

Methodological challenges for agricultural statistical system

Sfide metodologiche per il sistema delle statistiche agricole

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Riassunto: in questo lavoro, dopo un cenno alle richieste che il settore delle statistiche agricole del sistema Statistico nazionale dovrà soddisfare nei prossimi anni ed alle principali innovazioni effettuate dal Servizio Agricoltura nelle indagini strutturali e congiunturali nell'ultimo quinquennio, vengono suggerite alcune linee di ricerca che si ritengono prioritarie per il miglioramento del livello qualitativo delle statistiche ufficiali del settore agricolo. Poiché, la fase di raccolta dei dati e di controllo e correzione è stata oggetto di importanti investimenti negli ultimi anni consentendo, un significativo miglioramento in termini di tempestività, particolare interesse dovrà essere posta nei prossimi anni sulle metodologie che permettono un più efficiente impiego delle informazioni disponibili.

Keywords: balanced sampling, calibration, data management, expert information, quality report, sampling design, small area estimation, surveys process, web surveys.

1. Introduction

Before describing such research programs, it's necessary to mention that the agricultural official statistics output is entrusted to several institutions. Among them, besides Istat (Italian National Statistics Institute) must be mentioned the "ministero delle Politiche Agricole e Forestali (MIPAF)", l'istituto Nazionale di Economia Agraria, the "Agenzia per le erogazioni in agricoltura (AGEA)", the "Istituto Nazionale di Economia Agraria (INEA)", the "Istituto di Servizi per il Mercato Agricolo Alimentare (ISMEA)", the regional statistical offices, the "Istituto Ricerche Economiche per la Pesca e l'Acquacoltura (IREPA)".

The collection of the official statistics is described in the National Statistical Program and can be synthesize in about 60 projects. The majority of them are surveys carried out on farms or other units acting in the agri-food branch. The discussion, the selection and the coordination of these projects takes place during the quality circle (CdQ) in which all the statistical institutions and the main trade associations are represented.

In Italy the official agricultural statistical activities are managed by Istat and in general by National Statistical System (SISTAN) that are constantly aimed to improve the produced and disseminated information.

In this paper the necessary and still being tested innovations that SISTAN and in particular its agricultural sector have detected to satisfy users needs, will be described.

In order to describe the research choices undertaken, it's necessary, besides defining the statistical output as the result of the transformation of the collected or available information, to specify:

- which will be the development of the statistical products request;

- their needed quality and the factors influencing it;
- the sources and the information cost to obtain such products;
- the statistical methods and instruments able to obtain the needed quality.

In this paper it will be showed how to improve the quality even though the problem of the definition of a satisfactory quality threshold arises. The latter will be one of the most important challenges for all the system.

The paper is structured as follows. Section 2 summarized the main needs, in terms of product, that SISTAN will have to face with; section 3 will remind the most important innovations introduced in surveys statistical processes in last 5 years; finally section 4 will list some of the most significant line of research activated by Istat agriculture department or felt as essential to meet the quality standards requests by the community.

2. Some development of statistical information requests

Agricultural statistics have always held a prominent place in the EU statistical system, reflecting the high degree of integration of EU agriculture, the importance of the Common Agricultural Policy (CAP) in the EU budget and the essential role of agricultural statistics in the decision-making process of the CAP.

The European Statistical Program, currently under discussion for 2008-2012, reflects such importance as well as the cornerstones of CAP reform mainly focused on rural development, environmental compliance and food safety (Commission of the European Communities, 2005). It contains a set of proposals on statistical processes and products.

As for the processes, the most significant proposals are:

- structural statistics could be less frequent but should meet the need for detailed and sometimes specific geographical breakdowns;
- short term statistics should be integrated and simplified through the implementation of a new system for data collection and delivery;
- the farm statistical register should be built up in each country following common standards;
- statistical burden on units should be reduced by favouring the use of alternative source of information (e.g. administrative sources) other than statistical surveys;
- the use of the Internet should be encouraged– not only for data dissemination to end users, but also for other parts of the statistical production.

Concerning the phenomena of interest, European Commission suggests to devote greater attention to the following topics:

- organic farming, organic food market and food safety;
- rural development (crops for bio-fuel and GMO crops, renewable energy, certified production, other gainful activities);
- Forestry statistics: with particular attention to the development of a comprehensive set of criteria and indicators needed for the environmental and sustainable management of the forests and the wood-derived industries.

Such requests will be very resources demanding. Moreover, some of these information are requested by local administrations usually at a very detailed geographical level or on not planned domains of study. Some simple examples are the requested concerning the following topics: local effects of European and national policies; local relevance of farm

activities other than traditional agricultural activities (agritourism, production of renewable energy, maintenance of territory, educational activities, etc), rural quality of life, multifunctionality, etc.

Furthermore, statistics on topics not yet covered by European regulations are of great interest for national and local policy makers. Some of them concern social and structural changes of rural population and means of production: seeds for traditional and organic productions, feeds and fertilizers. It should be noted that the heterogeneity of Italian agriculture characteristics makes difficult to face these problems using traditional sampling surveys or estimation methods.

The requests formulated by ESS, reflecting European policy makers needs, address the research towards emerging issues such as:

1. definition of an European “common statistical language” of concepts, classifications and methodologies;
2. common standards to build up farm statistical register;
3. definition of agricultural holdings and set up of a threshold that states the minimum size for the inclusion in the Census or the sampling survey and allows comparison of statistics throughout European countries;
4. a larger use of Internet;
5. policies and tools for confidentiality management in the ESS;

Actually the methods used by Istat allow to meet the quality requirements of European Regulation. However some new technical tools and statistical methods need to be developed or gained by Istat in order to satisfy the requests coming out from national users.

In the following paragraphs a list of promising technologies and methods is presented and described. All of them share a common feature: a better use of the information available.

3. Improvements already achieved

In this paragraph, after a short review of the basic sampling design used in the official statistics on agriculture, some of the main innovations introduced in last years by Istat in the survey processes are described with reference to short term and structural surveys.

Basic sampling design

Farms surveys have been based, for years, on frames, methods and techniques not coherent among them (Benedetti, 2000). The above situation has prevented for long time to satisfy the minimum requirements of integration or at least comparison of the obtained estimates. Such considerations led Istat to study a complex structure of surveys based on the logic of subsamples selected from a “master” survey taken as reference frame. The Farm Structure Survey that has been performed during 90’s, seemed naturally answer to these question. Moreover, this survey had a dimension able to make it possible to utilize the above subsamples to produce estimates on variables that are not those for which the structure survey had been designed.

This structure worked very well for some surveys (some short term surveys as subsamples of FFS), but created some problems in the case of the bigger structure

surveys. Such problem was mainly due to difficulties in coordinating the survey processes carried out by different network of interviewers and for the levels of response burden caused by two or more very demanding questionnaire. For these reasons, as it will be remarked in the follow, the sampling scheme for some surveys has been modified after the 2000 census moving away from the subsampling rule.

Short term surveys

In last years, some innovations have been brought in this area with the main objective to save time and computational costs needed in the data management. Such innovations allowed for an increase of the other quality dimension of disseminated information too.

In particular, the experience showed the necessity to develop a tool useful to work on surveys, carried out several times on the same units. In fact existing products were not fit for being adopted in a suitable way to the panel approach commonly used in short terms surveys.

Such tool, whose acronym is AGAIN (*Analisi e Gestione Automatica delle Indagini*), is a generalized system for the complete and unitary management of ISTAT surveys on agriculture. The main utilities contained in such system are the following (Benedetti *et al.*, 2001):

- 1) designing the sample. The procedure is multivariate and uses, in the case of stratified sampling, a generalization proposed by Bethel (1989) of Neyman's classic formulas for the calculation of optimum numerosity;
- 2) producing estimates and relative sampling errors. This module enables estimation of the totals of each variable of interest, as well as the relative sampling errors, by means of the Horvitz-Thompson estimator. It also permits adjustment of the basic sampling design weights by total non-response, producing the so-called 'base weights'. These weights can be adjusted further in AGAIN by means of calibration (Deville and Särndal, 1992), so that the current survey estimates are coherent both with those produced by other surveys and with the information yielded by the reference frame;
- 3) data editing. this module has been designed to fully exploit the sample designs developed to better use auxiliary information, and to facilitate the detection of possible errors in the raw data. The strategy selected to detect errors is mainly based on a data 'navigation' approach, rather than on an algorithmic structure. It was decided not to use a Fellegi-Holt approach, for two main reasons: (i) when AGAIN was developed some technical problems didn't allow an easy integration with GEIS (the software implementing the Fellegi-Holt methodology; Fellegi-Holt, 1976), (ii) only if the errors present in the data-set to be checked are stochastic in nature this method detect errors in an optimal manner, but in the case of short term statistics most important errors were represented by outliers or by systematic errors, (III) furthermore the questionnaire structures of short terms survey are quite simple and the edits used to check the data can be managed without the use of GEIS. For these reasons priority was given to develop an *ad hoc* flexible correction modules allowing for various strategies of intervention (manual or automatic) on data with respectively greater or lesser relevance to the final estimates. The operations can be carried out easily through AGAIN's implementation of SAS® procedures which, by virtue of the new technological frame introduced in the SAS/AF® module, ensure high interactivity and high-resolution graphic images.

Structural surveys

Just after the agricultural Census carried out in 2000, structural surveys have been submitted to a deep revision mainly aimed at gaining punctuality and timelessness in data dissemination.

Indeed, Farm Structure Survey 2003 final results (microdata) were planned to be delivered to Eurostat by the end of December 2004, while for the 2005 edition the deadline has been anticipated to the end of October.

For the survey on economic results of agricultural holdings (RICA-REA) the objective is to issue, starting with the 2005 edition, the final results in 16-18 months by the end of the reference year. At the moment the process takes more than 28 months.

To meet these quality goals, the analysis of the surveys processes flows suggested improvement on the following aspects:

1. sampling design;
2. data entry;
3. data editing.

The following reasons explain why the innovations was needed:

- FSS is carried out through a tightened collaboration among Istat and the regional administrations in charge of data collection and partly of survey design planning;
- RICA-REA survey is carried out through a tightened collaboration between Istat and INEA that is in charge of Italian FADN survey.

FSS sampling design. The main innovation regarded the principle the sampling design is based on (Ballin e Salvi, 2004). The search for an optimal sampling scheme has been indeed substituted by the merge of a set of sampling designs optimised at regional level. The changes regarded: (1) introduction of a take all stratum and definition of stratification considering regional peculiarities; (2) introduction of local objectives as constraints to the definition of sample size and allocation; (3) exclusion from the sampled population of very small farms surveyed by previous editions of the surveys even though they were outside the scope of FSS regulation. These holdings didn't contribute significantly to the phenomena observed by the survey but they caused the biggest problem in all phases of the survey because of difficulties in updating their contacts, high nonresponse rate, outliers, check and editing step. It is understood that steps 1 and 2 were allowed only by the significant contribution of regional administrations. This approach resulted in a sample size of about 55.000 units with a reduction of about 30.000 units. It should be underlined that such reduction didn't affect the expected sampling errors at national level with respect to the surveys editions carried out in 90's.

RICA-REA sampling design. The new sampling design reflects the choice performed by SISTAN on carry out a single survey on the economic result of agricultural holdings (Corsetti *et al.*, 2004). Two independent economic surveys, indeed, were carried out in Italy until 2002. The first one, named REA, used to be conducted by Istat on a subsample of FSS survey with the aim of obtaining information suitable for SEC 95. The collection of data was performed by retrospective interviews. The second one, named RICA, was carried out by Inea on a voluntary sample in order to accomplish to FADN regulation. The collection of data was performed by an ongoing recording of bookkeeping data. The two surveys differ both on reference

population and variables of interest. The RICA's reference population was included in the REA's one and, on the opposite, the whole set of information asked by REA were deducible from RICA variables. The new sampling design was defined considering both the objectives of REA and the objectives of RICA and the constraints given by resources devoted to data collection. The main features of this new sampling design are:

- expected coefficient of variations have been fixed both on REA and RICA variables of interest;
- about 80% of sample size has been resulted from RICA reference population;
- the sample is negatively coordinated with FSS sample in order to reduce the response burden
- voluntary units have been admitted as self representative units;
- a take all stratum has been defined for more influent units.

This changes will allow Istat, after the 2003 testing, to benefit from the well-organized network of INEA interviewers and Inea to avoid some biases due to the voluntary sampling scheme previously adopted.

The second aspect under revision for both surveys has been the collection and data entry process.

FSS collection and data entry step. For this survey data collection phase after the PAPI interview followed these steps:

- the filled in questionnaire were collected by a regional coordinator in charge of a first revision;
- the questionnaire correctly compiled or compiled with minor errors were delivered to istat;
- Istat carried out a second and deeper revision on paper questionnaire and after this check the data entry phase were performed by a company in charge of the software development too;
- in case of hard errors each actor referred to the responsible of the previous step for a solution (company in charge of data entry referred to Istat, Istat to regional coordinator, regional coordinator to the interviewer).

To avoid the timelines problems arising from this procedure it was decided to make data collection and data entry steps closer to the interview. The interview is still carried out by *PAPI* because it is recognised as a good technique to interview the farmers but interviewers, or other personnel in touch with him, are supplied with a data entry tool developed by istat using BLAISE. Hard errors are corrected directly by interviewers.

RICA-REA collection and data entry steps. In the case of REA these steps were performed as in the case FSS and of course it encountered the same problems. The collection step of RICA was carried out using a software (CONTINEA) developed for bookkeeping purposes and asking for an ongoing collection of data during the year. This method has been maintained after the two surveys were joined for those units accepting the burden/service offered by this software. For the others units a PAPI interview is performed but the interviewer network has been supplied by a new friendly software for the data entry. As in the case of FSS this innovation allowed for a significant gain of efficiency and reduction of non sampling errors.

Both survey have taken benefits from the reduction of errors during the data collection and data entry step. Nevertheless important changes have been introduced in the check phase. In particular, a structural version of the software “AGAIN”, including all steps of survey management following the data collection and data entry steps, has been developed. Some utilities as sampling design and selection step have not been included in the structural version. It shares with the short term version the friendliness and other than graphical and numerical methods for macro and micro editing, outliers detection using cross sectional and longitudinal information, it includes the Fellegi-Holt methodology that showed its suitability to check and correct not influent errors. Another features of structural version of AGAIN is that it allows that some operators work simultaneously (Ballin *et al.* 2004).

4. Future challenges

The innovations described in the previous paragraph (sample design, data collection and data entry, automation of data check) allowed a significant gain in timeliness. Some improvements have been realized also in terms of non sampling errors, response burden for the units and, through the recourse of AGAIN, in documentation of survey process. Nevertheless the quality of the agricultural statistics needs other improvements mainly regarding accuracy, accessibility and coherence among surveys. All the results should be achieved having in mind the need for a reduction of the response burden on units. The keyword to obtain these results is a more efficient use of the available information. In the following some areas of possible improvements are listed and methods currently under investigation are described.

Sampling design. The major innovation will be given by the availability of the register of agricultural holdings yearly updated on the basis of administrative archives. This register will allow a better implementation of the sampling scheme previously described based on FSS as a master sample.

The proposed modifications of the currently adopted sampling scheme includes:

- the use of balanced sampling in order to reduce the sample size by a better use of the administrative information contained in the register; (Benedetti *et al.*, 2004)
- the coordination of samples in order to reduce the burden on units and to exploit the efficiency of the networks of interviewers. Sample for structure surveys will be negatively coordinated. The overlapping among some short term surveys and FSS will be maintained for those surveys that can be carried out by the same network of interviewers or in the same period;
- the use of panel approach to allow for longitudinal analysis and monitoring activities of the farm structures will be confirmed.

Data collection. As it has been pointed out by some authors web surveys are now a fact of life. For this reason the Agricultural Statistical Service in Istat started investigating the suitability of this data collection for agricultural topics. The results obtained in surveys on households and enterprises showed that web surveys can be assimilated to CATI surveys. Nevertheless some doubts arise in the

case of surveys on farms since, as Census 2000 demonstrated, internet connection is not largely spread among farms and its availability usually related to size (the farms using internet being the biggest ones). However some promising results have been achieved in case of the survey on fishing in lakes, carried out through the Chamber of Commerce.

An additional web survey will be put on trial on farms managed by public institution (mainly Municipalities) usually characterized by large extension of fallows and forestry.

Estimation method. This is the field where greater improvements are needed. At the moment the agricultural statistics based on sample surveys are obtained using linear estimators. Units weights are adjusted by calibration method in order to correct for total non response or to achieve some coherence with results issued by some other surveys. Most of times the main aim of calibration is to obtain sufficient accuracy at regional level.

Two main limits should be underlined in the way the calibration approach is currently applied.

The first one regards the search for the models used in the calibration step. Most of the times the search for these models is not supported by an economical or by a causal analysis of the relationship among auxiliary variables, regional characteristics and phenomena of interest. It is easy to demonstrate that this lack of analysis negatively affects the efficiency of the estimators. For this reason, as in the case of the sampling design, the main contribution to the model definition could derive from the knowledge of regional characteristics owned by local experts. Furthermore, local experts are the only owners of the necessary knowledge needed to carry out estimates using small area estimation methods. In this field some very promising results (Pratesi and Salvati, 2004) have been obtained in the framework of a projects¹² carry out jointly by Universities of Cassino, Florence and Pisa and by Istat.

The second aspect regards the effects on accuracy of the estimates when sampling errors affect the benchmark used for model specification. Neglecting this issue can entail a relevant underestimation of the variance components. Some results on the minimal level of accuracy required to improve estimates efficiency using calibration has been obtained by Ballin and Martino (2004) in a pilot exercise conducted using 2003 FSS and AGRIT data on four regions (*Piemonte, Veneto, Lazio, Emilia Romagna*). The total agricultural area was used as auxiliary variable, while vector of variables of interest included total area for *cereals*, grain maize, *apple tree*, *potatos*, *wineyard*, *UDE* and number of cattle. However, if we are looking for a integration among surveys that enables an improvement of the accuracy, a deeper investigation for the case with multivariate auxiliary variables would be needed.

Finally, it is currently under investigation a method based on the Bayesian Network for a model-assisted approach supporting nonlinear estimators. Some results on this topic can be found in Ballin, Scanu e Vicard (2005).

¹ Progetto di ricerca di interesse Nazionale “innovazioni nelle indagini campionarie nel sistema delle statistiche agroambientali: metodi, organizzazione, contenuti”

² Progetto di ricerca di interesse Nazionale “l’informazione statistica in agricoltura: necessità attuali e sviluppi futuri”

Elicitation. Expert information, as it was pointed out previously, is certainly one of the most important sources of knowledge useful to improve the estimators used in sample surveys. Such information has been mainly used until now to produce short term statistics on crops. At the moment the experts information is collected using a Delphy method. The quality of the estimates derived can be evaluated only looking at the historical results because at the present time process cannot be documented. Furthermore, no experiment have been carried out in order to integrate the statistics obtained by such expert information and results belonging to other source of information.

Even though no much literature exists nowadays on how to combine evaluations provided by experts an direct observation, one of the most promising method in this field seems to be the Bayesian approach (see for instance, Martin et al., 2005). The idea can be summarized as follow. Let us suppose that one wants to estimate the parameter θ of the distribution of the variable y (for instance the area invested to a specified crop in the current crop year) and that two sources of data are available:

- information deriving from experts elicitation, available in advance respect to any direct data collection and characterized by high variability;
- a sampling survey whose results are available in a second time, but extremely accurate .

Based on this approach, the distribution of y , elicited from experts opinions, can be treated as a sort of "a priori" information. The results of the a direct investigation can be thought as the likelihood - available in a second time but extremely concentrated around the mean value of the direct observations. The update of the prior distribution in the posterior distribution - obtained through the information furnished by the likelihood recurring to the well-known Bayes theorem - allows to conduct the inference on the parameters exploiting both the evaluation made by the experts and the results of the investigation in ground.

An official statistics sector where the application of this strategy appears promising is represented by the short terms statistics on crops areas and production. Here the main source of data is currently represented by the investigation based on experts estimation conducted by the National Institute of Statistics, but other data are made available through sampling survey during the crop year.

The experts evaluations are formulated by a network of experts having knowledge at the local level. They produce, during the crop year according to a pre-scheduled calendar, information on the areas invested to the main crops and the related harvested production. The enquiry satisfies the demand to provide early estimates with an elevated level of territorial detail but it has the limit not to furnish indications on the reliability of the estimates.

The adoption of this approach in the context of short term statistics on crops, while providing more accurate statistics, would also allow to give robustness to the statistical production process. It would guarantee, indeed, the management of the following situations:

- not informative prior (absence of experts evaluation): estimates based uniquely on the likelihood (sampling survey estimates based on direct observation);

- no likelihood (lack of data collected in field): estimates based uniquely on the prior information (experts evaluations);
- informative prior (experts evaluations) and available likelihood: estimates based on the posterior distributions.

Quality reports and quality level. Even if quality reports, written following Eurostat's guidelines, have been issued for structure surveys in last years, a lack of information on the quality of agriculture official statistics can be complained. For these reason a project aimed in delivering more accurate evaluation on the quality level have been put in action. Among its objectives the most challenging are: a specification of a quality report (coherent with Eurostat's guidelines) driven for the necessities of main users of agriculture statistics; a definition of a quality reports for short terms statistics and, overall following Bergdahl and, Elvers (2006), providing guidelines to support producers and users in defining a set of criteria suitable to fix the level of sufficient quality with respect to statistics' intended use.

The listed topics don't cover all the possible research subjects that can significantly improve the efficiency of processes carried out by Istat and the consequent quality of statistical information disseminated. For example, the use of record linkage methodology could help to solve the problems that arise when a link between Istat databases and administrative archives is performed; this is the case of quality products or agritourism activities data.

We could continuing in listing useful methodologies and statistical tools but it is from the strict cooperation with the scientific and users communities that can rise the most profitable lines of research and the methodological priorities for Istat.

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