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# COMPARATIVE ANALYSIS OF ALTERNATIVE SAMPLING PLANS TO CREATE A FARM ACCOUNTANCY DATA NETWORK FOR THE AGRICULTURAL SECTOR OF NAVARRA

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*This study presents the method that was followed and the results of the analysis for establishing a sampling plan for the Farm Accountancy Data Network (FADN) of the commercial agricultural sector of the Spanish Autonomous Community of Navarra. The first part of the study presents the categories considered of the different stratification criteria for the commercial farms of Navarra: geographical units (subregions), types of farming (TF) and economic size in ESU (European Size Unit). Then the authors define sampling plans with different objectives to be compared. These objectives are: i) maximum accuracy in the estimation of the Standard Gross Margin (SGM) for the whole of the commercial agricultural sector, ii) the same accuracy in the various types of farming (TF) and iii) the same accuracy in the individual strata. Special attention is given to the effects of introducing geographical units as a stratification criterion. Given the sample size and the characteristics of the population of commercial farms in Navarra the plan without geographical stratification that gives approximately the same accuracy in each TF seems to be the most suitable sampling plan for the FADN of this region. Even though this study is limited to Navarra, it may be of help when considering sampling plans for FADN not only in other Autonomous Communities but also on a national scale.*

**Keywords:** Farm accountancy data network (FADN), stratified sampling, sample surveys, Navarra

**AMS Classification (MSC 2000):** 62D05

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## 1. INTRODUCTION

In spite of the increasing use of data from farm accountancy networks in European countries to analyse various aspects of the agricultural sector, the accuracy of the information used is not usually studied. Publications on this subject are few and, in general, of restricted diffusion.

This may be due to the complexity of obtaining samples for the networks with which the accuracy of the estimates, relevant to the numerous variables collected from the farms, can be determined.

And this is perhaps the reason why each country in the European Union adopts a different method of obtaining the sample of its farm accountancy data network (FADN), as shown in the Table of Appendix 1, taken from Commission of the European Communities (1989).

So it is not surprising that the statistical sample design of the FADN is one of the aspects suggested for improvement by a group of experts of the concerted action Pacioli[1] (Beers et al., 1995, p. 58).

The aim of this study is to present the method followed to obtain the sample of the FADN of the Autonomous Community of Navarra, a territorial Unit for Statistics of the European Union[2].

The field of observation is the commercial agricultural sector of Navarra that includes farms of an economic size larger than or equal to 4 European Size Units (ESU)[3], which were 11388 in 1989, the date of the last agricultural census in Spain.

There is wide consensus that the sample of an FADN should be obtained after stratification of the field of observation (population), as well as of the stratification criteria to be taken into account: types of farming (TF), economic size (measured in ESU) and geographic area (subregions). These are the criteria suggested by the Commission of the EU and accepted by member states[4].

[1] The concerted action Pacioli (Panel in Accounting of Innovation Offering a Lead-up to the use of Information modelling) recently submitted to the Management Committee of the FADN of the EU a series of reflection papers with suggestions for improvement (Poppe and Beers, 1995 and 1996a; Poppe et al., 1996b). These papers proceed from workshops attended by international experts; the discussions and summaries have been published (see references of the publications in the above-mentioned reflection papers).

[2] The name given by Eurostat to the geografical units that are the base of the organisation of the FADN of the European Union.

[3] A European Size Unit (ESU) is a number of ECUs (1200 in 1997) of standard gross margin. For more information on the definition of this and any other term used in the Farm Accountancy Data Network refer to Commission of the European Communities (1989).

[4] It should be noted, however, that the categories of criteria used differ from one country to another (see

In our opinion, a sample plan for building a Farm Accountancy Data Network for a region must allow for the analysis of different results in the sector (by subregion or TF, for example) without losing sight of the fact that they are integrated in the whole of the regional agricultural sector. The network must also allow a study of the evolution of the sector.

On this basis, the objectives we set will be less ambitions the smaller the size of the sample, i.e. from a small sample size we cannot expect to obtain very accurate estimates in farms of a particular size, belonging to a TF and a particular subregion. In this case, good estimates for the whole TF, the whole region and/or the whole size class, will have to suffice, and it is not possible to obtain accurate estimates in a single stratum: size class * subregion * TF, unless a large part of the sample was allocated to this stratum of the population, thus losing the aforementioned global perspective.

In the case of Navarra, budget limitations restrict the sample size to 400 farms per year, so the problem is to obtain the distribution of the fixed sample size among the different strata of the population.

The first part of this study describes the methodology used, in particular, the classes or groups of different stratification criteria considered by the FADN of Navarra before this study and how they have been modified to obtain the sample. The evaluation procedure and the allocation method of the sample are stated later, as well as the different sampling plan objectives to be compared.

The second part gives the results of comparing the various sampling plans, each one corresponding to a different objective, and the influence of the introduction of subregions as a stratification criterion.

The information for this study was provided by the Department of Agriculture of the Government of Navarra.

As already stated, although the key objective of the analysis of the different plans is to obtain a sampling plan for the FADN of Navarra, we are not aware of studies of farm accountancy networks in which sampling plans with different objectives are compared, nor do we know of studies which analyze the effect of considering or not considering the stratification by geographic units. We believe that these aspects, although referring here only to Navarra, can help in drawing up sampling plans in other Autonomous Communities, as well as on a national scale. Given the diversity of plans used in the EU the problem is still unsolved.

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Commission of the European Communities, 1989) and that some countries add other stratification criteria in their national networks, such as age of the farmer in Holland (Boers and al. 1994) or the farm area and the farm system of work, full or part-time, in Denmark (Institute of Agricultural Economics, 1994).

## 2. METHODOLOGY

### 2.1. Starting Point

The number of agricultural subregions called «comarcas» usually considered in the analysis of the agricultural sector of Navarra is 7[5], and the number of TFs in this Community is 51. The FADN for Navarra considered 8 classes of economic size, in ESU, defined by the boundaries[6]:

4-6, 6-8, 8-12, 12-16, 16-40, 40-60, 60-100 and >100

Consequently, the field of observation should be divided in a first approximation into:

7 SUBREGIONS * 51 TFs * 8 SIZE CLASSES = 2.856 STRATA

Although many of these strata are empty, the number with at least one farm, which is 1036, is much higher than the sample size. So if we want the farms represented by the sample are to be close to the field of observation[7], it is necessary to consider fewer categories in one or more of the three stratification criteria; those taken into account to analyze the distinct sampling plans are presented next.

### 2.2. Categories of the stratification criteria

The seven «comarcas» have been considered in the plans when including the geographical stratification criterion.

The decision on the TFs, or more precisely on the aggregations of TFs, to be considered was one of the most difficult aspects in establishing a sampling plan, since it is impossible to avoid a certain amount of subjectivity in its handling. Table 1 shows the TF groups finally selected, along with the codes adopted in the study (Roman Numerals I to XI), their composition and relative importance in relation to the standard gross margin (SGM) and the total number of farms in the commercial agricultural sector of Navarra.

[5] Nord-occidental, Pirineos, Cuenca de Pamplona, Tierra de Estella, Navarra media, Ribera alta and Ribera baja.

[6] Muñoz Segura, J.C. and Beperet Aizkorbe, M. (1993, p.19).

[7] All or nearly all the strata have to be sampled.

**Table 1.** Aggregation of the TFs for the fadn of Navarra. Importance of the groups of TFs selected

| Notation of the group in this document | Composition of the group (*) | % of the total SGM of the population | % of the total number of farms of the population |
|---|---|---|---|
| TF I | 111+112+113 | 20.0 | 18.9 |
| TF II | 123 | 9.6 | 12.3 |
| TF III | 1244 | 8.1 | 11.0 |
| TF IV | 311 | 3.2 | 3.7 |
| TF V | 411+412 | 8.2 | 7.9 |
| TF VI | 441 | 12.8 | 8.6 |
| TF VII | 421+422+431+432+442+443+444 | 7.2 | 8.9 |
| TF VIII | 5011+5012+5013+5021+5022+5023+ 5031+5032 | 7.9 | 3.3 |
| TF IX | 121+122+1241+601+602+603+604+605+6061+6062 | 12.1 | 14.8 |
| TF X | 711+712+721+722+723+811+813+814+821+822+8232 | 7.6 | 6.5 |
| TF XI | 2011+2012+2013+3211+3213+340 | 3.4 | 4.2 |

(*) The codes of TF and their meaning correspond to those in the «Commission Decision 85/377/EEC, of 7 June 1985», O.J. n° L220, 17-8-85.

To obtain these groups, the relative importance of each of the 51 initial TFs in relation to the standard gross margin of the field of observation in 1989 is used as a starting point. The basic criteria for the creation of the 11 groups were the following: i) not to disregard any TF. This allows estimates for all the field of observation and the analysis of the commercial agricultural sector of Navarra, as well as an indication of its evolution from a global perspective. ii) not to aggregate the most important TFs, so that they can be studied separately. iii) to aggregate the less important TFs with a certain degree of similarity[8].

Finally, five farm size classes were adopted, in ESU, which in EU terminology[9] correspond to: 1. Small (4-8 ESU), 2. Medium-low (8-16 ESU), 3. Medium-high (16-40 ESU), 4. Large (40-100 ESU) and 5. Very Large ((100 ESU).

This division of farm sizes, the one suggested by the Commission of the EU, also corresponds to the optimum aggregation into five classes, if all commercial farms of Navarra are initially divided into the eight classes mentioned earlier. This partition is optimum in relation to the criterion of the accumulated distribution of the square root of the number of farms, proposed by Dalenius and Hodge (1959).

[8]For further details of this or of other aspects of the methodology see Júdez and Chaya (1994).
[9]See Commission of the European Communities (1989, p. 4)

### 2.3. Evaluation Procedure

The essential characteristic used to evaluate the sample of each plan is the coefficient of variation of the estimator of the total of the SGM, which is the same as that of the mean of the SGM[10]. This coefficient is obtained for: i) all the commercial farms of the agricultural sector of Navarra, ii) the farms belonging to the various TFs, iii) the farms of the different «comarcas», when a geographical stratification is used, and iv) the farms of each of the individual strata.

### 2.4. Allocation of the sample to the strata

The two most usual methods of allocating sample numbers to different strata, the proportional method and Neyman method, are compared. Table 2 shows the coefficients of variation of the estimators of the total SGM for the whole of commercial agricultural sector of Navarra and for each type of farming, when the sample is distributed among the strata TF * SIZE CLASS using the proportional method (representative sample) and using Neyman method (optimum allocation).

**Table 2.** Coefficients of variation, as percentages, of the estimators of the total SGM with the neyman allocation and with the proportional allocation for all the commercial farms of Navarra and for different TFs

| | **Allocation** | | **(Proportional / / Neyman)*100** |
|---|---|---|---|
| | **Neyman** | **Proportional** | |
| Navarra | 1.14 | 4.23 | 372 |
| TF I | 2.66 | 3.87 | 145 |
| TF II | 3.75 | 5.59 | 149 |
| TF III | 4.04 | 4.15 | 103 |
| TF IV | 7.10 | 8.20 | 116 |
| TF V | 3.98 | 6.48 | 163 |
| TF VI | 3.05 | 26.66 | 874 |
| TF VII | 4.34 | 5.20 | 120 |
| TF VIII | 3.36 | 22.44 | 668 |
| TF IX | 3.19 | 9.12 | 286 |
| TF X | 4.18 | 7.88 | 188 |
| TF XI | 6.29 | 7.27 | 115 |

[10] In the future when we talk of the accuracy of the estimator of the SGM, we refer indistinctly to the estimator of its mean and of its total, since they have the same coefficient of variation.

The coefficient of variation for the whole of Navarra is 272 % higher when proportional allocation is used. This percentage varies between 3 % and 774 % in the estimates of the different TFs. The considerable advantage of Neyman method over the proportional allocation in our case led us to compare sampling plans which we now analyze, using only the optimum allocation.

### 2.5. Sampling plans to compare

Once the categories of different criteria to stratify the field of observation have been defined, the sampling plans corresponding to the following objectives are evaluated: i) maximum accuracy in the estimates of the whole of the commercial agricultural sector of Navarra, ii) the same accuracy in the estimates of each TF, iii) the same accuracy in each of the strata.

These plans are first evaluated without introducing the «comarcas» as a stratification criterion; the consequences of its introduction studied later[11].

## 3. RESULTS

### 3.1. Sampling plans without geographical stratification

Table 3 shows the coefficients of variation of the estimators of the SGM of the sampling plans associated with each of the three objectives mentioned earlier, and Table 4 presents the characteristics (maximum value, average and coefficient of variation) of the coefficient of variation of the estimators of the SGM in the distinct TF * SIZE CLASS strata[12] for these plans. We make the following comments on these Tables:

1. The best accuracy in the estimates of the SGM for the whole of the field of observation is obtained, logically, in the plan whose objective is to maximise this accuracy, which corresponds to a coefficient of variation of 1.14 %. This plan presents a strong heterogeneity in the accuracy of the estimates of the SGM in each TF (coefficients of variation varying between 2.66 % and 7.10 %) and in each stratum, where the average of the coefficient of variation is approximately 10 %.
2. In the plan designed to obtain the same accuracy for the different TFs the average of its coefficient of variation, 3.74 %, is the lowest of the three plans studied.

[11] The determination of the SGM, its mean and variance in the new strata when the categories of some stratification criteria were aggregated or divided the allocation of the sample to the strata and the evaluation of different sampling plans were carried out using Fortran programs elaborated by the authors.

[12] This concerns the characteristics of the non zero coefficients of variation.

3. The homogeneity of the coefficients of variation of the estimators of the SGM of the strata, for the plan designed to obtain the same accuracy in the estimates of the SGM of each stratum, is accompanied by a very high coefficient of variation for these estimators (about 8 % on average).

4. Having to disregard good accuracy at an individual stratum level (the average of the coefficients of variation of the estimators of the SGM in the strata go from 8 % to 10 % in the plans studied), the choice of a sample plan must be made by comparing the accuracy of the estimators of the total SGM for all the commercial farms of Navarra and for each of the TFs.

In view of these results, the plan aimed at achieving accuracy among the TFs seems to be the most interesting; it leads, in general, to the most accurate estimates in each TF, and the accuracy of the estimator of the SGM for all the commercial farms of Navarra is only slightly inferior to that of the plan aimed at optimising the accuracy of this estimator. The distribution of the sample among the strata is shown in Table 5.

**Table 3.** Coefficients of variation (CV), as percentage, of the estimators of the total SGM for all the commercial farms of Navarra and for the TF, according to different objetives

| | **Objectives** | | |
|---|---|---|---|
| | **Maximum accuracy Navarra estimate** | **Same accuracy TF estimates** | **Same accuracy strata estimates** |
| Navarra | 1.14 | 1.26 | 1.35 |
| TF I | 2.66 | 3.76 | 4.21 |
| TF II | 3.75 | 3.74 | 3.92 |
| TF III | 4.04 | 3.71 | 4.16 |
| TF IV | 7.10 | 3.76 | 4.13 |
| TF V | 3.98 | 3.71 | 3.18 |
| TF VI | 3.05 | 3.74 | 3.62 |
| TF VII | 4.34 | 3.72 | 4.10 |
| TF VIII | 3.36 | 3.77 | 4.22 |
| TF IX | 3.19 | 3.76 | 3.95 |
| TF X | 4.18 | 3.75 | 3.93 |
| TF XI | 6.29 | 3.73 | 3.82 |
| Average of TF coefficients | 4.18 | 3.74 | 3.99 |
| CV ( %) of TF coefficient | 31.07 | 0.50 | 4.48 |

**Table 4.** Maximum value, average and coefficient of variation (CV) of the coefficients of variation ( %),of the estimators of the total SGM of the strata according to different objectives

| | **Objectives** | | |
|---|---|---|---|
| | **Maximum accuracy Navarra estimate** | **Same accuracy TF estimates** | **Same accuracy strata estimates** |
| Maximum | 22.845 | 21.315 | 9.401 |
| Average | 10.004 | 9.031 | 8.057 |
| CV ( %) | 37.035 | 32.235 | 4.378 |

**Table 5.** Sample to obtain the same accuracy of the estimators of the total SGM of each TF

| **TFs** | **SIZE CLASS** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | |
| TF I | 5 | 8 | 18 | 8 | 1 | 40 |
| TF II | 9 | 8 | 10 | 4 | 6 | 37 |
| TF III | 9 | 11 | 10 | 2 | 3 | 35 |
| TF IV | 6 | 8 | 15 | 7 | 1 | 37 |
| TF V | 5 | 9 | 11 | 5 | 6 | 36 |
| TF VI | 2 | 6 | 12 | 8 | 4 | 32 |
| TF VII | 8 | 11 | 12 | 5 | 1 | 37 |
| TF VIII | 1 | 2 | 7 | 8 | 23 | 41 |
| TF IX | 8 | 10 | 9 | 3 | 7 | 37 |
| TF X | 3 | 7 | 13 | 7 | 8 | 38 |
| TF XI | 8 | 6 | 9 | 5 | 2 | 30 |
| TOTAL | 64 | 86 | 126 | 62 | 62 | 400 |

### 3.2. Influence of the introduction of the geographical stratification

The introduction of the geographical stratification, which, as seen above, adds a criterium with seven categories, increases the number of strata (11 TFs * 5 SIZE CLASS) to 385. Of these strata, 90 contain no farms.

If the aim is to obtain unbiased estimates, it is necessary to sample at least one farm from each stratum with farms. This means that given the small sample size, in many of

the strata only one farm can be selected, and that the handling of this sampling plan will be more difficult than if the subregions were not used as a stratification criterion[13].

Table 6 allows us to compare the coefficients of variation of the estimators of the SGM, in the whole commercial agriculture sector of Navarra and in the different TFs, when the allocation of the sample is made with and without geographical stratification[14]

**Table 6.** Coefficients of variation (%) of the estimators of the total SGM for the allocations with and without geographical stratification for all the commercial farms of Navarra and for the different TF

| | **Without geographical stratification** | **With geographical stratification** |
|---|---|---|
| Navarra | 1.14 | 1.34 |
| TF I | 2.66 | 3.20 |
| TF II | 3.75 | 4.34 |
| TF III | 4.04 | 4.66 |
| TF IV | 7.10 | 8.18 |
| TF V | 3.98 | 4.75 |
| TF VI | 3.05 | 3.72 |
| TF VII | 4.34 | 4.78 |
| TF VIII | 3.36 | 4.18 |
| TF IX | 3.19 | 3.77 |
| TF X | 4.18 | 4.81 |
| TF XI | 6.29 | 6.78 |

The Table shows that the accuracy of the estimators of the SGM for all the commercial farms of Navarra and for each TF worsens when the subregion is introduced as a stratification criterion.

This disadvantage of the stratified sample by «comarcas», illustrated in Table 6 in the context of a sampling plan to obtain the maximum accuracy in the estimate of the SGM for the whole of the field of observation, is also found when the objective is to reach

[13]Difficulties will be found in obtaining farms for all the 293 strata, especially given the small number of farms in many of them (33 strata contain only one farm).

[14]When geographical stratification is used, the coefficients of variation of the estimator of the SGM in each «comarca» are: 3.32 in the Nord-occidental, 4.54 in Pirineos, 3.98 in Cuenca de Pamplona, 3.57 in Tierra de Estella, 3.88 in Navarra media, 2.96 in Ribera alta and 3.16 in Ribera baja.

the same accuracy in each TF. The lower level of accuracy is unexpected. In our case, it is due to a combination of two facts: the large number of strata with a small number of farms, and the small size of the sample compared to the number of strata. A detailed analysis of this result can be found in Júdez and Chaya (1999).

## 4. DISCUSSION AND CONCLUSIONS

We have seen that in our case, the optimum allocation of the sample gives estimates that are considerably more precise than those using proportional allocation. However, this type of allocation calls for a high proportion of holdings of the largest size classes in the sample[15], due to the high variance of the SGM in these classes. This can create a problem if it is difficult to rely on the collaboration of the large farms with the network. In this case, although one or more of the farms that should appear in the sample is not surveyed and the objective sample cannot be reached, it is foreseen that the estimates obtained from this «possible» sample are more accurate than those that would be reached with a proportional allocation. One can also analyze the larger strata in detail and detect the farms which contribute most to the variance of the strata, in order to include all of them in the sample. Then, the rest of the farms in the strata can show a decrease in the variance, and in consequence the number of farms to be included in the sample of these strata will also decrease.

For estimates of means and totals, a weighting is needed for each stratum. This makes the estimates with the sample in which the «comarca» is not considered as a stratification criterion, simpler and less subject to error than those when this criterion is adopted. The problem of weighting is worsened if the same weights are maintained for ten years (time between two censuses). Besides, as seem above, the estimates are less accurate in our case, and the sampling plan more difficult to handle, when the geographic stratification is considered.

If it were essential to obtain estimates at a subregional level, the handling of the sampling plans dealt with in this study can be improved in two ways: one, by reducing the number of categories of some of the stratification criteria (the criterion chosen could be the economic size) and secondly, by not sampling the less important strata. The first option when reducing the number of economic size classes increase the variance of the estimates[16], and the second, used by some EU countries lead to biased estimates. An analysis of the consequences of this later procedure in our case will be made in a future study.

[15] In some TFs, the optimum allocation contains all the farms of the size class ( 100 ESU.

[16] For a detailed analysis of the effects on the SMG estimates of reducing the categories of the stratification criteria considered here, see the above mentioned work of Júdez and Chaya (1999).

Considering the disadvantages of the sampling plans with geographical stratification if estimates by subregion are not essential, as in the case of Navarra[17], a sampling plan in which these are aggregated seems to be more suitable. To try to obtain good estimates in the individual strata does not make much sense in our case given the size of the sample, and these estimates are not very accurate in any of the plans studied.

When the estimates of great interest are those related to the different TF, the sampling plan without subregional stratification, aimed at of obtaining comparable accuracy in the estimates of the distinct TFs, is the best of the plans studied. In fact, this plan, not only provides the greatest homogeneity in the accuracy of the estimates of the SGM of the TF, but it also gives the smaller coefficient of variation of the estimator in each TF. The accuracy that can be expected in the estimate of the whole commercial agricultural sector of Navarra with this sampling plan is very close to that of the plan aimed at maximising the accuracy of this estimate.

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The authors consider themselves responsible for any errors in this article.

[17] In Navarra, the estimates of the agricultural sector of greatest interest at a subregional level, are actually already obtained by other procedures.

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**Appendix 1.** Sampling procedures in different countries of the european union

| | **Determination of sample size** | | | **Method of selection** |
|---|---|---|---|---|
| | A fixed number of farms from each cell in the field of observation | A fixed proportion of farms from each cell in the field of observation | A variable proportion-taking account of variability in the field of observation | |
| Belgique | | | Yes | Non-random |
| Danmark | | | Yes | Random |
| Deutschland | | | Yes (Neymann-Tschuprow) | Random |
| Ellas | Yes | | | Non-random |
| España | | 1 % (except for large cells where sample is increased) | | Non-random |
| France | | | Yes | Random |
| Ireland | Yes | | | Random |
| Italia | | | Yes (Neymann-Pearson) | Non Random |
| Luxembourg | | Yes | | Random |
| Nederland | | | Yes | Non-random |
| Portugal | | Yes | | Non-random |
| United Kingdom | | | Yes | Random |

Source: Commission of the european communities (1989, p. 21).