all the farms are very similar, a limited number of observations is enough to draw reliable conclusions (in the extreme case that all farms are exactly identical, it would be enough to have only one observation). In case of less homogeneous groups it is important to have a larger number of observations to make reliable estimates. The choice of the stratification variables has therefore an important impact on the quality of the sample.
This way of selecting farms allows making unbiased estimates for the whole population of farms. Stratification assures that all groups are properly represented, thereby allowing separate estimations for all groups. All groups together make up the whole population. In the FADN this is achieved by assigning a weight to each sample farm. The weight is calculated by dividing the number of population farms in a group by the number of sample farms in the same group.

Stratification also improves the representativeness of the sample in case of non-response. If a farm which is asked to join the FADN system refuses, another farm in the same size class and of the same type of farming can be selected. If there is a difference between the selection plan and the actual implementation, stratification helps to improve the representativeness by taking into account the real sampling fraction.

Finally, stratification makes maintenance of the sample easier. Due to attrition and changes in the population it is sometimes necessary to supplement certain groups. Stratification makes a more focused replacement possible.

The relationship between the agricultural population and the FADN sample is presented in Figure 2.1. The agricultural census provides an almost complete description of the agricultural population. Part of this census or part of this population is defined as the field of observation in the FADN.

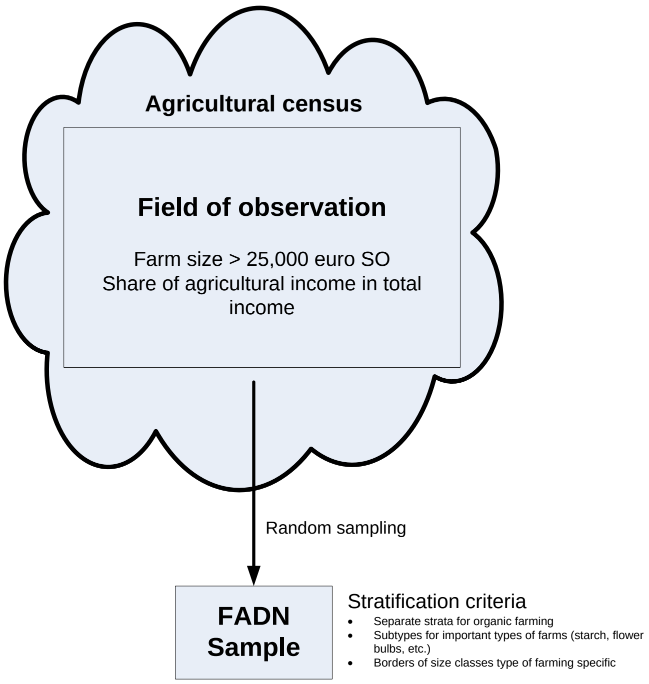

Figure 2.1 *Agricultural population and the FADN sample.*
Source: Vrolijk et al. (2009a).

Output measure
In 2010, the Standard Output measure was introduced in FADN as the basis for determining the farm economic size, replacing the previously used Standard Gross Margin (SGM) and accompanying European Size Unit (ESU). Standard Output refers to the standard value of gross production. The Standard Output of an agricultural product (crop or livestock), abbreviated as SO, is the average monetary value of the agricultural output at farm-gate price, in euros per hectare or per head of livestock. There is a regional SO coefficient for each product, as an average value over a reference period (5 years). The Netherlands consists of one region. The sum of all the SO per hectare of crop and per head of livestock in a farm is a measure of its overall economic size, expressed in euros.

Lower threshold
A lower threshold of 25,000 euros SO is applied. This threshold has been specified in the legislation underlying the FADN. The historical background was to distinguish small farms which were only held as a hobby or as side activity from real commercial farms producing for the market. Although the number of farms excluded from the field of survey is quite substantial, the percentage of production value which is not covered due to this threshold is very limited.

Other income sources
For practical and methodological reasons a limitation on ‘other income of the holding’ is used. Clear rules have been specified whether a firm belongs to the field of observation or not. A firm should have at least 25,000 euros SO from primary agricultural activities, at least 25% of the turnover should come from primary agricultural activities and agricultural activities - in the broadest sense, so as to include other gainful activities - should be the largest share of turnover of the holding.

Stratification criteria
Given the above mentioned criteria the field of observation of the FADN system is defined. Within this field of observation a stratification scheme is used. The stratification of the Dutch FADN is based on the economic size of the farm and type of farming. Although these criteria are similar to those used by the Commission, a more detailed look reveals substantial differences with the EU stratification. Differences are for example the use of separate strata for organic farming, and in several types of farming more detailed subtypes of farming are specified which are relevant for Dutch Agriculture (for example starch potato farms, flower bulb farms, horticultural farms by type of production).
The Dutch situation is somewhat more complicated compared to many other Member States due to the fact that the size classes vary across types of farming. The size distribution of, for example, horticultural farms is completely different from the size distribution of arable farms. For 2012, this is illustrated in figure 2.2. This figure shows that 99% of all arable farms are smaller than 1,000,000 euros SO, while almost 80% of the tomato firms are larger than 1,000,000 euros SO (the dashed line marks the 1,000,000 euros SO level). To take these differences into account the borders of the size classes have been established for each type of farming separately. Despite this complication the strata are still a cross section between types of farming and size-classes. In total 129 strata have been defined.

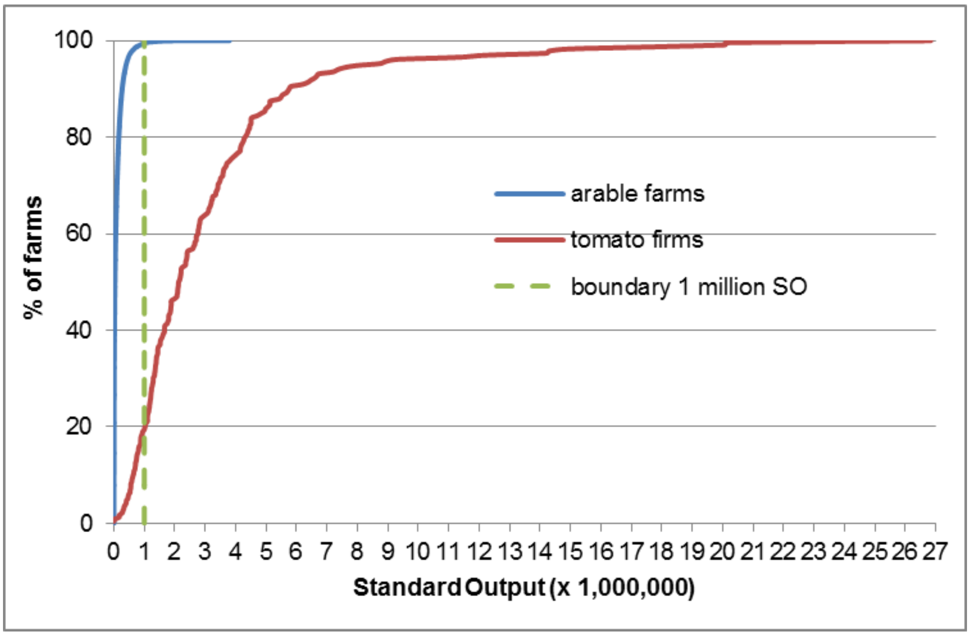

Figure 2.2 *Distribution of arable farms and tomato firms in 2012.*
Source: Agricultural Census, Statistics Netherlands, calculations LEI Wageningen UR.

2.2 Sampling and recruitment processes

Figure 2.3 presents an overview of the sampling and recruitment processes. The agricultural census from Statistics Netherlands (CBS) is the starting point for the random sampling of farms. The random sampling takes place based on the selection plan as submitted to the European Commission. The selection plan will be further described in Chapter 4. Based on the selection plan, farms from the agricultural census are randomly drawn. This census (as available to researchers) does not contain addresses but only farm identifiers. The farm addresses from the selected farms are received from the ministry of Economic Affairs. Farm identifiers are coupled to their addresses and forwarded to the regional offices that are responsible for contacting farmers to request their participation. The farmers either refuse or accept the request to participate and the authorisations are collected and forwarded the central office in The Hague. These authorisations are used to receive electronically available information from banks, suppliers, governmental institutions and others. The information on the acceptance and refusal of farmers is also used to verify the quality of the sample (see Chapter 6).

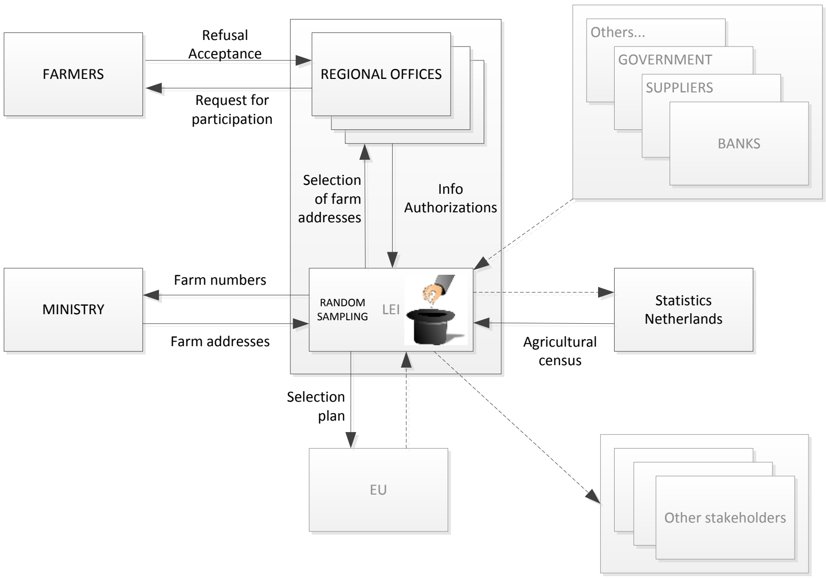

Figure 2.3 *Sampling and recruitment processes.*
Source: Vrolijk et al. (2009a).

3 Introduction

This chapter describes the population or, more precisely, the field of observation as covered by the FADN sample. The lower threshold and the consequences of its application will be described in section 3.2. Section 3.3 describes the strata which are used to divide the population. Section 3.4 reports the number of farms in each of the strata.

3.1 Defining the field of observation

Collecting detailed information at farm level requires considerable time and money. To assure an efficient and effective allocation of the available budget, the sample design focuses on certain groups in the population. Given the limited capacity it is important to apply a sampling procedure that optimises the reliability of the sample estimates (through stratification).

In 2012, a lower threshold of 25,000 euros SO implied that 19,993 farms were not covered by the FADN sample. This is a large number of farms, but they are only responsible for 1.09% of the total production capacity expressed in SO. The 2012 population (field of observation) of the Dutch contribution to the EU FADN system is displayed in Table 3.1.

Table 3.1

Number of farms and their relative economic importance (measured in Standard Output - SO) in the 2012 agricultural census.

	Number of farms	Percentage SO
All farms in the agricultural census (a)	68,810	100.00
Farms less than 25,000 euros SO (b)	19,993	1,09
Total of covered farms (a) - (b)	48,817	98,91

Source: Agricultural Census, Statistics Netherlands and FADN, calculations by LEI Wageningen UR.

3.2 Stratification scheme in 2012

Farms are allocated to strata according to the following stratification variables:

- Type of farming. The number of size classes within a type of farming in 2012 ranges from 4 to 6 (see Table 3.2).
- Size class. In total 25 types of farming are distinguished (see Table 3.2).

The Dutch FADN typology differs in its degree of details from the European FADN (FADN, 2012): some farm types are not present in Dutch agriculture (e.g. olives, citrus fruits are not listed) and some types are further detailed (like vegetables within horticulture). For a number of types of farming a distinction is made between organic farming and non-organic farming. A compromise was found to fulfil the increasing demand for research on organic farms. Random selection of organic farms from the total population would result in a very low number of observations because of the low proportion of organic farms. The definition of separate strata would result in many practical problems. The number of strata would double. The problem of empty or nearly empty strata would increase seriously. In line with the existing stratification, a number of types of farming were selected where organic farming is especially relevant. The types that were originally selected were: field crop farms, dairy farms, field vegetables and combined crop farms (Vrolijk and Lodder, 2002). The growth in the organic sector however was lower than expected and aimed for by policy makers. This resulted in practical problems in the recruitment of organic farms, for example due to the fact that the number of farms according to the selection plan was close to or even higher than the actual number of farms in the population. To deal with this problem a number of organic strata have been combined. 'Organic field crops farms' , field vegetables' and 'combined crop farms' have been integrated in one stratum 'organic crop farms' (Vrolijk, 2006).

The breakdown in subtypes is as follows: 'field crop farms' have been itemised in 'starch potato farms', 'organic crops' and all 'other field crop farms'. The 'vegetables under glass' farms have been broken down in 'sweet pepper', 'cucumber', 'tomato' and 'other'. 'Cut flowers under glass' are divided into roses', 'chrysanthemums' and 'other cut flowers'. The dairy farms are split into organic and non-organic dairy farms. Within 'field vegetables' and the combined crop farms' the organic farms have been separated. These are subsequently combined with the organic field crop farms.

Table 3.2 presents the number of farms in the 2012 population according to size class and type of farming. The table shows that 48,817 (compared to 50,557 in 2011) farms fall within the field of observation. Dairy farms are clearly the largest group of farms. About one in every three farms is classified as a dairy farm.

Table 3.2

Stratification of the Dutch FADN sample 2012, including the number of farms per stratum according to the 2012 agricultural census.

<table>
<tr><th>lower boundary (k€ SO)</th><th>25</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th rowspan="2">Total</th></tr>
<tr><th>upper boundary (k€ SO)</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th>infinity</th></tr>
<tr><td colspan="10">Type of farming</td></tr>
<tr><td colspan="10">Field crop farms</td></tr>
<tr><td>- Starch potatoes</td><td colspan="2">323</td><td>358</td><td>87</td><td colspan="4">20</td><td>788</td></tr>
<tr><td>- Organic crops</td><td colspan="2">89</td><td>90</td><td>53</td><td colspan="4">20</td><td>252</td></tr>
<tr><td>- Other field crop farms</td><td colspan="2">2,830</td><td>1,914</td><td>905</td><td colspan="4">338</td><td>5,987</td></tr>
<tr><td colspan="10">Horticulture</td></tr>
<tr><td colspan="10">Vegetables under glass</td></tr>
<tr><td>- Sweet pepper</td><td colspan="2">1</td><td colspan="2">18</td><td>48</td><td>46</td><td>58</td><td>49</td><td>220</td></tr>
<tr><td>- Cucumber</td><td colspan="2">1</td><td colspan="2">25</td><td>56</td><td>41</td><td>49</td><td>8</td><td>180</td></tr>
<tr><td>- Tomato</td><td colspan="2">1</td><td colspan="2">12</td><td>31</td><td>40</td><td>63</td><td>84</td><td>231</td></tr>
<tr><td>- Other</td><td colspan="2">90</td><td colspan="2">240</td><td>89</td><td>26</td><td>30</td><td>11</td><td>486</td></tr>
<tr><td>Cut flowers under glass</td><td colspan="2">78</td><td colspan="2">476</td><td>333</td><td>168</td><td>207</td><td>85</td><td>1347</td></tr>
<tr><td>Plants</td><td colspan="2">65</td><td colspan="2">228</td><td>169</td><td>124</td><td>141</td><td>125</td><td>852</td></tr>
<tr><td>Field vegetables</td><td colspan="2">269</td><td colspan="2">391</td><td>91</td><td colspan="3">61</td><td>812</td></tr>
<tr><td>Fruit</td><td colspan="2">425</td><td>491</td><td>378</td><td colspan="4">138</td><td>1,432</td></tr>
<tr><td>Tree nursery</td><td colspan="2">728</td><td colspan="2">1,144</td><td>277</td><td colspan="3">202</td><td>2,351</td></tr>
<tr><td>Flower bulbs</td><td colspan="2">109</td><td colspan="2">271</td><td>131</td><td colspan="3">122</td><td>633</td></tr>
<tr><td>Other horticulture</td><td colspan="2">465</td><td colspan="2">864</td><td>230</td><td colspan="3">217</td><td>1,776</td></tr>
<tr><td colspan="10">Grazing livestock</td></tr>
<tr><td colspan="10">Dairy</td></tr>
<tr><td>- Organic</td><td colspan="2">32</td><td>205</td><td>91</td><td colspan="4">17</td><td>345</td></tr>
<tr><td>- Non-organic</td><td colspan="2">1,085</td><td>7,602</td><td>6,703</td><td colspan="4">1,072</td><td>16,462</td></tr>
<tr><td>Calf fattening</td><td colspan="2">228</td><td colspan="2">530</td><td>365</td><td colspan="3">184</td><td>1,307</td></tr>
<tr><td>Other grazing livestock</td><td>2,772</td><td>1,365</td><td>595</td><td>212</td><td colspan="4">74</td><td>5,018</td></tr>
<tr><td colspan="10">Intensive livestock</td></tr>
<tr><td>Breeding pigs</td><td colspan="2">30</td><td>121</td><td>350</td><td>343</td><td colspan="3">191</td><td>1,035</td></tr>
<tr><td>Fattening pigs</td><td colspan="2">460</td><td>653</td><td>398</td><td>305</td><td colspan="3">187</td><td>2,003</td></tr>
<tr><td>Integrated pig farms</td><td colspan="2">6</td><td>55</td><td>189</td><td>330</td><td colspan="3">242</td><td>822</td></tr>
<tr><td>Consumption eggs</td><td colspan="2">47</td><td colspan="2">311</td><td>188</td><td colspan="3">115</td><td>661</td></tr>
<tr><td>Broilers</td><td colspan="2">8</td><td colspan="2">97</td><td>147</td><td colspan="3">174</td><td>426</td></tr>
<tr><td>Other intensive livestock</td><td colspan="2">40</td><td colspan="2">260</td><td>227</td><td colspan="3">112</td><td>639</td></tr>
<tr><td>Combined</td><td colspan="2">771</td><td>723</td><td>726</td><td>417</td><td colspan="3">115</td><td>2,752</td></tr>
<tr><td>Total</td><td colspan="8"></td><td>48,817</td></tr>
</table>

4 Selection plan

4.1 Introduction

The allocation of the total capacity of sample farms is based on the relative importance and the heterogeneity of the different types of farming (see Dijk *et al.*, 1995a and Vrolijk and Lodder, 2002). Several strata may be combined for an optimal stratification (determination of thresholds of size classes) and optimal allocation (distribution of sample capacity over the different size classes) has been applied.

4.2 Selection plan

The design principles of the sample of the FADN system facilitate an efficient alignment with the goals of the system (see Chapter 2). A summary of the 2012 selection plan is provided in table 4.1. Given the goals of the FADN system the numbers provided in the table are the required number of observations per type of farming. The 2012 selection plan has not changed compared to the 2011 selection plan.

Table 4.1

Desired sampling size per type of farming (selection plan), 2012.

Type of farming	Code	Number of farms		
		Main type	Type	Sub type
Field crop farms	1	210		
- Starch potatoes			30	
- Organic crops			30	
- Other field crop farms			150	
Horticulture		550		
Vegetables under glass	2111		130	
- Sweet pepper				31
- Cucumber				29
- Tomato				30
- Other				40
Cut flowers under glass	2121		120	
- Rose				23
- Chrysanthemum				23
- Other				74
Plants	2122		70	
Other horticulture	2131, 2310, 2331, 3500, 3699		40	
Field vegetables	2210		45	
Fruit	3610		45	
Tree nursery	2320		55	
Flower bulbs	2221		45	
Grazing livestock		420		
Dairy	4500		330	
- Non-organic				300
- Organic				30
Calf fattening	4611		40	
Other grazing livestock	4612, 4810, 4830, 4841, 4842, 4843		50	
Intensive livestock		230		
Breeding pigs	5111		50	
Fattening pigs	5121		50	
Integrated pig farms	5131		40	
Consumption eggs	5211		30	
Broilers	5221		30	
Other intensive livestock	5231, 5301		30	
Combined	6, 7, 8	90		
Total		1,500		

5 Recruitment of farms

5.1 Basic principles

In October 2011, an assessment was made of the farms available for the FADN system for 2012 (considering farms dropping out of the system). The recruitment of new farms for the year 2012 took place from October 2011 to February 2012).

5.2 Elaboration of selection plan

Table 5.1 gives a more detailed description of the 2012 selection plan as presented in Table 4.1.

Table 5.1

Detailed selection plan 2012 per stratum.

<table>
<tr><th>lower boundary (K€ SO)</th><th>25</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th rowspan="2">Total</th></tr>
<tr><th>upper boundary (K€ SO)</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th>infinity</th></tr>
<tr><td>Type of farming</td><td colspan="9"></td></tr>
<tr><td>Starch potatoes</td><td colspan="2">8</td><td>14</td><td>5</td><td colspan="4">3</td><td>30</td></tr>
<tr><td>Organic crops</td><td colspan="2">5</td><td>12</td><td>9</td><td colspan="4">4</td><td>30</td></tr>
<tr><td>Other field crops</td><td colspan="2">37</td><td>52</td><td>35</td><td colspan="4">26</td><td>150</td></tr>
<tr><td>Vegetables under glass</td><td colspan="2">5</td><td colspan="2">43</td><td>35</td><td>16</td><td>19</td><td>12</td><td>130</td></tr>
<tr><td>Plants under glass</td><td colspan="2">5</td><td colspan="2">15</td><td>15</td><td>8</td><td>14</td><td>13</td><td>70</td></tr>
<tr><td>Flower under glass</td><td colspan="2">7</td><td colspan="2">39</td><td>30</td><td>16</td><td>22</td><td>6</td><td>120</td></tr>
<tr><td>Field vegetables</td><td colspan="2">11</td><td colspan="2">21</td><td>7</td><td colspan="3">6</td><td>45</td></tr>
<tr><td>Flower bulbs</td><td colspan="2">8</td><td colspan="2">11</td><td>12</td><td colspan="3">14</td><td>45</td></tr>
<tr><td>Other horticulture</td><td colspan="2">8</td><td colspan="2">12</td><td>8</td><td colspan="3">12</td><td>40</td></tr>
<tr><td>Tree nurseries</td><td colspan="2">7</td><td colspan="2">20</td><td>13</td><td colspan="3">15</td><td>55</td></tr>
<tr><td>Fruits</td><td colspan="2">8</td><td>18</td><td>12</td><td colspan="4">7</td><td>45</td></tr>
<tr><td>Organic dairy</td><td colspan="2">5</td><td>15</td><td>9</td><td colspan="4">1</td><td>30</td></tr>
<tr><td>Non-organic dairy</td><td colspan="2">20</td><td>130</td><td>110</td><td colspan="4">40</td><td>300</td></tr>
<tr><td>Calf fattening</td><td colspan="2">5</td><td colspan="2">14</td><td>11</td><td colspan="3">10</td><td>40</td></tr>
<tr><td>Other grazing livestock</td><td>8</td><td>11</td><td>15</td><td>7</td><td colspan="4">9</td><td>50</td></tr>
<tr><td>Breeding pigs</td><td colspan="2">3</td><td>6</td><td>18</td><td>13</td><td colspan="3">10</td><td>50</td></tr>
<tr><td>Fattening pigs</td><td colspan="2">6</td><td>11</td><td>12</td><td>12</td><td colspan="3">9</td><td>50</td></tr>
<tr><td>Integrated pig farms</td><td colspan="2">5</td><td>8</td><td>9</td><td>9</td><td colspan="3">9</td><td>40</td></tr>
<tr><td>Consumption eggs</td><td colspan="2">4</td><td colspan="2">10</td><td>8</td><td colspan="3">8</td><td>30</td></tr>
<tr><td>Other intensive livestock</td><td colspan="2">5</td><td colspan="2">12</td><td>8</td><td colspan="3">5</td><td>30</td></tr>
<tr><td>Broilers</td><td colspan="2">1</td><td colspan="2">7</td><td>8</td><td colspan="3">14</td><td>30</td></tr>
<tr><td>Combined farms</td><td colspan="2">10</td><td>18</td><td>28</td><td>22</td><td colspan="3">12</td><td>90</td></tr>
<tr><td>Total</td><td colspan="8"></td><td>1,500</td></tr>
</table>

5.3 Recruitment of farms

Based on the available number of farms in the FADN sample and the expected number of farms ending their participation before or during 2012 an estimate was made of the number of farms to be recruited. Furthermore, the variant of bookkeeping has been explicitly considered. Poppe (2004) describes that the introduction of a new bookkeeping system and budget cuts resulted in a large pressure on available capacity. To deal with this pressure, a flexible data collection system has been introduced with two main variants in the data collection: the EU variant and the Corporate Social Performance (CSP) variant. In the EU farm-income variant the most essential financial economic information is collected. This is the information that each member state is obliged to provide to

Brussels. The information covered in this variant mainly focuses on family farm income, the balance sheet, a limited number of technical data (cropping pattern, livestock) and information on the EU subsidies. In the second variant, the CSP variant, a wide range of data is collected for EU and national purposes. It covers all the topics that are nowadays considered relevant in a report on the sustainability of a company or a farm. Therefore, besides the financial economic information as collected in the EU variant, a wide range of data is collected such as environmental data, other farm incomes, off-farm income, animal welfare, animal health and the level of innovation of firms.
An evaluation has been made of the policy and research relevance of sectors and based on this importance a decision has been made whether a type of farming is assigned to the EU variant, the CSP variant or a combination of both.

Based on the number of farms to be recruited, the 2012 farms were randomly selected from the 2011 agricultural census. The random draw of farms took place per stratum. The number of farms drawn per stratum was 10 times higher than the required number of farms to ensure enough addresses, even with a high non-response rate in specific types of farming. Using these addresses farms were contacted and asked to participate in the FADN.

Ninety new farms were recruited for the accounting year 2012. The average response rate is 22%. Despite the effort, no new tree nursery firms were willing to participate.

Table 5.2[1]

Response rate in different types of farming, recruitment for CSP variant, 2012

Farming types a)	Number of refusals	Recruited farms	Unsuitable farms	Total farms	Unsuitable %	Response %
Field crop farms						
- Other field crop farms	6	3	2	11	18	33
Horticulture						
Vegetables under glass						
- Tomato	16	3	11	30	37	16
- Other	32	7	27	66	41	18
Cut flowers under glass						
- Rose	14	8	10	32	31	36
- Chrysanthemum	10	3	8	21	38	23
- Other	72	18	41	131	31	20
Plants	3	1	1	5	20	25
Fruit	10	4	4	18	22	29
Tree nursery	3	0	5	8	63	0
Flower bulbs	50	13	18	81	22	21
Grazing livestock						
Other grazing livestock	11	2	6	19	32	15
Intensive livestock						
Breeding pigs	36	17	16	69	23	32
Fattening pigs	13	2	1	16	6	13
Integrated pig farms	19	5	12	36	33	21
Total	323	90	170	583	29	22

a) Only farming types with recruiting activities are displayed

Table 5.3 describes the number of farms where accounts were completed for the first time for the bookkeeping year 2012. Due to several factors this is not exactly the same as the number of newly recruited farms. First, farms can drop out during the first year of participation or even right after recruitment. On second thought farms who were recruited, withdraw their participation. Or the quality of their bookkeeping is too poor to process. Second, this table includes the farms in the EU variant as well. And third, the farm type and size can be different in the year of bookkeeping compared to the year of selection.

[1] Accidentally, table 5.2 in the publication of book-keeping year 2011 also referred to 2012 instead of 2011.

Table 5.3

Number of farms with 2012 as first year of completion of bookkeeping, recruited for EU or CSP variant.

<table>
<tr><th>lower boundary (k€ SO)</th><th>25</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th rowspan="2">Total</th></tr>
<tr><th>upper boundary (k€ SO)</th><th>50</th><th>100</th><th>250</th><th>500</th><th>1,000</th><th>1,500</th><th>3,000</th><th>infinity</th></tr>
<tr><td colspan="10">Type of farming</td></tr>
<tr><td colspan="10">Field crop farms</td></tr>
<tr><td>- Organic crops</td><td colspan="2">0</td><td>1</td><td>0</td><td colspan="4">0</td><td>1</td></tr>
<tr><td>- Other field crop farms</td><td colspan="2">0</td><td>2</td><td>0</td><td colspan="4">1</td><td>3</td></tr>
<tr><td colspan="10">Horticulture</td></tr>
<tr><td colspan="10">Vegetables under glass</td></tr>
<tr><td>- Sweet pepper</td><td colspan="2">0</td><td colspan="2">0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>4</td></tr>
<tr><td>- Cucumber</td><td colspan="2">0</td><td colspan="2">1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>- Tomato</td><td colspan="2">0</td><td colspan="2">0</td><td>0</td><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>- Other</td><td colspan="2">1</td><td colspan="2">1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Cut flowers under glass</td><td colspan="2">1</td><td colspan="2">7</td><td>4</td><td>0</td><td>1</td><td>0</td><td>13</td></tr>
<tr><td>Plants</td><td colspan="2">0</td><td colspan="2">0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Field vegetables</td><td colspan="2">0</td><td colspan="2">1</td><td>2</td><td colspan="3">1</td><td>4</td></tr>
<tr><td>Fruit</td><td colspan="2">0</td><td>1</td><td>1</td><td colspan="4">0</td><td>2</td></tr>
<tr><td>Flower bulbs</td><td colspan="2">2</td><td colspan="2">2</td><td>1</td><td colspan="3">5</td><td>10</td></tr>
<tr><td>Other horticulture</td><td colspan="2">0</td><td colspan="2">1</td><td>0</td><td colspan="3">0</td><td>1</td></tr>
<tr><td colspan="10">Grazing livestock</td></tr>
<tr><td colspan="10">Dairy</td></tr>
<tr><td>- Non-organic</td><td colspan="2">0</td><td colspan="2">8</td><td>1</td><td colspan="3">2</td><td>11</td></tr>
<tr><td>Calf fattening</td><td colspan="2">1</td><td colspan="2">3</td><td>3</td><td colspan="3">2</td><td>9</td></tr>
<tr><td>Other grazing livestock</td><td>3</td><td>2</td><td>6</td><td>3</td><td colspan="4">1</td><td>15</td></tr>
<tr><td colspan="10">Intensive livestock</td></tr>
<tr><td>Breeding pigs</td><td colspan="2">0</td><td>0</td><td>3</td><td>2</td><td colspan="3">0</td><td>5</td></tr>
<tr><td>Fattening pigs</td><td colspan="2">0</td><td>3</td><td>0</td><td>1</td><td colspan="3">1</td><td>5</td></tr>
<tr><td>Integrated pig farms</td><td colspan="2">0</td><td>5</td><td>1</td><td>2</td><td colspan="3">1</td><td>9</td></tr>
<tr><td>Consumption eggs</td><td colspan="2">1</td><td colspan="2">0</td><td>0</td><td colspan="3">0</td><td>1</td></tr>
<tr><td>Broilers</td><td colspan="2">0</td><td colspan="2">0</td><td>0</td><td colspan="3">2</td><td>2</td></tr>
<tr><td>Other intensive livestock</td><td colspan="2">0</td><td colspan="2">1</td><td>3</td><td colspan="3">1</td><td>5</td></tr>
<tr><td>Combined</td><td colspan="2">2</td><td>6</td><td>3</td><td>5</td><td colspan="3">5</td><td>21</td></tr>
<tr><td>Total</td><td colspan="8"></td><td>130</td></tr>
</table>

a) Only farming types with farms with first year of completion of bookkeeping are displayed

A comparison of the field of observation (population) and the sample available for research purposes in 2012 is presented in Table 5.4. In 2012 the total number of farms which are available for research providing standard list of variables is 1,528. More detailed data available for research can be drawn from a sample of 1,223 farms (CSP variant).

Table 5.4

Number of farms in the population and sample according to the EU and CSP variant, 2012

Type of farming	Code	Number of farms		
		Population	Total sample (EU+CSP)	CSP
Field crop farms	*1*			
- Starch potatoes		788	27	27
- Organic crops		252	28	27
- Other field crop farms		5,987	155	144
Horticulture	*2+3*			
Vegetables under glass	2111			
- Sweet pepper		220	29	29
- Cucumber		180	29	29
- Tomato		231	25	25
- Other		486	40	39
Cut flowers under glass	2121	1,347	111	100
Plants	2122	852	63	61
Field vegetables	2210	812	38	19
Fruit	3610	1432	46	37
Tree nursery	2320	2351	44	19
Bulbs	2221	633	39	30
Other horticulture		1776	68	30
Grazing livestock	*4*			
Dairy	4500			
- Organic		345	36	36
- Non-organic		16,462	312	258
Calf fattening	4611	1,307	48	30
Other grazing livestock	4843	5,018	63	40
Intensive livestock	*5*			
Breeding pigs	5111	1,035	52	49
Fattening pigs	5121	2,003	56	51
Integrated pig farms	5131	822	39	34
Consumption eggs	5211	661	35	31
Broilers	5022	426	32	32
Other intensive livestock	*other 5*	639	34	10
Combined	*6-8*	2,752	79	36
Total		48,817	1,528	1,223

5.4 Supply of farm results to the European Commission

The final delivery of 2012 data to the EU has taken place in December 2013. Data of 1,521 farms of the bookkeeping year 2012 have been provided to and accepted by Brussels (Table 5.5). The target number of 1,500 farms has been reached.

Table 5.5

Bookkeeping year	Provided to the European Commission
2001	1,330
2002	1,358
2003	1,435
2004	1,418
2005	1,458
2006	1,506
2007	1,511
2008	1,501
2009	1,565
2010	1,501
2011	1,478
2012	1,521

6 Evaluation of the sample

6.1 Introduction

In this chapter the FADN sample for the year 2012 is evaluated both qualitatively and quantitatively. Section 6.2 provides an evaluation of the methodology of stratification and weighting. A crucial element is the calculation of weights. Section 6.3 provides the quantitative evaluation. This section focuses on the quality of the estimations based on the sample. This chapter is based on the standard approach of making estimations based on weights assigned to farms.

6.2 Evaluation of stratification and weighting

6.2.1 Introduction

This section deals with some practical problems related to the estimation process. Weights of individual farms are used to make estimations of frequencies, totals and averages of groups of farms (aggregated results) based on the data from the agricultural census and the FADN data.

The method to calculate the weights of individual farms is crucial. The goal is to achieve unbiased estimates with a minimal variance. This enables the estimation of the confidence interval of the real population value and the minimisation of the total error. This is true for direct estimators. In the case of a ratio estimator this is not necessarily true, but ratio estimators are outside the scope of this publication (see Vrolijk *et al.*, 2002, for a more extensive description of ratio estimators and other estimators).

6.2.2 Method of calculation of weights

The objective of the Dutch FADN system is to give a representative view of the total population. The question is therefore how to draw conclusions on totals, averages and frequencies that are valid for the whole population based on individual farm data. For example, how much is the average family farm income of all farms in agriculture and horticulture? The practical solution is found in weighting: the individual farm data are raised to the population level (for some variables the estimated values can be compared to the data that are available for the whole population, i.e. data which are included in the yearly agricultural census). A weight is assigned to every observed farm in the FADN system. The weight is defined as the ratio between the number of farms in a stratum according to the agricultural census and the number of farms in the sample (in the FADN system). The population in a specific stratum is continuously changing. Therefore the sample and population farms that belong to a stratum in year 2012 are not exactly the same as the farms that belong to that stratum in year 2011. The (post) stratification of the farms in 2012 is based on the 2012 agricultural census. Due to these changes farms included in one stratum could have had different inclusion probabilities at the time of recruitment. In theory, to achieve unbiased estimators these differences in inclusion probabilities should be taken into account in the estimation process. However, the consequence of this would be a very complicated system with many different substrata with different inclusion probabilities. Therefore this complicated procedure is not applied. As a result, the theoretical assumption of a strict a-select sample cannot be validated.

Although the calculation method applied in practice can lead to systematic distortions between estimated values and true values, the assumption of a random sample is made. This leads to several practical advantages. The method to calculate weights is relatively easy, involving a limited set of homogeneous strata and resulting in a more effective use of data. A detailed discussion on the calculation of different weights and the resulted population estimates can be found in Appendix 1.

Because of the applied sampling procedure (see Section 2.1) the different strata have different sampling fractions. Strata with relatively homogeneous units have a lower sampling fraction than very heterogeneous strata. This also implies that farms have very diverging weights. Farms from a homogeneous cluster will have a larger weight (in principle the reciprocal of the sampling fraction) and therefore represent a larger number of farms. The differences in sampling fractions are shown in table 6.1. These percentages are calculated by dividing the required number of farms in the selection plan (Table 5.1) by the number of population units (Table 3.2).

Table 6.1

Sampling fractions in different strata (2012 sample)

lower boundary (k€ SO)	**25**	**50**	**100**	**250**	**500**	**1**	**1,5**	**3**
upper boundary (k€ SO)	**50**	**100**	**250**	**500**	**1**	**1,5**	**3**	**infinity**
Type of farming								
Field crop farms								
- Starch potatoes	0,02		0,04	0,06	0,15			
- Organic crops	0,06		0,13	0,17	0,20			
- Other field crop farms	0,01		0,03	0,04	0,08			
Horticulture								
Vegetables under glass								
- Sweet pepper	n.a.		0,44		0,23	0,09	0,09	0,06
- Cucumber	n.a.		0,28		0,20	0,12	0,08	0,25
- Tomato	n.a.		0,58		0,19	0,10	0,11	0,07
- Other	0,06		0,09		0,08	0,12	0,10	0,09
Cut flowers under glass	0,09		0,08		0,09	0,10	0,11	0,07
Plants	0,08		0,07		0,09	0,06	0,10	0,10
Field vegetables	0,04		0,05		0,08	0,10		
Fruit	0,02		0,04	0,03	0,05			
Tree nursery	0,01		0,02		0,05	0,07		
Flower bulbs	0,07		0,04		0,09	0,11		
Other horticulture	0,02		0,01		0,03	0,06		
Grazing livestock								
Dairy								
- Organic	0,16		0,07	0,10	0,06			
- Non-organic	0,02		0,02	0,02	0,04			
Calf fattening	0,02		0,03		0,03	0,05		
Other grazing livestock	0,00	0,01	0,03	0,03	0,12			
Intensive livestock								
Breeding pigs	0,10		0,05	0,05	0,04	0,05		
Fattening pigs	0,01		0,02	0,03	0,04	0,05		
Integrated pig farms	0,83		0,15	0,05	0,03	0,04		
Consumption eggs	0,09		0,03		0,04	0,07		
Broilers	0,13		0,07		0,05	0,08		
Other intensive livestock	0,13		0,05		0,04	0,04		
Combined	0,01		0,02	0,04	0,05	0,10		

6.2.3 Remarks on the weights

In the report on farm results for 2012 the research population is defined as all farms in the 2012 agricultural census (above the lower threshold). The weight per farm is calculated as the ratio between the number of farms in the census and the number of farms in the sample.

In the calculation of aggregate results (averages, frequencies and totals) for the year 2012, the 2012 agricultural census is the starting point. Because of the registration of farms in the population (almost all farms are registered in the agricultural census) the aggregate numbers of farms are exactly the same as the numbers of farms in the census. However, in using these numbers in the calculation of weights for estimations for 2012 two remarks should be made.

Every year all horticultural and agricultural farms are registered in the agricultural census, but this registration only represents the situation at a certain moment during the year. Therefore it is possible that farms are missing from this registration, although the statistical office tries to correct for that. Furthermore, the number of farms tends to decrease significantly (this trend is stronger for certain types of farms and less strong for others). As a consequence estimations might be overestimations of reality. Distortions in the number of farms in the census can therefore cause incorrect estimations of aggregates.

The typology of farms according to the agricultural census might differ from the typology according to the FADN data. The census reflects the situation at a certain point in time, while the FADN system describes the farm during a whole year. In order to take these differences into account two weighting methodologies are available in the Dutch FADN system. From a theoretical point of view weighting based on the characteristics of the farm in the census is more appropriate. The census is used as the sampling frame; the weights should reflect information from this sampling process. If there are substantial differences, then the variables type and size of farming in the agricultural census are different from the variables size and type of farming in the FADN. In a weighting procedure based on the population numbers in the census and the characteristics in the FADN these variables are considered to be the same.

6.3 Quantitative evaluation of the 2012 sample

6.3.1 Introduction

This section focuses on the quality of the estimations based on the 2012 FADN sample. In the post-stratification, changes in the selection plan, from book-keeping year 2013 on, have been retroactively implemented in year 2012, so that for researchers this scheme was already available. In the selection plan of 2013, the cut flowers under glass are merged in one type and the other grazing livestock is split up into goats and other. The remainder of this chapter is based on this new scheme.
Figure 6.1 shows the same structure as displayed in Figure 2.1, but it adds the quality aspects: coverage, response rate, representativeness and reliability of estimates. The response rate and the accompanying non-response, has already been described in the previous chapter. Section 6.3.2 provides information on the coverage of the sample; the coverage compares the total population as described by the census and the field of observation of the FADN sample. Section 6.3.3 analyses the extent to which distortions might occur between the sample and the population due to over or under representation of farms with specific characteristics; it compares the characteristics of the field of observation and the actual FADN sample. Section 6.3.3 provides information on the reliability of estimates based on the FADN sample.

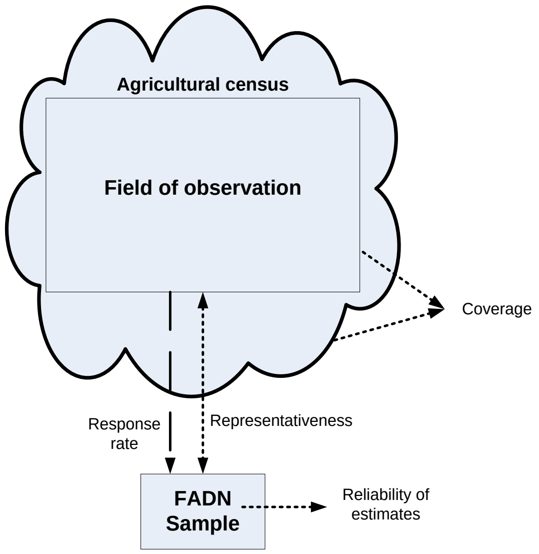

Figure 6.1 Quality aspects of the Dutch FADN.
Source: Vrolijk et al. (2009a).

6.3.2 Coverage

It is desirable to have a sample that represents the population as accurate as possible. A clear distinction should be made between the coverage and the representativeness. This section describes the coverage, Section 6.3.3 deals with the representativeness. To get an idea about the extent to which the total population is covered by the sample it is relevant to distinguish several aspects (Figure 6.2). Farms that are too small or are not registered in time are not part of the agricultural census (b). The sampling frame (c) is the basis for the choice of sample farms and consists of farms registered in the agricultural census that fulfil the size criteria: larger than 25,000 euros SO. From this sampling frame the sample is drawn (d).

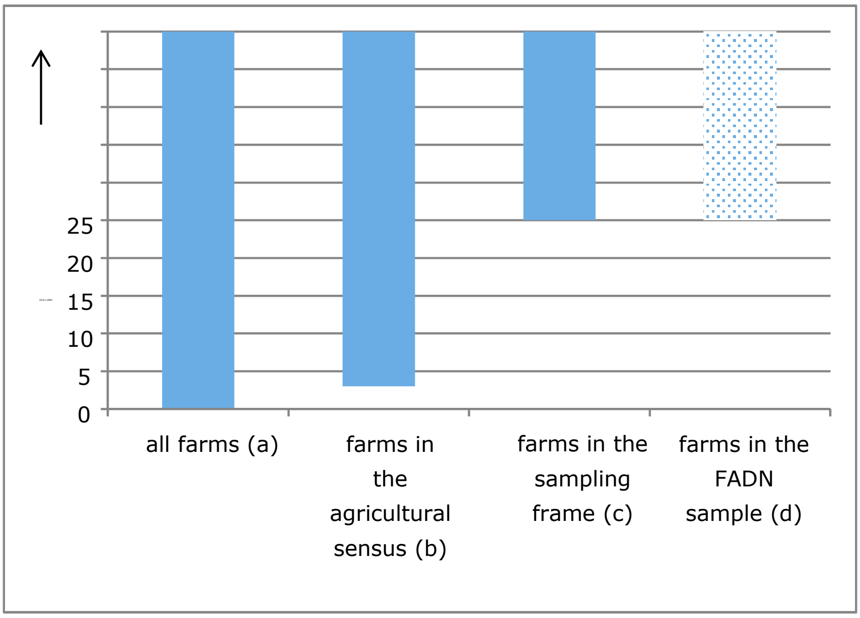

Figure 6.2 *Relationship between all farms and FADN sample concerning lower threshold.*

Table 6.2 gives an indication to what extent the FADN sample in 2012 covers the whole population. Table 6.2 presents some characteristics for the total sample for example: area of crops, number of animals and labour. A comparison is made between the farms in the sampling frame (all the farms that have a chance of being included in the FADN sample) (c) and the total population as described by the agricultural census (b). Direct comparison with all farms (a) would be better but the unregistered farms are unknown, and the practical difference is very limited. The sampling frame covers the population to a large extent. For example with respect to size (calculated in euros SO), the coverage is 99% (Table 3.1). The upper threshold has been abolished from 2010 on. However, the sample farms do not yet include many farms above the former upper threshold, although in recent years the recruitment of farms focuses on these very large firms. This implies that the average size of the farms in the sample is smaller than the average size in the population (compare Table 6.4).

Table 6.2
Coverage of the sample compared to agricultural census, 2012.

Selected characteristics of the sample a)	Number according to census	Covered by sampling frame ≥ 25,000 euros SO (%)
Farms	68,810	70.9
Standard output (million euros)	19,060	98.9
Total labour (AWU)	161,178	89.7
Family labour (AWU)	93,807	84.9
Paid labour (AWU)	67,371	96.3
Area (hectare)		
Agricultural area	1,841,752	93.0
Grassland	794,864	90.3
Green maize	230,766	90.3
Arable	951,756	94.7
Winter wheat	136,388	95.4
Sugar beet	72,724	97.7
Starch potato	43,321	99.2
Seed potato	39,159	99.9
Ware potato	67,452	99.1
Seed onion	20,993	99.5
Horticulture in the open air	85,170	99.5
Headed cabbage	2,617	99.1
Leek	2,426	99.8
Brussels sprouts	2,707	99.9
Asparagus	2,893	98.1
Cauliflower	2,249	99.4
Apple	7,948	99.5
Pear	8,169	99.3
Park trees	5,954	99.4
Hedges	2,670	99.3
Tulip bulbs	11,248	99.9
Horticulture under glass	9,962	100.0
Cucumber	622	100.0
Sweet pepper	1,313	100.0
Tomatoes	1,691	100.0
Chrysanthemum	504	100.0
Roses	407	100.0
Pot plant flower	867	100.0
Pot plant green	485	100.0
Number		
Dairy cows	1,483,991	100.0
Fattening calves	908,367	99.9
Breeding pigs	1,179,925	100.0
Fattening pigs	5,873,911	99.9
Broilers	43,846,343	100.0
Laying hens	42,810,311	100.0

a. Main crops and livestock are listed and not farming types

Source: Agricultural Census, Statistics Netherlands, processed by LEI Wageningen UR.

In policy analysis and research it is essential to distinguish between farming types (for example specialised pig fattening farms) and agricultural activities (pig fattening). In the report on the redesign of the FADN sample it was illustrated that types of farming should not be the only focus of research (Vrolijk and Lodder, 2002). Agricultural activities are important in many research projects.
To give a complete picture of a certain agricultural activity it is important to look at the activities on all farm types. For example, not only pig fattening farms will create added value from pig fattening, also other types of farms can be involved in this activity (although it is not their main business). Table 6.3 describes to which extent a certain activity can be found on certain types of farming in 2012. For example, 78% of the cattle activities can be found on the dairy farms and 17% on the farms that belong to ‘other farms’ category and 4% on combined farms. The intensive livestock sector pigs and poultry are highly specialized. Almost 90% of the activities can be found on the specialized farms. The activity vegetables in the open air is more divers. On the specialized farms 62% of the vegetables in the open air (in SO) can be found. The combined and other farms also have a large share of the production of vegetables in the open air.

Table 6.3

Relationship between types of farming and agricultural activities - share of SO 2012.

Animals or crops	Cattle	Pigs	Poultry	Arable crops	Vege-tables open air	Fruit	Tree Nursery	Flower bulbs	Vegetables glass	Ornamental plants
Type of farming										
Dairy	77.9	1.2	0.2	14.5	0.9	0.5	0.3	0.6	0.0	0.0
Pig	0.5	89.7	0.6	3.2	2.8	0.3	1.2	0.9	0.0	0.0
Poultry	0.2	0.3	89.7	1.3	0.5	0.1	0.2	0.1	0.0	0.0
Arable	0.1	0.0	0.1	63.0	2.3	0.7	0.1	1.0	0.0	0.0
Vegetables open air	0.0	0.0	0.0	0.8	62.3	0.9	0.3	0.1	0.3	0.0
Fruit	0.0	0.0	0.0	0.3	0.4	85.4	0.1	0.0	0.0	0.0
Tree nursery	0.1	0.2	0.1	0.4	0.6	0.4	89.2	0.2	0.0	0.1
Flower bulbs	0.0	0.0	0.0	0.7	0.6	0.0	0.0	70.7	0.0	0.1
Vegetables under glass	0.0	0.0	0.0	0.1	1.9	0.5	0.1	0.0	88.0	0.0
Ornamental plants[1)]	0.0	0.0	0.0	0.0	0.2	0.3	0.3	5.6	0.5	93.0
Combined	3.9	7.3	6.8	11.5	16.6	8.6	5.6	8.0	0.2	0.0
Other	17.1	1.3	2.6	4.3	11.1	2.2	2.6	12.7	11.0	6.8
Total agriculture	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Agricultural Census, Statistics Netherlands, calculations by LEI Wageningen UR

1) Consists of cut flowers under glass and pot plants.

6.3.3 Representativeness

Because of the stratification scheme, the sample will provide a good representation of the population on the main characteristics (stratification variables) at the beginning of a year. During the year farms might drop out of the sample and changes might occur in the population. Despite these changes the representativeness is maintained by applying post-stratification on the resulting sample and the changed population. Representativeness with respect to the stratification variables does not necessarily imply that the sample is representative for all variables. Such a full representativeness is impossible unless the sample size approximates the whole population or all variables highly correlate with the stratification variables. Table 6.4 shows to what extent the sample is representative for a number of variables in the agricultural census. Averages per farm in the census and in the FADN are compared. To make a relevant comparison, farms in the census are selected according to FADN size criteria. If the relative difference in averages is more than two times the relative standard error then it is less likely that these differences can be explained by sampling errors. A star (*) next to a specific variable indicates that difference between FADN and census average is significant, i.e. there is a significant difference between the sample and the population.

Regarding the significant differences for the horticulture under glass (also related to the differences in labour), an explanation can be found in the fact that the upper threshold was recently abolished. The firms in the sample were smaller than the firms in the population. By focusing on the larger farms during the recruitment process, this difference will become smaller in the future. For the difference in SO dairy, no other explanation than sampling errors can be found.

Table 6.4
Comparison of farms in the agricultural census and farms in the Dutch FADN.

Variable	Average per farm 2012		Significant (5%)
	Census ≥ 25,000 euros SO	FADN	
Size (Standard Output)			
Total	396,497.18	394,449.63	
Arable crops	38,605.46	39,475.60	
Grassland	10,825.46	10,876.60	
Horticulture open air	49,259.52	51,757.93	
Horticulture under glass	102,762.99	89,475.01	*
Dairy	79,243.76	83,291.78	*
Veal	14,636.46	13,761.16	
Fattening pigs	27,159.76	28,856.47	
Breeding pigs	22,652.61	23,593.38	
Broilers	9,774.51	9,863.53	
Laying hens	9,887.84	10,680.68	
Size (ha)			
Total	36.03	36.90	
Arable crops	18.95	19.61	
Cereals	4.10	4.40	
Tuberous and root crops	4.63	4.84	
Permanent grassland	14.15	14.22	
Horticulture open air	1.78	1.92	
Pome and stone fruit	0.35	0.37	
Tree nursery	0.33	0.32	
Flower bulbs	0.49	0.62	
Vegetables open air	0.49	0.50	
Horticulture under glass	0.21	0.18	*
Vegetables under glass	0.10	0.09	*
Tomatoes	0.04	0.03	*
Cucumber	0.01	0.01	
Sweet pepper	0.03	0.02	
Cut flowers	0.05	0.04	*
Roses	0.01	0.01	
Chrysanthemum	0.01	0.01	
Pot plants	0.04	0.04	
Labour (AWU)			
Male	1.83	1.73	*
Paid labour	1.37	1.11	*

Source: Agricultural Census, Statistics Netherlands and FADN, calculations by LEI Wageningen UR

Table 6.4 gives a description for the whole population. In case of research projects on specific types of farming, similar tables could be generated for only farms of that type of farming.

A comparison between the sample and the population as registered in the agricultural census does not fully answer the question whether estimations of financial, economic and technical characteristics are bias free. Quality of farm management for example is not recorded in the data and thus cannot be statistically tested. Thus it is possible that farms with relatively good or bad management skills and therefore performance are over represented in the sample.

6.3.4 Reliability

The previous subsection provides some indicators whether there are systematic differences between the sample and the population (representativeness of sample). This section focuses on the reliability of the estimates.
The calculation of averages of groups based on sampling units implies that there can be differences between the estimated value and the true population value. These differences may occur due to the random selection of units to be included in the sample. Table 6.5 provides an indication of the level of precision of the estimates for a set of important goal variables in 2012 sample.

This section provides the reliability of estimates for a number of important goal variables for different types of farming. This calculation is based on the available CSP observations (see Section 5.3). Tables

6.5 and Table 6.6 present the standard errors of estimated goal variables as well as their relative standard error (coefficient of variation). The coefficient of variation is defined as the standard error divided by the group average. A higher coefficient of variation implies less reliable estimates, but the value is strongly affected by the absolute value of the average. If the average value approaches zero, the coefficient of variation can become very large. If the average value is negative, the coefficient of variation is negative as well. This is the case with for example savings.

The precision of estimates is determined by the standard error of the estimate of a variable. The standard error is used to calculate the confidence interval. This confidence interval describes the range in which the true population value will be given a certain level of certainty. The confidence interval ranges from the calculated average minus two times the standard error to the calculated average plus two times the standard error. For example, the standard error 10,952 for starch potatoes farms signals that average farm income on such farms can vary within the confidence interval 138,079 +/- 1.96*10,952 , i.e. (€116,612 - €159,546).

Table 6.5

Standard error of estimates and coefficient of variation (in italics) of important goal variables per type of farming, based on CSP variant, 2012.

Type of farming	Goal variable					
	farm income, €	total revenues, €	return, a)	savings, €	total income,€	net farm result, €
Field crop farms						
- Starch potatoes	10,952	87,204	4.4	12,437	12,964	8,589
	0.08	*0.20*	*0.03*	*0.13*	*0.08*	*0.10*
- Organic crops	20,549	53,053	4.0	26,219	20,876	16,453
	0.47	*0.13*	*0.04*	*0.69*	*0.39*	*-1.77*
- Other field crop farms	8,052	14,699	2.9	10,402	9,891	7,360
	0.07	*0.04*	*0.03*	*0.14*	*0.07*	*0.14*
Horticulture						
Vegetables under glass						
- Sweet pepper	50,183	342,965	2.2	45,477	51,488	41,887
	-3.18	*0.14*	*0.02*	*-0.37*	*123.21*	*-1.96*
- Cucumber	45,356	83,317	1.7	45,383	46,215	39,268
	1.40	*0.05*	*0.02*	*-1.46*	*1.38*	*-1.06*
- Tomato	211,585	1,003,104	2.1	98,819	217,483	211,606
	0.53	*0.22*	*0.02*	*0.70*	*0.55*	*0.51*
- Other	16,103	49,680	2.7	14,581	15,869	14,530
	0.22	*0.07*	*0.03*	*-6.65*	*0.21*	*-7.27*
Cut flowers under glass	20,048	88,379	1.8	17,435	19,832	18,563
	0.21	*0.06*	*0.02*	*0.70*	*0.19*	*0.68*
Plants	37,496	231,463	2.8	36,512	38,326	35,795
	0.24	*0.11*	*0.03*	*1.43*	*0.22*	*0.44*
Field vegetables	10,296	51,844	4.4	11,435	10,713	13,836
	0.21	*0.11*	*0.05*	*-1.39*	*0.19*	*-0.51*
Fruit	0,206	44,494	7.4	19,478	21,953	17,249
	0.21	*0.12*	*0.08*	*0.37*	*0.20*	*0.46*
Tree nurseries	12,712	47,816	3.8	12,444	11,860	10,926
	0.17	*0.13*	*0.04*	*5.99*	*0.14*	*-0.85*
Flower bulbs	35,372	161,919	3.3	32,119	35,618	37,032
	0.41	*0.15*	*0.04*	*1.47*	*0.37*	*-11.87*

Type of farming	Goal variable					
	farm income, €	total revenues, €	return, a)	savings, €	total income,€	net farm result, €
Other horticulture	29,587	105,978	3.2	21,420	30,382	24,484
	0.21	*0.13*	*0.03*	*0.32*	*0.19*	*0.44*
Grazing livestock						
Dairy						
- Organic	6,188	10,328	2.1	5,048	5,999	6,363
	0.24	*0.04*	*0.03*	*11.81*	*0.13*	*-0.13*
- Non-organic	3,583	7,170	0.8	3,784	3,730	3,244
	0.11	*0.02*	*0.01*	*-0.66*	*0.08*	*-0.08*
Calf fattening	6,746	38,971	3.1	15,643	7,319	7,387
	0.16	*0.13*	*0.03*	*0.75*	*0.13*	*-0.35*
Goats	18,458	39,525	6.8	17,905	19,142	19,215
	0.48	*0.10*	*0.08*	*1.01*	*0.34*	*-0.30*
Other grazing livestock	11,970	21,266	5.6	6,243	12,415	9,658
	-11.29	*0.16*	*0.09*	*-0.38*	*0.48*	*-0.17*
Intensive livestock						
Breeding pigs	15,488	73,163	1.0	14,029	15,402	14,173
	0.16	*0.08*	*0.01*	*0.29*	*0.14*	*0.46*
Fattening pigs	4,573	22,697	0.9	5,875	4,942	3,984
	0.14	*0.04*	*0.01*	*0.36*	*0.09*	*-0.56*
Integrated pig farms	16,989	85,218	1.3	24,119	16,848	14,318
	0.28	*0.07*	*0.01*	*0.82*	*0.23*	*-3.17*
Consumption eggs	21,752	69,273	2.4	22,248	20,786	17,925
	0.17	*0.07*	*0.02*	*0.31*	*0.14*	*0.24*
Broilers	13,186	98,486	1.0	14,101	14,859	14,926
	0.27	*0.07*	*0.01*	*-3.39*	*0.26*	*-1.99*
Other intensive livestock	34,002	199,189	1.9	32,841	33,492	36,438
	2.17	*0.23*	*0.02*	*-1.37*	*1.15*	*-1.19*
Combined	20,715	44,298	4.2	18,663	20,823	14,922
	0.30	*0.10*	*.05*	*0.46*	*0.24*	*54.07*

a) Revenues per 100 euros costs

Table 6.6
Reliability of estimates (coefficient of variation in italics) of important goal variables per main type of farming, based on CSP variant (2012).

Type of farming	Goal variable					
	farm income, €	total revenues, €	Return a)	Savings, €	total income, €	net farm result, €
Field crops	7,008	16,003	2.6	9,021	8,584	6,372
	0.06	*0.04*	*0.02*	*0.12*	*0.06*	*0.12*
Vegetables under glass	46,002	219,646	1.4	43,213	47,224	45,426
	0.40	*0.11*	*0.01*	*1.53*	*0.39*	*0.60*
Cut flowers under glass	20,048	88,379	1.8	17,435	19,832	18,563
	0.21	*0.06*	*0.02*	*0.70*	*0.19*	*0.68*
Pigs	5,997	29,204	0.6	7,059	6,042	5,293
	0.11	*0.04*	*0.01*	*0.26*	*0.08*	*1.45*
Poultry	14,201	57,133	1.5	14,614	13,917	12,371
	0.14	*0.05*	*0.02*	*0.35*	*0.12*	*0.29*
Grazing livestock	3,556	7,063	1.3	3,116	3,696	3,072
	0.13	*0.02*	*0.02*	*-0.52*	*0.09*	*-0.07*
All farms	3,099	10,524	0.8	2,943	3,243	2,725
	0.05	*0.02*	*0.01*	*0.15*	*0.04*	*-0.41*

a. Revenues per 100 euros costs

There are clear differences in the significance of estimates between different types of farming. Following Table 6.5, the estimates for the dairy sector (non-organic) are the most reliable (the lowest coefficient of variation) because of the large number of farms included in the sample, which reflects the importance of the dairy sector in Dutch agriculture. The decision on the number of farms is described in Vrolijk and Lodder (2002).

The previous tables give an indication of the reliability of estimates for certain types of farming. These tables are used to evaluate the allocation of sampling capacity to the different types of farming. Also in research projects the tables give an indication of the reliability of estimates and should therefore be considered before drawing statistical conclusions.

The tables also give an indication of the dispersion (variability) of observations. A large dispersion makes it more difficult to make precise estimates of group characteristics. Dispersion is however also one of the main advantages of the FADN system. The micro economic information at farm level makes it possible to show and analyse differences between farms, for example research about sustainability performance (Dolman *et al.*, 2012). The European Commission has no requirements regarding the reliability. However, it is one of the factors that is taken into account by determining the distribution of farms over the farm-types and size classes.

References

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

Deville, J-C. and Särndal, C-E. (1992). Calibration Estimators in Survey Sampling, Journal of the American Statistical Association, 87, 376-382.

Dijk, J., K. Lodder, J. Luyt en H.C. Pruis, Voorstel voor de indeling van de populatie land- en tuinbouwbedrijven in groepen en bijbehorend keuzeplan. Interne Nota 437. Landbouw-Economisch Instituut (LEI-DLO), Den Haag, 1995a.

Dolman, M.A., H.C.J. Vrolijk, I.J.M. de Boer, Exploring variation in economic, environmental and societal performance among Dutch fattening pig farms. Livestock Science 149 (2012) 1 – 2.

Goffau, A. de, T. C. van Leeuwen, A. van den Ham, G.J. Doornewaard and B. Fraters, Minerals Policy Monitoring Programme Report 2007-2010 : Methods and procedures, 2012.

Henry, K and Valliant, R., 2012, Comparing Alternative Weight Adjustment Methods. Section on Survey Research Methods – JSM 2012. http://www.amstat.org/sections/SRMS/Proceedings/y2012/Files/306157_76012.pdf

Izrael, David, Michael P. Battaglia and Martin R. Frankeland, Extreme Survey Weight Adjustment as a Component of Sample Balancing (a.k.a. Raking), Paper 247-2009, SAS Global Forum 2009.

Levy, P.S. en S. Lemeshow, Sampling of populations, Methods and Applications, Wiley, New York, 1991.

Phillip S. Kott, 2006, Using Calibration Weighting to Adjust for Nonresponse and Coverage Errors, Survey Methodology, Vol. 32, No. 2, pp. 133-142 Statistics Canada, Catalogue No. 12001.

Poppe, K.J., Het Bedrijven-Informatienet van A tot Z. Rapport 1.03.06. LEI, Den Haag, 2004.

Sanders, J., CH-FARMIS, an agricultural sector model for Swiss agriculture, 2006.

Särndal, Carl Erik, 2007, The calibration approach in survey: theory and practice. Survey Methodology, Vol. 33, No. 2, pp. 99-119. Statistics Canada, Catalogue no. 12001X.

Vrolijk, H.C.J. en K. Lodder, Voorstel tot vernieuwing van het steekproefplan voor het Bedrijven-Informatienet. Rapport 1.02.02. LEI, Den Haag, 2002.

Vrolijk, H.C.J., W. Dol en G. Cotteleer, Schatten van kenmerken van kleine deelgebieden. LEI, Den Haag, 2002.

Vrolijk, H.C.J., Sampling of organic farms in the Dutch FADN: lessons learned. In: M. Rippin, H. Willer, N. Lampkin, A. Vaughan, Towards a European Framework for Organic Market Information. pp. 87-90, 2006.

Vrolijk, H.C.J., H.B. van der Veen and J.P.M. van Dijk, Sample of Dutch FADN 2007. Design principles and quality of the sample of agricultural and horticultural holdings. Report 2009-067, LEI, The Hague, 2009a.

Wolter, Kirk M, 2007. Introduction to Variance Estimation. Second Edition. Springer.

Annex 1 Alternative survey weights for FADN

A1.1 Introduction

The Dutch FADN consists of a stratified random sample of the Dutch agricultural and horticultural farms. Depending on different typologies of farms in the population (i.e. all Dutch agricultural and horticultural farms) and farms included in the target population (i.e. all the farms for which the sample is to be used to make inference. See Chapter 3 in the main report for more details), different sets of survey weights are distinguished for the estimation of the target population characteristics using FADN data. For proper estimation and interpretation of population characteristics, it is important to use the right set of survey weights.

By design, survey weights usually reflect different selection probabilities of the sample farms following the chosen typology and stratification. After sampling, survey weights are often adjusted to correct for known discrepancies between the sample and the population (e.g., coverage error). Such discrepancies may occur for some population characteristics that were not taken into account in the sampling plan. More specifically, a number of problems emerged in recent years have made it necessary to adjust the survey weights of FADN sample:

- Empty or singular strata: For FADN sample, the stratification plan has to follow certain rules of the EU that cover large and small farms. Since the farms in the Netherlands are on average much larger than farmers in other countries, the strata with the smallest farms contain no or only a small number of farms in the population. This can lead to empty or singular strata in the sample for which no weights can be calculated. That stratum in the target population will automatically not be represented.
- Problem of representativeness expressed in average farm size due to under coverage of certain types of farms. For example, since farms in the FADN sample are mainly based on the selection of the previous years, the average farm size in the sample can be lower than the average farm size in the population when the population now contains more large farmers than in the previous year. Another example is the exclusion of farms with size larger than the upper boundary set by the FADN in the years before 2010. Although in recent years more large farms are recruited, this might still have an effect on the farm size in the sample.

The scientific literature on survey data analysis suggests various approaches and methods to overcome these problems in sampling and estimation. Some of these approaches and methods concerning adjustment of sample weights could be readily applied to the FADN sample. This leads to alternative survey weights for the estimation of population characteristics.

Adjustments of survey weights have implications to the unbiasedness and precision of the estimator used and need to be implemented with care. Since different survey weights lead to different estimates of population characteristics, it is important to choose the right set of weights and understand how sample weights may have influenced the estimates. The objective of the analysis is to describe the theoretical background and practical implementation of alternative survey weights and their implications to the estimation of population characteristics of Dutch farms.

A1.2 Theoretical background

A1.2.1 Introduction

Samples are widely used in practical businesses and in scientific research. Compared with population census, sampling has the advantages of reduced cost, greater speed, greater scope and greater accuracy (Cochran, 1977). In sampling theory several methods of sample selection and of estimation have been developed that provide estimates of sufficient precision at lowest possible costs. This paragraph discusses the theoretical underpinnings of sampling and the use of different survey weights in making estimations of population characteristics.

A1.2.2 Sampling, estimation and weighting

Sampling methods can be broadly divided into two types: probability sampling and nonprobability sampling. A probability sampling method utilizes some form of random selection to assure that the different units in the population have known probabilities of being chosen. Probability sampling enables statistical inference from the sample to the population. Alternatives to probability sampling are called nonprobability sampling. Nonprobability sampling is not a product of a randomized selection processes. Subjects in such samples sample are usually selected on the basis of their accessibility or by the purposive personal judgment of the researcher. The downside of nonprobability sampling method is that an unknown proportion of the entire population might not be sampled. As a result, the sample may or may not represent the entire population accurately. Therefore, the results of the research cannot be used to draw conclusions of the entire population.

Using the survey sample, characteristics of the population can be estimated using so-called estimators. An estimator is a function by which an estimate of some population characteristic is calculated from the sample results. As different estimators may produce different estimates, statistical theory is concerned with defining properties that can be used to compare different estimators. Two properties of estimators are often considered: unbiasedness and precision.

An estimator is unbiased when the expected value of the estimator taken over all possible samples following the sampling plan has the same value as the true characteristic. Precision of an estimator refers to the variance of the sample estimates obtained from all possible samples using the same estimator. Low variance means higher precision of the estimator. The standard deviation of the sample estimates is called the standard error of the estimator.

Given a survey sample, weights are often used in estimators to obtain population estimates. A weight is a measure of the relative importance of a unit in the target population. The use of weights is pervasive in survey studies as way to ‘scale up’ the sample characteristics to the population characteristics. For the estimator of the population total is:

$$\hat{Y} = \sum_{i \in s} W_i Y_i \, , \qquad (1)$$

where s denotes the sample, Y_i is the characteristic of interest, and W_i is the weight associated with the i-th unit in the sample. When $Y_i \equiv 1$, the statistic $\hat{N} = \sum_{i \in s} W_i$ is an estimator of the size of the eligible population, if W_i is the number of units in the population represented by the i-th unit in the sample. Depending on how the weights are constructed, the variance of the estimators using weights is calculated or estimated differently following sampling theory. A number of examples are described below.

In a simple random sample weights are equal for all units. In practice this is, however, often not the case, resulting in a large variance of the estimate. Several methods for assigning different weights to different units are available. In the following we describe stratified weights, post-stratified weights, calibrated weights and imputed weights.

A1.2.3 Survey weights in stratified random sampling

A1.2.3.1 Survey weights and sampling design

Stratified random sampling is one of the basic sampling designs commonly used in practice (Wolter, 2007, p.11). In stratified sampling, a population of N units is first divided into non-overlapping subpopulations of N_1, N_2, …, N_L units. These subpopulations comprise the whole of the population, i.e., $\sum_{h=1}^{L} N_h = N$. The subpopulations are called strata. When the strata have been determined, a sample is drawn from each stratum with the drawings being made independently in different strata. The sample sizes within the strata are denoted by n_1, n_2, …, n_L, respectively. When a simple random sample is taken in each stratum, the whole procedure is described as stratified random sampling.

When the sampling rates in the strata are unequal in a stratified sample design, survey weights are used to reflect this information in order to produce an unbiased estimator. As a convention, the weights are calculated as the reverse of the inclusion probability by dividing in each stratum the number of units in the population by the number of units in the sample. Since the strata and number of sample units are known by sampling design, these weights are called design weights.

A1.2.3.2 Estimators and standard error

For stratified random sampling without replacement, the estimator of population total $\hat{Y}$ for a variable of interest (y) using the design weights is (Cochran, 1977):

$$\hat{Y} = \sum_{h=1}^{L} \sum_{i=1}^{n_h} w_h y_{hi} = \sum_{h=1}^{L} N_h \overline{y_h} \tag{2}$$

where:
h is the index of the stratum in the sample and the population
L is the total number of strata in the sample and the population
y_{hi} is the value of the variable of interest y of the i-th unit in stratum h
$\bar{y}_h$ is the mean value of y in the population in stratum h
w_h is the design weight for units in stratum h, $w_h = \frac{N_h}{n_h}$
N_h is the number of farms in de population in stratum h
n_h is the number of farms in the sample in stratum h
i is the index of the unit in the stratum

The variance of the estimator of population total $\hat{Y}$ is estimated as:

$$\widehat{Var}\left(\hat{Y}\right) = \sum_{h=1}^{L} N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h}\right) s_h^2 \tag{3}$$

where:

$$s_h = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} (y_{hi} - \bar{y}_h)^2 \tag{4}$$

The standard error of the estimator is the square root of the estimated variance.

The estimator of population mean is:

$$\hat{\bar{Y}} = \frac{1}{N} \sum_{h=1}^{L} \sum_{i=1}^{n_h} w_h y_{hi} = \sum_{h=1}^{L} W_h \bar{y}_h \, , \tag{5}$$

where $W_h = \frac{N_h}{N}$ is called the stratum weight. The variance of the estimator is estimated as:

$$\widehat{Var}\left(\hat{\bar{Y}}\right) = \sum_{h=1}^{L} W_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h}\right) s_h^2 \tag{6}$$

Stratification can reduce the variance of estimates, making stratified random sampling a much more efficient method of sampling than simple random sampling.

A1.2.3.3 Post stratification

Post stratification is generally used when it is impossible to stratify the population before drawing the sample s. The stratum sizes N_h are known from another source. The stratum to which a given unit belongs to is not known until the data have been collected. Post stratification is also method for adjusting the design weights after the data have been collected, usually to account for non-response and underrepresented groups in the population due to sampling error. The post stratification adjustment has the following advantages:

- Adjusts weights to sum to the post stratum sizes in the population
- Reduces bias due to nonresponse and underrepresented groups
- Can result in smaller variance estimates

When it is impossible to stratify the population before drawing the sample, a simple random sample without replacement of size n can be taken. If n is large enough, the sample is likely to resemble a stratified sample with proportional allocation. Let n_1, n_2, …, n_L be the number of units sampled from each stratum, N_1, N_2, …, N_L be the number of units in the stratum in the population, and $\bar{y}_1$, $\bar{y}_2$,…, $\bar{y}_L$be the corresponding sample means. A 'stratified' estimate of the population mean $\hat{\bar{Y}}$ is:

$$\hat{\bar{Y}} = \sum_{h=1}^{L} \frac{N_h}{N} \bar{y}_h. \tag{7}$$

Suppose that n_h is reasonably large (>20), the variance of the estimator is (Cochran, 1977):

$$\widehat{Var}\left(\hat{\bar{Y}}\right) = (1 - \frac{n}{N}) \sum_{h=1}^{L} \frac{N_h}{N} \frac{s_h^2}{n} \tag{8}$$

The variance of the estimator for population total using post stratification weights is:

$$\widehat{Var}\left(\hat{Y}\right) = \sum_{h=1}^{L} N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h}\right) s_h^2 + \frac{N^2}{n^2} \sum_{h=1}^{H} (1 - W_h) s_h^2, \tag{9}$$

As can be seen from formula, the post stratification variance is larger than the variance using the design weights (the second term in the formula represents the increase) because of the randomness of the number of units in each stratum after sampling. The second term will however be small if the sample size is reasonably large and is therefore often ignored in practice.

A1.2.4 Survey weights adjustment using auxiliary information

A1.2.4.1 Calibrated weights

When auxiliary information is available, the relationship between the study variable y and the auxiliary variable x can be exploited to produce more precise estimates. Ratio and regression estimators are examples of the use of auxiliary information in estimation. For example, the ratio estimator for population total Y is of the form:

$$\hat{Y}_R = \hat{R} X , \tag{10}$$

where X is the population total of x, and $\hat{R}$ is estimated as $\frac{\bar{y}}{\bar{x}}$. The linear regression estimate of the population mean $\bar{Y}$ is of the form:

$$\hat{\bar{Y}} = \bar{y} + b(\bar{X} - \bar{x}) , \tag{11}$$

where $\bar{X}$ is the population mean of the auxiliary variable x, and b is the linear regression coefficient of y on x.

Auxiliary variables can first of all be the stratification variables. By calibrating the aggregated value of these auxiliary variables to the statistical reference data of the total population, it is possible to improve the representativeness of the sample for the auxiliary variables. A calibration weighting technique can increase the representativeness of the sample with regard to a calibration variable (Kott, 2006; Sanders, 2006). A calibration model can be used to minimize a distance function which is a measure of the difference between the new and initial weights. This is done under the constraint that the aggregated sample values of certain auxiliary characteristics are consistent with the statistical reference data of the total population, and that the sum of the weights for every unit type is the same as the number of units in the population.

Following Deville and Särndal (1992), the variance of the estimated total is:

$$v(\hat{Y}) = \sum_{i \in s} \sum_{j \in s} (\Delta_{ij}/\pi_{ij})(w_i e_i)(w_j e_j) \tag{12}$$

where:
S =
w_i is the calibrated weight for unit i ;
π_i, is the inclusion probabilities for sample unit i;
π_{ij} is the joint inclusion probability for sample unit i and j ;
$\Delta_{ij} is\, \pi_{ij} - \pi_i\pi_j$
$\pi_{ii} is\, \pi_i$;
$\pi_{jj} is\, \pi_j$;
e_i is the residual term calculated for unit i as follows:

$$e_i = y_i - \hat{b}_1 x_i - \hat{b}_0$$

$$\hat{b}_1 = \frac{\sum(x_i - \bar{x_i})(y_i - \bar{y_i})}{\sum(x_i - \bar{x}_i)^2}$$

$$\hat{b}_0 = \bar{y} - \hat{b}_1\bar{x}$$

In the case of stratified random sampling, the inclusion probabilities are calculated as follows:

$$\pi_i = \frac{n_h}{N_h}, if\ i \in U_h$$

$$\pi_{ij} = \begin{cases} \dfrac{n_h(n_h-1)}{N_h(N_h-1)}, if\ i,j \in U_h \&\ i \neq j; \\ \pi_i\pi_j\ , if\ i \in U_h, j \in U_{h'}, h \neq h'; \end{cases}$$

Then formula (12) becomes:

$$v(\hat{Y}) = \sum_{h=1}^{L} \sum_{i \in U_h} \sum_{j \in U_h} (\Delta_{ij}/\pi_{ij})(w_i e_{i)})(w_j e_j), \qquad (13)$$

A1.2.4.2 Imputed weights using statistical matching

Statistical matching uses unit characteristics known for both the sample and the population to identify for each unit in the population a number (three to five) of most resembling sample units (Vrolijk *et al.* 2002). For this purpose, one can distinguish characteristics, which should be fully identical (for example farm type), and characteristics that should resemble as closely as possible (for example farm size). The characteristics used for best possible resemblance can be differentiated in terms of their relative importance by allotting different weights. The core assumption in statistical matching is that units showing resemblance in the imputation variables will also be comparable with respect to the target variables.

After identifying the group of best resembling sample units for a certain unit in the population, these matched sample units receive a weight, in proportion to the degree of resemblance. The sample unit with the best resemblance receives the highest weight. For every unit in the total population the best resembling units are identified and weights are assigned to these units. For every unit in the population, the total weight assigned to the matched sample units equals 1.
The ultimate weight for each sample unit is the sum of all weights allocated to that sample unit. These ultimate weights are used for weighting the sample results (de Goffau *et al.*, 2012).

Since each unit in the population has now an imputed value for the target variable, the average of the population can be calculated. This calculation, however, does not take into account the uncertainty introduced by the imputation process. To estimate the uncertainty of population estimate using imputation, multiple imputations can be used. This means making a number of imputed datasets for the population (or different sets of imputed weights). The variability of these datasets provides information on the variance of the population estimate using imputation. The total variance of the estimate can be divided into the variance of the average given an imputed dataset (within variance) and the variance of the average between different imputed datasets (between variance) (Levy and Lemeshow, 1991). The within variance is calculated as:

$$s_w^2 = \frac{\sum_{i=1}^{k} \frac{\sum_{j=1}^{n} (y_{ij} - \bar{Y}_{Ii})^2}{n-1}}{k}, \quad (14)$$

where k is the number of different imputations, y_{ij} is the value of a unit j in the population, and $\bar{Y}_{Ii}$ is the calculated population mean based on the imputed dataset i. The between variance is calculated as:

$$s_b^2 = \frac{\sum_{i=1}^{k} (\bar{Y}_{Ii} - \bar{\bar{Y}}_I)^2}{k-1}. \quad (15)$$

The estimated variance of the imputed population mean is then calculated as:

$$V(\bar{Y}_I) = s_w^2 + (1 + \frac{1}{k} s_b^2) \quad (16)$$

A1.2.5 Comparing alternative weight adjusting methods

After the weight adjustments, it is important to evaluate the statistical quality of the estimates on their unbiasedness and variance. Furthermore, comparing the adjusted weights with the design weights can offer first insight into the potential problem. Theoretically, two aspects are relevant: the correlation between the adjusted weights and the design weights and extreme weights (Henry and Valliant 2012).

Correlation
When weights are loosely interpreted as the number of units in the population represented by the unit in the sample, it is important to verify whether the weights used are indeed representative of the population structure based on the variable of interest. Since the design weight usually represents the population structure well, higher correlation with the design weight suggests higher representativeness of the adjusted weights. For imputation and calibration methods, high correlation of adjusted weights with the original weights is therefore preferable as the original weights represent the inclusion probabilities that should lead to unbiased point estimates.

Extreme weights
The occurrence of extreme weights can lead to high variance of the estimator and reduces the quality of the estimation. There are no strict rules to define extreme weights or for trimming weights. Different surveys follow different rules and therefore in practice there are several procedures to trim extreme weights. Some common procedures for trimming large weights include: 1) identifying any weight bigger than 4 or 5 times the mean weight as an outlier weight and trimming that weight by making it equal to the limit, 2) identifying any weight bigger than the median weight plus 5 or 6 times the inter-quartile range of the weights and trimming the weight by making equal to the limit, and 3) truncating weights above a certain percentile like 95 or 99 in the distribution of weights (Izrael et al, 2009).

A1.3 Application of weighing methods to Dutch FADN

In this chapter we discuss the practical considerations of applying alternative weights to Dutch FADN and evaluate the outcomes on their statistical quality. We first briefly describe the sets of weights that are currently used in research using FADN data. Then we consider the feasibility and maintainability of implementing this methods and embedding them in the computational environment. After that we assess the representativeness of the estimates and examine the features of the weights. Finally, the standard errors of the estimates using different methods are compared.

For research, various sets of weights are available, based among others on the way that the farm type and size is determined. For the analysis, only one of these weights is used: the one where both CSP (see section 5.3 of the main text) and EU farms are included and where the size and typology is based on information from the census and Standard Output (SO). Only the size and farm type are used as imputation factors and calibration variables.

An alternative way to calculate post-stratified weights is using technical information from the sample to calculate the farm size and determine the farm type. The information from the census is based on one moment in time, while the information from FADN is based on the average number of animals and actual acreage used during the year. Farm size and typology might differ between the FADN information and the information from the sample.

Although in research often these weights, based on technical information of the sample farms, are used, they are not useful for analysing the statistical effects, especially the representativeness. Differences between the information in the FADN and in the sample influence the analysis and mix these differences with sample effects. For that reason we focus on the information available from the census.

For both the calibration and imputation method, farm types had to match exactly. Additionally the farm size expressed in SO is used. For the imputation method the matched farm should resemble as close as possible. For the calibration method, the total of SO per farm type should be at most 1% more or less than the sample.

A1.3.1 Feasibility and maintainability

Besides the theoretical considerations, the estimation methods using different adjustments of survey weights can be compared on practical aspects such as feasibility and maintainability of implementation.

Currently, the weights are recalculated a number of times a year. Especially in the period when every week the administration of more sample farms is completed, a frequent recalculation is necessary. Consequently, it is necessary that a new method can be automated and coupled with Artis2 to obtain estimates and their variance.

For the calculation of imputed weighs, LEI has developed software called STARS. It is possible to start STARS with a batch file. Consequently it is possible to make a procedure in Artis which starts the imputation process. The output of the imputation process can be imported in Artis with the same procedure. This procedure can be started automatically, for example weekly.

The model for calculating calibrated weights is made in GAMS. It is possible to start GAMS from Artis and import the new weights. However, there is one major drawback. If no optimum is found, the model will not calculate new weights. This might especially be the case in the period that not all sample farms are finished.

A possible solution might be that an error log file is generated. However, then the calibration process has to be started by hand, after changing calibration parameters.

A1.3.2 Representativeness

Size in SO

Table A1.1 shows the differences in average size (in SO) based on the stratified weights, imputed weights and the calibrated weights. As you can see, the calibrated weightings are by far optimal. Since the size in SO is the calibration variable, it is not surprising that the difference is lower than the boundary of 1%. Striking is the fact that for a number of farm types, the average farm size based on imputed weights differs more than the stratified weights.

[2] The technical system in which the Dutch FADN data are collected.

Table A1.1

Deviation from average farm size of the target population for the different weighting methods (data 2012).

Farm type	Stratified	Imputed	Calibrated
starch potatoes	2%	-3%	1%
organic crops	-1%	-13%	-1%
other field crops	5%	-1%	1%
peppers	-12%	-16%	-1%
cucumber	3%	0%	1%
tomatoes	-24%	-24%	-1%
vegetables indoor	-3%	-9%	-1%
flower indoor	-2%	-5%	-1%
plants indoor	0%	-4%	0%
vegetables in the open air	-1%	-9%	-1%
specialised fruits	1%	-3%	1%
specialised nurseries	11%	-8%	1%
bulbs	1%	-5%	1%
other horticulture	16%	-18%	1%
organic dairy	0%	-2%	0%
other dairy	4%	0%	1%
calf fattening	0%	-6%	0%
goats	-13%	-15%	-1%
other grazing livestock	7%	-3%	1%
specialised pig rearing	0%	-7%	0%
specialised pig fattening	10%	0%	1%
pig rearing and fattening combined	-7%	-10%	-1%
consumption eggs	1%	-10%	1%
broilers	9%	-4%	1%
other intensive livestock	3%	-5%	1%
mixed farms	3%	-1%	1%

Source: National census and FADN

*absolute differences greater than 5% are highlighted

Other variables

Table A1.2 shows for some additional variables how well the averages of the census are represented by the weighted averages. Some variables are structurally not very well represented by the sample. This is especially the case for the number of paid labour units. Also for some arable farm types, the distribution of the crops differs between the sample and the census. If we look for example at the other field crops, the census has relatively less seed potatoes, sugar beets and winter wheat, and more consumption potatoes.

Table A1.2 shows the most important combinations of farm types and variables. In 17 cases, the imputed average shows the best fit, in 29 cases the stratified and in 34 the calibrated weight is the best. An average of the absolute deviation gives the same order (deviations of 10, 11 and 12% on average).

Table A1.2

Average of census related to average based on different weights (data 2012).

Farm type	variable	Average census	stratified	imputed	calibrated
starch potatoes	hectare arable crops	77,5	0%	-5%	0%
	hectare sugar beet	13,2	21%	15%	19%
	hectare total	78,4	0%	-5%	-1%
	hectare starch potatoes	36,8	-2%	-7%	-4%
	hectare spring barley	10,9	-4%	-6%	-4%
organic crops	paid labour units	1,7	0%	-18%	0%
	hectare arable crops	49,6	-7%	-15%	-7%
	hectare consumption potatoes	5,0	-16%	-21%	-16%
	hectare total	58,4	-8%	-17%	-8%
other field crops	hectare arable crops	54,3	9%	2%	7%
	hectare consumption potatoes	7,5	-23%	-30%	-27%
	hectare seed potatoes	5,4	23%	26%	17%
	hectare sugar beet	6,8	24%	12%	23%
	hectare total	56,7	8%	0%	5%
	hectare winter wheat	16,4	19%	11%	16%
peppers	paid labour units	11,2	-17%	-11%	-16%
	hectare horticulture under glass	5,6	-11%	-16%	-1%
cucumber	paid labour units	9,8	4%	0%	2%
	hectare horticulture under glass	3,2	2%	-1%	0%
tomatoes	paid labour units	23,9	-27%	-25%	11%
	hectare horticulture under glass	7,2	-19%	-18%	12%
flower indoor	paid labour units	5,8	-17%	-18%	-16%
	hectare horticulture under glass	1,7	-9%	-11%	-8%
plants indoor	paid labour units	9,2	-16%	-26%	-16%
	hectare horticulture under glass	2,1	3%	0%	3%
vegetables in the open air	paid labour units	3,5	-1%	-5%	-1%
	hectare arable crops	7,5	-7%	-14%	-7%
	hectare total	24,4	4%	-4%	4%
specialised fruits	paid labour units	1,9	28%	23%	27%
	hectare total	13,9	-10%	-13%	-10%
specialised nurseries	paid labour units	2,9	-25%	-21%	-28%
	hectare total	9,4	5%	-20%	3%
bulbs	paid labour units	3,9	-22%	-19%	-22%
	hectare arable crops	9,1	-23%	-28%	-23%
	hectare total	35,4	2%	-5%	2%
organic dairy	hectare arable crops	13,1	11%	20%	11%
	dairy cows	67,9	2%	0%	2%
	hectare permanent grassland	41,8	-5%	-10%	-5%
	hectare total	59,6	-3%	-4%	-3%
other dairy	hectare arable crops	17,1	9%	7%	5%
	hectare permanent grassland	30,2	0%	-2%	-1%
	hectare total	48,3	3%	1%	1%
goats	hectare arable crops	9,0	-12%	-14%	-14%
	hectare permanent grassland	7,3	42%	46%	42%
	hectare total	17,4	8%	8%	7%
specialised pig rearing	paid labour units	1,0	2%	-10%	2%
	hectare arable crops	8,7	0%	-12%	0%
	SO breeding pigs	641.320	1%	-5%	1%
	SO fattening pigs	36.503	-5%	-21%	-5%
	hectare total	12,1	-2%	-4%	-2%
specialised pig fattening	SO fattening pigs	339.793	13%	4%	4%
	hectare total	10,9	-23%	-25%	-29%
pig rearing and fattening combined	hectare arable crops	14,9	13%	15%	18%
	SO breeding pigs	407.692	-2%	-4%	8%
	SO fattening pigs	474.002	-12%	-13%	-8%
	hectare total	18,7	14%	13%	15%
consumption eggs	SO laying hens	611.843	-3%	-14%	-3%
	hectare total	9,0	-22%	-26%	-22%
broilers	hectare arable crops	16,3	5%	1%	5%
	SO broilers	965.691	6%	-7%	-2%
	hectare total	18,1	9%	1%	10%

Source: National census and FADN

*absolute differences greater than 15% are highlighted

In both the imputation and calibration method, it would be possible to include additional variables for adjusting weights. Using the imputation method, for example information about paid labour can be used as an additional calibration factor. That might improve the fit.

The calibration method also offers the opportunity to add more variables and boundaries. The calibration model can include conditions for which types farms additional variables should be relevant. Where the imputation method always finds farms that will resemble as closely as possible, the calibration method might not find a solution if too many additional variables are added, the limits for the acceptable range should be broad enough. However in that case, the added value of additional calibration variables is limited.

A1.3.3 Comparison of different sets of weights

Correlation
Table A1.3 shows the correlation between the original stratified weight and the weights resulting from the imputation and calibration process. The original weights usually show higher correlations with the calibrated weights than with the imputed weights. The calibrated weights show in general a very high correlation with the original ones. A high correlation of adjusted weights with the original weights is preferable as the original post-stratified weights are an indicator for the inclusion probabilities that should lead to unbiased point estimates. The farm types with the highest improvement in representativeness for the calibration method (table A1.1) have the lowest correlation with the original weights. That relation is not so obvious and logical for the imputation method.

Table A1.3
Correlation between original stratified weights and calibrated or imputed weights (2012).

Farm type	imputed	calibrated
starch potatoes	,795**	,981**
organic crops	,768**	1,000**
other field crops	,694**	,965**
peppers	,613**	,873**
cucumber	,495**	,960**
tomatoes	,558**	,415*
vegetables indoor	,596**	,984**
flower indoor	,588**	,974**
plants indoor	,562**	1,000**
vegetables in the open air	,812**	1,000**
specialised fruits	,883**	1,000**
specialised nurseries	,822**	,997**
bulbs	,799**	1,000**
other horticulture	0,228	,784**
organic dairy	,368*	1,000**
other dairy	,598**	,771**
calf fattening	,602**	1,000**
goats	,664**	0,352
other grazing livestock	,714**	,952**
specialised pig rearing	,370**	1,000**
specialised pig fattening	,542**	,792**
pig rearing and fattening combined	,513**	,822**
consumption eggs	,611**	1,000**
broilers	,575**	,926**
other intensive livestock	,642**	,969**
mixed farms	,775**	1,000**

Extreme weights
Table A1.4 shows the maximum weight per farm type divided by the average weight for that farm type. For some farm types this ratio increases when applying the imputation or calibration method. Table A1.5 shows the maximum weighted size divided by the average weighted size for every farm type. Additionally the maximum share of one farm in the production capacity of a sector is shown. Although the alternative weighting methods generate more extreme weights, this is inseparable from the goal to increase representiveness. The farm types where the representativeness improved the

most such as tomatoes, peppers, goats (table A1.1), have the largest increase in maximum share of production capacity (table A1.5).

Table A1.4

Maximum weight related to average weight (data 2012).

Farm type	stratified	imputated	calibrated
starch potatoes	1,58	2,80	1,97
organic crops	2,47	3,41	2,47
other field crops	2,44	8,10	5,30
peppers	1,52	2,35	1,85
cucumber	1,32	2,49	1,67
tomatoes	1,36	1,67	7,69
vegetables indoor	2,47	2,56	2,54
flower indoor	2,14	3,02	2,14
plants indoor	1,60	2,97	1,60
vegetables in the open air	2,52	2,75	2,52
specialised fruits	3,41	4,25	3,51
specialised nurseries	3,41	3,76	3,84
bulbs	2,39	2,18	2,41
other horticulture	1,31	5,18	3,48
organic dairy	1,18	2,35	1,18
other dairy	1,43	3,94	7,67
calf fattening	1,39	2,45	1,39
goats	1,48	1,91	1,92
other grazing livestock	1,58	3,55	2,41
specialised pig rearing	1,52	2,08	1,52
specialised pig fattening	1,56	6,27	4,75
pig rearing and fattening combined	1,57	3,85	2,40
consumption eggs	1,65	2,36	1,65
broilers	1,97	2,78	3,07
other intensive livestock	1,45	2,42	1,81
mixed farms	3,16	6,24	3,31

*maximum weights greater than 5 times average weight are highlighted

Table A1.5

Weights multiplied by size expressed in SO (data 2012)

	Max divided by mean			share		
Farm type	**stratified**	**imputed**	**calibrated**	**stratified**	**imputed**	**calibrated**
starch potatoes	1,67	2,66	1,69	6%	10%	6%
organic crops	5,22	2,94	5,22	19%	11%	19%
other field crops	3,55	3,42	3,1	2%	2%	2%
peppers	5,34	3,59	8,23	18%	12%	28%
cucumber	2,01	2,44	2,05	7%	8%	7%
tomatoes	2,81	3,6	8,95	11%	14%	36%
vegetables indoor	4,35	3,35	5,07	11%	8%	13%
flower indoor	4,43	5,89	4,52	4%	5%	4%
plants indoor	5,86	4,76	5,86	9%	8%	9%
vegetables in the open air	3,27	2,69	3,27	9%	7%	9%
specialised fruits	2,16	1,91	2,15	5%	4%	5%
specialised nurseries	5,27	3,45	5,1	12%	8%	12%
bulbs	3,51	3,28	3,52	9%	8%	9%
other horticulture	6,86	7,67	4,99	10%	11%	7%
organic dairy	1,42	2,04	1,42	4%	6%	4%
other dairy	1,97	3,63	4,43	1%	1%	1%
calf fattening	2,04	2,5	2,04	4%	5%	4%
goats	2,32	1,95	5,02	12%	10%	26%
other grazing livestock	3,72	3,27	3,05	9%	8%	7%
specialised pig rearing	4,38	3,34	4,38	8%	6%	8%
specialised pig fattening	2,85	2,3	2,45	5%	4%	4%
pig rearing and fattening combined	2,89	3,64	4,91	7%	9%	13%
consumption eggs	2,95	3,13	2,95	8%	9%	8%
broilers	2,63	2,21	2,66	8%	7%	9%
other intensive livestock	4,05	2,47	4,14	12%	7%	12%
mixed farms	3,37	2,46	2,44	4%	3%	3%

**maximum weights greater than 5 times average weight and shares greater than 10% are highlighted*

A1.3.4 Standard errors

Table A1.6 shows the standard errors of estimated farm profit for the three analysed weightings methods. The imputed method shows the lowest standard errors.
For farm types where the representativeness improved when applying the calibration method, the standard errors are higher than the other two methods.

Table A1.6
*standard errors of farm profit, *1,000 euros (data 2012)*

Farm type	stratified	imputed	calibrated
starch potatoes	11	4	9
organic crops	21	8	19
other field crops	8	2	7
peppers	50	21	48
cucumber	45	20	35
tomatoes	211	84	249
vegetables indoor	16	9	17
flower indoor	19	6	19
plants indoor	34	13	35
vegetables in the open air	11	4	11
specialised fruits	15	4	12
specialised nurseries	20	4	19
bulbs	25	8	25
other horticulture	26	7	17
organic dairy	7	3	7
other dairy	3	1	3
calf fattening	6	2	6
goats	20	7	33
other grazing livestock	9	1	9
specialised pig rearing	15	4	13
specialised pig fattening	5	1	5
pig rearing and fattening combined	16	4	16
consumption eggs	21	6	20
broilers	13	3	10
other intensive livestock	214	38	129
mixed farms	10	3	10

A1.4 Conclusions and recommendations

Table A1.7 shows a summary of the results. Unfortunately, no single method is the best on all analysed aspects. While the calibration method improves the representativeness considerably, with a high correlation with the original weights, the standard errors are higher. Also this method might be less easy to implement. If no optimum is found, no weights are found. This makes it harder to implement this method if recalculation of weights has to be automated.

Table A1.7
Summary of evaluation (+ or – compared to alternatives)

	Stratification	Imputation	Calibration
Feasibility	+	+	- No optimum?
Maintainability	- Merged cells have to be maintained	+	+
Representativeness	-	+ Inclusion of more variables will further improve this aspect	++ Inclusion of more variables will further improve this aspect
Correlation with stratified weights	n.r.	0	++
Extreme weights	+	0	-
Standard errors	0	+	0

Advice
As shown in the table, the three weight adjustments all have their advantages and limitations. The choice of the applied method should depend on the objective of the estimation, the problem encountered in the sampling process, and other practical constraints. It is advisable, that when time and resources permit, to compare the outcomes of different methods for statistical qualities and seek

explanations for the differences found. More specifically, when point estimate of the population characteristics is the main objective, calibration is the most suitable method. This is especially the case when the sample is considered not representative with regard to certain characteristics of interest of the target population. The only advantage of imputation is better precision, the method may have lower accuracy.

LEI Wageningen UR
P.O. Box 29703
2502 LS Den Haag
The Netherlands
T +31 (0)70 335 83 30
E publicatie.lei@wur.nl
www.wageningenUR.nl/en/lei

REPORT
LEI 2014-027
ISBN 978-90-8615-694-8

LEI Wageningen UR carries out socio-economic research and is the strategic partner for governments and the business community in the field of sustainable economic development within the domain of food and the living environment. LEI is part of Wageningen UR (University and Research centre), forming the Social Sciences Group together with the Department of Social Sciences and Wageningen UR Centre for Development Innovation.

The mission of Wageningen UR (University & Research centre) is 'To explore the potential of nature to improve the quality of life'. Within Wageningen UR, nine specialised research institutes of the DLO Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment. With approximately 30 locations, 6,000 members of staff and 9,000 students, Wageningen UR is one of the leading organisations in its domain worldwide. The integral approach to problems and the cooperation between the various disciplines are at the heart of the unique Wageningen Approach.

To explore the potential of nature to improve the quality of life

LEI Wageningen UR
Postbus 29703
2502 LS Den Haag
E publicatie.lei@wur.nl
www.wageningenUR.nl/lei

REPORT
LEI 2014-027
ISBN 978-90-8615-694-8

LEI Wageningen UR is een onafhankelijk, internationaal toonaangevend, sociaaleconomisch onderzoeksinstituut. De unieke data, modellen en kennis van het LEI bieden opdrachtgevers op vernieuwende wijze inzichten en integrale adviezen bij beleid en besluitvorming, en dragen uiteindelijk bij aan een duurzamere wereld. Het LEI maakt deel uit van Wageningen UR (University & Research centre). Daarbinnen vormt het samen met het Departement Maatschappijwetenschappen van Wageningen University en het Wageningen UR Centre for Development Innovation van de Social Sciences Group.

De missie van Wageningen UR (University & Research centre) is 'To explore the potential of nature to improve the quality of life'. Binnen Wageningen UR bundelen 9 gespecialiseerde onderzoeksinstituten van stichting DLO en Wageningen University hun krachten om bij te dragen aan de oplossing van belangrijke vragen in het domein van gezonde voeding en leefomgeving. Met ongeveer 30 vestigingen, 6.500 medewerkers en 10.000 studenten behoort Wageningen UR wereldwijd tot de aansprekende kennisinstellingen binnen haar domein. De integrale benadering van de vraagstukken en de samenwerking tussen verschillende disciplines vormen het hart van de unieke Wageningen aanpak.