

Trends in Agricultural Statistics – An Outline of Development Work at Statistics Sweden

Knut Medin¹ and Bernt Wilson²

Abstract: In recent years, Statistics Sweden has conducted a general review of its agricultural statistics. This article emphasizes the prerequisites and motives for this development work. Stress is laid on a statistical approach, and on improvements in statistical methodology.

Among the methodological projects mentioned are the use of a farm typology, the idea of farm models, longitudinal and spatial analyses, projections and forecasts, and the use of geographical coordinates.

Examples of “new” statistical areas include agricultural structure and infrastructure, family farming, and part-time farming. Respondent burden, confidentiality and integrity, and the demands of budgetary restraints are discussed as important background factors.

Key-words: Agriculture; official statistics; Sweden; development work; statistical methodology.

1. Introduction

In Sweden those parts of official agricultural statistics that refer to farms are, in most cases, produced by Statistics Sweden. This article describes current developments within this branch of statistics, but the objective also is to examine the background of the development work and especially to indicate prerequisites and motives.

The article includes: a short overview of Swedish agricultural statistics; a discussion on needs, aims, and restrictions of the development work; and a survey of development projects.

Some of these projects, such as the one referring to “spatial analysis,” are of a general methodological character. Most of the projects, however, deal with subject matter. In this case the article concentrates on areas which can be regarded as more or less “new,” at least for Swedish agricultural statistics.

From a historical point of view, it can be said that modern agricultural statistics was introduced when the Central Bureau of Statistics (now called Statistics Sweden) started planning its first Census of Agriculture, taken in 1927. Since then development work has continued with varying intensity, directed both by progress in statistical methodology and by

¹ Consultant to Statistics Sweden, Stockholm; formerly Head of the Department for Area Statistics.

² Head of the Division for Postal Surveys in Agriculture, Statistics Sweden, Örebro.

Acknowledgments: The authors wish to acknowledge the assistance given by numerous colleagues at Statistics Sweden. This also includes many helpful comments and suggestions made in connection with earlier versions of the article. The authors also wish to thank the referees for their valuable suggestions.

the changing need for agricultural statistics for political, administrative, and scientific purposes.

The present phase of Swedish agricultural statistics goes back to the late 1960s, when a government committee proposed a number of changes. The most important change was the introduction of the Farm Register, which now has a central role in the overall system of agricultural statistics.

The development work dealt with here started in the middle of the 1970s and was directed by a small working group. The group delivered two main reports, see Statistics Sweden (1978, 1985a), which have been summarized by Hedqvist and Thorburn (1978) and by Hedqvist and Rösio (1985). About 80 changes and development projects were proposed by the working group. Most of these have now been completed.

The authors of this article have been members of the working group; this article is freely based on the group's reports.

2. Swedish Agricultural Statistics – An Overview

Major activities in agricultural statistics at Statistics Sweden are presented in Table 1.

Official agricultural statistics that are based on nonfarm data, i.e., data from mills, slaughterhouses, producers of agricultural machinery, etc., are in most cases produced by the National Agricultural Market Board. That board is also responsible for various forecasts and sector analyses.

In Sweden, forestry statistics are not regarded as a part of agricultural statistics but as a statistical branch of its own, for which the National Board of Forestry bears the main responsibility. However, because of the close links in this country between agriculture and forestry, these two economic activities can not always be separated in statistical reporting.

Outside the scope of agricultural statistics (though in most cases produced by Statistics Sweden) are official statistics in which agriculture represents only one of many activities, such as population statistics, labour force statistics, national accounts, etc.

In addition to the brief descriptions of the various activities presented in Table 1, some further comments may be appropriate with regard to the Farm Register, the Objective Crop Yield Surveys, and the Farm Book-keeping Survey.

A major part of Swedish agricultural statistics is based on the Farm Register. Since it was established in 1968, the register, in addition to statistical purposes, has been used administratively, inter alia by the 24 County Agricultural Boards and in the administration of the crop insurance.

The register consists of all enterprises (i.e., holdings, farms) in agriculture, horticulture, and forestry. It contains about 300 000 units which are divided into three categories:

1. about 105 000 holdings with at least 2.0 hectares of arable land;
2. about 2 000 additional holdings specializing in horticulture or with large-scale animal husbandry; and
3. about 190 000 other holdings, most of which with forest land only.

Data on categories (1) and (2) are brought up to date by an annual postal inquiry. Data on category (3) are brought up to date at an interval of about five years by the use of official real estate taxation registers.

The annual data collection takes place in the middle of June. It is compulsory for the farmer to complete a four-page form, which is distributed to him or her on the basis of the previous year's register. The Farm Register is in this way updated with regard to information on the holders, the real-estate units, acreages by different types of land, use of

Table 1. Major activities in agricultural statistics at Statistics Sweden

Farm Register (annual updating)	Registered data used for current statistics on holdings, holders, crop and animal husbandry, horticulture, etc. Also for censuses of agriculture and longitudinal studies. Sampling frame for regular and ad hoc sample surveys. Register created especially but not exclusively for statistical purposes (used for the calculation of crop damage compensations, etc.). Details for each farm updated by postal survey. All farms.
Census of Horticulture (every third year)	Statistics on plants grown, areas under glass or in the open, quantities produced, heating technique, etc. Content varies somewhat as between censuses. Postal survey (in some cases interviews). All 5 000 horticultural holdings.
Objective Crop Yield Surveys (annual, continous during season)	Yield per hectare statistics for eight important field crops (with detailed regional breakdown). In addition certain other statistics on crop husbandry. Survey based on the collection of crop samples combined with interviews. 12 000 farms.
Crop Outlook Reports (three times a year during season)	Crop outlook assessments made for 2 400 districts (whole of Sweden) by local agents. Basis for quantitative forecasts.
Farm Bookkeeping Survey (annual)	Statistics on farm economics in monetary and physical terms, calculated results. Data collection (whenever possible based on farmer's own bookkeeping) through local accounting offices. 1 000 farms.
Survey of Farmers' Assessed Incomes, Expenditures, Net Earnings, etc. (annual)	Statistics based on data reported by farmers to taxation authorities. Data transcribed and edited at Statistics Sweden. 7 000 farms. In addition a limited set of statistics based on data for all farms are obtained from the EDP-based tax assessment register combined with the Farm Register.
Agricultural Labour Force Survey (annual, as from 1988 every third year)	Telephone interviews four times a year. 1 000 farms.
Statistics on Boars and Covered Sows (monthly)	Data collection from all 6 000 boar keepers by postal survey.
Survey of Building Activities on Farms (annual)	Statistics on the construction and reconstruction of farm buildings. Telephone interviews based on a preliminary data collection linked to the farm registration.

arable land for different crops, horticultural production, and numbers of certain animals. In addition, there usually are some special items that vary from year to year.

Almost all data collected for the farm register is used for statistical purposes. The register is also used as a sampling frame for most regular and occasional sample surveys in agriculture. Since the concepts, definitions, identity numbers, etc., are the same in the register and in the sample surveys, it has been feasible to build up a highly consistent system for agricultural statistics. The Farm Register makes it possible: (1) to follow each holding over time, (2) to check the coverage against other official registers, especially those regarding land area, (3) to produce statistics for small administrative regions (parishes, municipalities, etc.), and (4) to produce new agricultural statistics without increasing the volume of data collected, for instance by new cross-classifications or through longitudinal studies.

Technically the register has been continually improved in recent years, especially by replacing manual methods by more efficient electronic data processing (EDP) methods. For details about the Farm Register, see Medin (1985) and the references presented there; see also Statistics Sweden (1983).

Since about 1960, the official statistics on crop yields are for main crops – winter wheat, spring wheat, rye, barley, oats, grass, table potatoes, and potatoes for processing – obtained through the Objective Crop Yield Surveys covering all of Sweden.

A sample of about 12 000 farms is selected annually from the Farm Register. On each of these farms, one field is selected for each crop included in the surveys, provided that crop is cultivated on that particular farm. On that field one to three sample plots are selected.

For grains and grass each plot is a circle one square metre in area; for potatoes the

plot is two metres in length along a row. These plots are harvested shortly before the farmers' own harvest by local personnel employed by the County Agricultural Boards. For grains and grass, the plot crop³ is sent to a central laboratory for drying and weighing. The potato crop is weighed in the field.

In this way, data on the biological yield are obtained. In addition subsamples are used to measure harvesting losses, yield quality, use of different crop varieties, farming practices, etc. The estimates are said to be objective since crop cutting is applied in combination with random sampling procedures.

The large sample size is needed to provide estimates for the 420 crop yield districts used for crop insurance calculations. Of course the results are used for many other purposes as well.

Doubts about the justification of this type of survey have been expressed by, e.g., Zarkovich (1977). However, in Sweden, the reliability of the survey results has not been called into question in recent years (for sufficiently large samples).

The main structure of the surveys has not changed much over the last 10 – 15 years but many details have been modified. Cost savings in both the sampling procedures and in the field work have been introduced. For details about the Objective Crop Yield Surveys, see Statistics Sweden (1987c) and Medin (1965). Söderlind (1982) documented the development of the surveys. For references to early papers by Nilsson, Zetterberg, and Söderlind, see Zarkovich (1977). The sampling design was studied by Jönrup (1976), among others.

For more than 70 years farm bookkeeping data has been systematically used to study

³ The crop quantity taken away is so small that it has not been regarded as necessary to compensate the farmer.

the economics of Swedish farming. At the beginning, this data collection could be characterized as scientific research in agricultural economics. Because of the increased use of the results as a basis for the agricultural policy debate the Farm Bookkeeping Survey has been gradually transformed into official statistics.

In 1976 the Farm Bookkeeping Survey was transferred from the National Board of Agriculture to Statistics Sweden. Since then, the survey has been closely coordinated with agricultural statistics in general. A sample design based on the new farm typology is now being introduced. Because of the high costs per unit, the Farm Bookkeeping Survey comprises only about 1000 farms chosen from a population consisting of certain farm categories of particular interest for agricultural policy deliberations. Every farm selected participates in the survey for four years, and one quarter of the sample is renewed every year.

The results tabulated in the Farm Bookkeeping Survey cover a large number of variables, both physical and monetary. In the last few years various models for calculating profitability given inflation have also been developed. For details about the survey, see Larsson, Medin, and Wilson (1987).

In the collection of farm data, Statistics Sweden has in recent years been assisted by regional agricultural authorities and organizations. The most important of these cooperating bodies have been the 24 County Agricultural Boards, which fall under the National Board of Agriculture. They take part in data collection not only for the Objective Crop Yield Surveys, but also for the Farm Register and for several other subbranches of agricultural statistics. In the data collection for the Farm Bookkeeping Survey, Statistics Sweden cooperates with local offices of a nation-wide accounting organization, belonging to the Federation of Swedish Farmers.

3. Need for Updating Procedures and Statistics

3.1. *Developments in the farming industry*

Needless to say, agricultural statistics have played a considerable role as a source of information on the great changes that have taken place in Swedish farming, especially after World War II. Intensive work was required to adjust statistical reporting to the changing technical, economic, and social conditions for farming and for rural life in general. Therefore, a few words on the development of Swedish agriculture may be appropriate.

Most agricultural products come from the plains in the southern and central parts of the country. However, there is a comparatively large number of small farms situated in the rest of Sweden, which is mainly forested. In recent years many small units have fallen into disuse or have been amalgamated into larger farms. Thus the total number of holdings decreased by about two-thirds from 1951 to 1986, while the total area of arable land decreased only from 3.5 to 2.9 million hectares. The most common type of farm enterprise is the family farm where almost all work is performed by the farmer and his or her family.

A decreasing need for manual work on farms, mainly due to mechanization, has led to an increase in the number of part-time farms. The farmer and spouse obtain more than half their total income from activities outside agriculture and forestry for about 65 % of all farms. Demand for efficiency has also led to more specialized production on farms.

3.2. *Agricultural policy aspects*

For a long while, the government has been deeply concerned about agriculture. Programmes approved by Parliament have had such aims as reasonable incomes for farmers,

reasonable food prices for consumers, and a level of food production in the country that guarantees a certain degree of self-sufficiency in case of war. These aims should be achieved by rationalization measures, price regulations, import-export regulations, subsidies, etc.

For many different reasons the exact content of the policy has changed from time to time with major revisions at intervals. However, there has been an obvious ambition from the side of the government to base changes on relevant and accurate statistics. This extends to statistics for the administration of established programmes and also to follow-up activities.

A few current political issues with (possible) effects on the need for agricultural statistics are: surplus of farm products, consequences of present land use restrictions, food quality, and distribution of income between categories of farmers.

3.3. *Importance of the crop insurance*

The introduction of a national crop insurance scheme in 1961 was to have considerable effects on official agricultural statistics. This followed from the basic assumption that, for each crop, the loss per hectare is approximately equal for all farms within reasonably small districts. The loss is expressed as the difference between the "normal" yield value and the "actual" yield value.

For most of the important crops, district data on the average yield per hectare is obtained through the Objective Crop Yield Surveys; for other crops various methods are applied. Areas of different crops reported to the Farm Register are also used when calculating the indemnities to which farmers may be entitled.

Statistics Sweden has been responsible not only for the yield surveys and the Farm Register but also for the technical administration of

the insurance. This administration has included the indemnity calculations for individual farmers although not the payments.

In connection with the crop insurance, Statistics Sweden has had to meet strict requirements for accurate basic data, regionalized statistics, timely EDP operations, etc. Necessary organizational and financial resources have, however, been made available with good results also for other uses of agricultural statistics. A description of the crop insurance during its early years was given by Medin (1965); an up-to-date review has been published by Statistics Sweden (1988).

According to a recent agreement between the government and the Federation of Swedish Farmers a new crop insurance scheme will be introduced in 1988. The main responsibility for the new insurance will be transferred to the federation. At the time this article was written, the full implications of these changes for official agricultural statistics were not yet apparent. It was, however, known that the Farm Register will be retained. The Objective Crop Yield Surveys will also be continued although in a considerably reduced form.

3.4. *International requests and foreign examples*

Sweden participated in the preparatory work for the first World Census of Agriculture around 1930 and later took active part in international efforts towards comparability and methodological development in agricultural statistics. Special reference should be made here to the work by the Food and Agricultural Organization, the Conference of European Statisticians (reporting to the Economic Commission for Europe) and the Organization for Economic Cooperation and Development as well as the work directed by the Chief Statisticians of the Nordic Countries. Agricultural statistics in the European

Economic Community have been given special attention and detailed comparisons can be found in Statistics Sweden (1976b).

4. Impact of Statistical Aims and Innovations

4.1. A statistical approach

In recent years, there has been a considerable discussion in Sweden about the significance of a "statistical approach" in official statistics. The discussion started with the presentation of a paper prepared in close connection with development work in agricultural and related statistics. It resulted in a special issue of *Statistical Review*, see Borglund, Jorner, Medin, Olofsson, and Polfeldt (1984).

4.2. The need to promote studies of change

Agricultural statistics traditionally reported estimates for a particular point in time or a particular time interval. The statistics have been based on data collected at more or less regular intervals. In addition to other applications, the results have sometimes been used for simple time series analyses.

Since changes in the agricultural industry, especially from the structural and economic points of view, have been greater and more rapid in recent decades, the need to analyze the changes, their causes and the change mechanisms has increased. This was stressed by Widén and Åstrand (1975).

Among other things, this interest in change has been reflected in demands for better comparability over time in statistical series. As a consequence, it has become necessary to clarify the effects of shifts and modifications in definitions, concepts, and methods used.

Longitudinal analyses (cf. Section 6.3) have been used to describe statistically the changes from time to time in different objects

such as holdings, herds, etc. The "net change statistics" have in this way been supplemented with "gross change statistics."

4.3. Some quality aspects

This is not the place to deal with all aspects of quality in Swedish agricultural statistics but to highlight our experience.

It is sometimes argued that the quality of the statistics will be impaired if the statistical data collection is coordinated with a collection of data for administrative purposes. However, generally speaking this has not happened to the Farm Register. One reason for this may be that the farmers, when filling in the forms, are well aware of the fact that the data will be used for many different purposes. The farm register has also escaped the problems encountered when the collection of data for statistics has been added to a data collection routine already used by an administrative body.

An elaborate evaluation study⁴ is the Annual Area Checking Survey in which the crop areas reported by farmers to the Farm Register are compared with control measurements in the fields, see Polfeldt (1977). This survey gives general information on the quality of the area data in the register. The results are also used for the calculation of correction factors to be applied when estimating the total yield of different crops. Furthermore, results for individual farms are used to check the data base for the crop insurance; in the case of a major error, legal action may be initiated by Statistics Sweden.

In almost all areas of agricultural statistics, comprehensive EDP editing programs have been applied. In some cases a technique called "macro checks" has been found a very

⁴ As a historical note it may be mentioned that funds were explicitly made available for a separate evaluation study in connection with the first Swedish Census of Agriculture in 1927, as reported by Statistics Sweden (1936).

efficient complement to traditional checking. In macro checks, preliminary statistical summaries are edited (instead of data for individual holdings). Abnormal observations are then traced back to the holdings and treated at that level.

Like so many other branches of statistics in different countries, Swedish agricultural statistics have experienced an increase in nonresponse rates in recent years. That tendency is certainly unhappy, though in most cases the rate is still comparatively low. To exemplify, the nonresponse is about 0.2 % in the Farm Register and about 2 % in the Objective Crop Yield Surveys, but is as large as about 30 % in the Farm Bookkeeping Survey.

The ambition to develop new statistics on changes has resulted in some severe quality problems. Measurement errors of small or even negligible importance in traditional statistics may indeed be significant if the data are used in a longitudinal study. The proper handling of these problems will certainly call for prolonged work.

4.4. *Timeliness*

It is easy to state that the value of a statistic is highly dependent on when it appears. However, experience from agricultural statistics in Sweden has shown that the situation is in reality somewhat more complex. The users of the statistics tend to adapt their procedures and routines to when the statistics have become available in the past. As a consequence it may take some time before the real effects of improved timeliness, both up-to-dateness and punctuality, become apparent. Even if the degree of timeliness has not been criticized much, a special drive for improvement has been regarded as an essential part of the development programme. As a result some statistics are now released considerably earlier than before. For a general discussion with examples from Swedish agricultural statistics, see Medin (1984).

4.5. *Effects of developments in general statistical methodology and production techniques*

The general methodological and technical progress in official statistics during the post-war period has, of course, been a great impetus for the development of Swedish agricultural statistics. First, the basic goal of using modern sampling in Swedish agricultural statistics was to avoid or reduce biases. Then questions about precision were discussed. Better sampling procedures have also been regarded as a valuable rationalization measure, especially given the financial stringency of recent years. For the history of sampling in Swedish agricultural statistics, see Dalenius (1957) and Medin (1983).

At Statistics Sweden the Objective Crop Yield Surveys were among the very first to apply electronic data processing (EDP). When powerful computers became available automated routines were developed for the annual surveys on crop areas and livestock numbers as described by Medin and Larson (1964) and Wilson (1967). Developments in agricultural statistics later on were closely linked to the remarkable developments in statistical data processing in general. (Nevertheless, against the background of their early experiences in agricultural statistics the authors of this article cannot refrain from wondering why the new technique has not had an even more profound effect on official statistics with regard to the specific statistical aspects of the work. This includes for instance data editing and the development of entirely new kinds of statistical results.)

In Sweden register techniques have been used for official statistics ever since the first census of population in 1749. However, the role of registers in official agricultural statistics has been limited until recent decades, during which two lines of development have emerged. The one is the use of administrative records; and an example is the regular use of

tax assessment data as a basis for farm income statistics. The other, which is by far the most important, dates back twenty years to the establishment of the Farm Register. Organized as a total panel, the register has opened up new means for agricultural statistics and their coordination.

For years, the extent to which central statistical offices ought to engage in statistical analysis has been the subject of debate. This was demonstrated for instance at the Washington seminar in 1977 on "Statistical services in ten years' time" arranged by the Conference of European Statisticians, see Duncan (1978). However, in recent years at Statistics Sweden there has been a clear tendency towards more analytical activities. In agricultural statistics this subject was treated by a special working party. One conclusion drawn was that analytical activities should not be separated from the more traditional statistical activities. On the contrary, to fulfil analytical aims it is often necessary to let these aims influence basic statistical procedures such as sample design and data collection. A list of potential projects was presented; many of these are now being implemented. An example, not mentioned elsewhere in this article, is the systematic application of multivariate statistical techniques to the data from the Objective Crop Yield Surveys to look for factors of importance for the level of yield obtained under regular farming conditions. Certain preliminary results have been presented by Statistics Sweden (1985 – 86).

5. Comments on Budgetary and Other Restraints

As is so often the case in official statistics, development work has been dependent on overcoming a number of hindrances. Some of these hindrances have in fact stimulated improvements in methods and routines.

Respondent burden often represents an important restriction. In Swedish agricul-

tural statistics, proposals for new data collections have always been treated in a careful manner. However, during the latter part of the 1970s, there was a considerable public debate about the responsibility of enterprises to answer statistical questionnaires. For that reason a special study of the time spent by farmers on reporting agricultural statistics was initiated. A rough estimate was that, on average, the farmers spent about one hour a year on this task, but a small group of farmers participating in several sample surveys spent considerably more time, see Hedqvist and Rösio (1984). The conclusion drawn was that, generally speaking, farmers are not overburdened. Consequently, no extra restraint was imposed.

Other kinds of restrictions follow from the legislation relating to confidentiality and integrity in connection with data collection and data storage. Those questions have been much debated in Sweden in recent years, not least with reference to official statistics. A Data Privacy Protection Act was passed in 1974. According to this act permission by the Data Inspection Board is often required in advance of a data collection for statistical purposes. However, the existence of legal provisions for confidentiality and integrity can increase the readiness of respondents to provide correct information. The Farm Register represents a special case. Although kept by Statistics Sweden it is used for both statistical and administrative purposes. This has called for and resulted in a separate government statute for the register but the twofold use of the data has in practice not been the cause of any great difficulty.

Due to existing budgetary restraints the total cost for statistics has not been allowed to increase in recent years; in fact total cost has had to decrease because of financial restraints prescribed since 1978. The importance of this cost restriction is difficult to interpret. Improvements in official statistics

can very well be achieved with reduced funding. A basic reason is that prerequisites for statistical work are changing all the time. Proper adjustments to these changes make new resources available; for more detailed arguments see Medin (1984). However, for the sake of completeness it should be added that in Swedish agricultural statistics, limited cost reductions have also been achieved in recent years by direct cuts in the production programmes: eliminated variables, reduced regional breakdown, smaller samples, etc.

6. Development Projects: Some Methodological Issues

6.1. Classification by type of farming

During recent decades farm typologies, i.e., classifications of farms according to type of farming, have been introduced in official agricultural statistics in a large number of countries. In Sweden work on a farm typology started in 1977, when a committee on farm typology was appointed with representatives for Statistics Sweden and principal users of agricultural statistics. The formal decision to introduce the new classification was taken in 1982.

The typology is used to classify the farms into a limited number of groups according to their production patterns. In the Swedish typology this is achieved by combining data on crop acreages and livestock numbers with standard labour requirements per hectare and per animal. Depending on the relative sizes of the total labour requirements in various enterprises, each farm is classified as a grain farm, a dairy farm, a pig farm, etc.

The classification is closely linked to the Farm Register which contains the acreage and livestock data needed. For each farm, its type is recorded annually in the register and from there transferred to almost all areas of

agricultural statistics. Thus, structural statistics can now convey information on the specialization in farming, while the statistics on farm economics contain particulars on how profitability varies between type groups.

The experience gained so far – including the very good reactions from users of agricultural statistics – clearly indicates that the farm typology is a valuable enhancement. Better insight into actual farming conditions has been achieved. In this connection it is worth noting that the costs involved are very small indeed since all necessary data already exist. For details see Wilson (1974), Jorner (1979), Medin (1985), Typologigruppen (1979, 1982), and Statistics Sweden (1987a).

6.2. Farm models

Based on ideas applied in Norway and Finland the concept of “farm models” has recently been introduced in Swedish discussions about the data basis for agricultural policy decisions. The idea is to “construct” a small set of farms with specialized and well-defined production patterns and to make synthetic calculations of production costs, revenue, income, etc. for these farms. These calculations – which should be based on accepted principles of farm business economics – will use agricultural statistics, standard values, forecasts, etc.

Compared with ordinary statistics the results should represent farms with more clearly defined production patterns. Another objective is to produce data for periods for which statistics are not yet available, e.g., present or future years.

An interagency working group has been established to develop and test the idea of farm models; Statistics Sweden is represented in that group. For the work done in Norway and Finland, see Budsjettnemnda for jordbruket (1986) and Ikonen (1985), respectively.

6.3. Longitudinal analysis

On the basis of the Farm Register, longitudinal studies on structural changes in farming have been carried out annually since 1971. To make this possible, the traditional definition of the holding had to be supplemented with rules referring to time. These rules answer questions such as: "If two farms have been amalgamated, which of them, if any, shall be regarded as remaining?" or "If a farm has been divided into two, which of these, if any, shall be regarded as a continuation of the original?" With the existence over time of the register units thus established, it has become possible to observe changes from year to year in a farm's size and type. These statistics are presented in matrix tables which show the transitions between different classes of holdings, for instance size classes of arable land or size classes of herds. These tables also contain data on the number of holdings that have started up or fallen into disuse during the year, see Medin and Wilson (1974, 1985) and Statistics Sweden (1987b). Future development work in this field is intended to include other areas of animal husbandry statistics and also forestry statistics.

6.4. Projections and forecasts

To aid decision-making by political bodies as well as in administration and business, agricultural statistics often have to be supplemented by projections and forecasts. These can, however, in many cases be said to predict future statistics and consequently the statistical agencies have to face the question of what their role should be. In the review of Swedish agricultural statistics the conclusion was that new projections and forecasts will probably be short-term and in fields where Statistics Sweden is already responsible for the corresponding statistics.

At this point, reference should be made to

development work on objective crop yield forecasts which was carried out in 1966–1975, see Statistics Sweden (1976a). The idea was to base the forecasts on field measurements of straw length, number of ears, etc., but also on meteorological information. The results were fairly encouraging, apart from the fact that a regular forecasting service would have been rather costly. It could therefore not be realized. Some years later Statistics Sweden cooperated in developing a model for crop yield forecasts based solely on meteorological data. Such forecasts are now made by the National Agricultural Market Board; see Rösio, Tillgren, and Loman (1979).

To the present, most of the forecasting work within agricultural statistics at Statistics Sweden refers to changes in the agricultural structure. A method linked to the above-mentioned longitudinal statistics received from the Farm Register has been developed. Transition matrices are used to compute Markovian projections over one to fifteen years, see Thorburn (1980, 1981, 1983), Wilson and Jorner (1984) and Statistics Sweden (1985b).

6.5. Use of geographical coordinates

Starting with a paper by Hägerstrand (1955) extensive development work has been in progress in Sweden on the use of geographical coordinates. The basic idea is that registers of real estates, houses, work places, archaeological finds, etc., should be supplemented with information on their latitude and longitude. For point objects this is fairly straightforward but for line objects such as roads or boundaries and area objects such as fields or farms, it is usually necessary to make approximations.

For official statistics the availability of geographical coordinates creates new opportunities; some examples from agricultural statistics follow.

Traditionally, statistical objects such as farms are classified according to pre-fixed divisions into parishes, local authority areas, counties, natural farming areas, etc. If coordinates are available, statistics can easily be produced for any required subdivision by introducing the coordinates of the new geographic boundaries. Suppose, for instance, that the geographical boundaries between different types of soil can be entered into a computer. If coordinates were available for all sample plots in the Objective Crop Yield Surveys, yield statistics for the various soil type districts could easily be calculated. Today such recalculations involve costly procedures.

It seems reasonable to assume that geographical coordinates will, in the future, create many new types of statistics. This may include regional ex post classifications, studies of distances, for instance, between farm centre and farm fields or between farm centre and different commercial centres, new routines for editing primary data, or new techniques for presenting agricultural statistics in the form of maps.

As to current developments in Sweden, geographical coordinates are being systematically recorded in the new EDP-based system for official land registration. This information will probably soon be available for use in some areas of agricultural statistics.

6.6. *Spatial analysis*

The rapid developments in the analysis of spatially-defined data during the last few years are well documented in the literature; for references see, e.g., Wilson and Bennett (1985) or Upton and Fingleton (1985). Obviously, many aspects of agriculture naturally lend themselves to this type of analysis. Therefore, in connection with the development work presented in this article a special working party was set up in 1983 to study spatial reporting in among others, agricultural

statistics. The result of the work has been published by Statistics Sweden (1984b). The following are a few of the many ideas presented in that report.

1. In agricultural statistics the regional breakdowns have traditionally been decided on in advance of the tabulations. An alternative approach would be to use the data collected as a basis for estimating isarithms, distinguishing different categories of land. A simple example could be the use of data from the Objective Crop Yield Surveys to divide the country into high yield and low yield districts (or according to some more developed yield level classification).
2. In sample surveys the material available is often too small to allow for a very detailed geographical breakdown. By use of models one could perhaps estimate average yields or total use of fertilizers in small areas such as municipalities.
3. For many subject matter areas, closer studies into the geographical variation would be appropriate. Areas mentioned include crop varieties, type of farming, water availability, etc.

7. **Development Projects: Some Subject Matter Issues**

In the present section the reader will find brief descriptions of fields where certain projects have been proposed. Most of these projects refer to variables which have so far not been included in Swedish agricultural statistics.

7.1. *Agricultural structure*

Fundamentally, the purpose of statistics on agricultural structure is to show the properties of the farms and the state and changes of its production factors: labour force (including the holder and his or her family), land and

other real capital (buildings, machinery, livestock, etc).

Most of these statistics are based on the Farm Register. The annual statistical reports thus contain regionally differentiated data on both the state of and the (net and gross) changes in the total population of farms. Special studies regarding the structure of both crop and animal husbandry have been carried out as parts of the 1981 Census of Agriculture as reported by Statistics Sweden (1984a). In this connection reference may also be made to Medin and Wilson (1985).

Development work in the statistics on agricultural structure has to be continued while new political and economic aspects need to be analyzed. For instance, one important aim is to highlight the continuing specialization process in crop or animal production. Resources should also be used to illustrate in depth the changes in ownership and tenancy, and to what extent holdings are engaged in both agriculture and forestry.

7.2. Family farming

The term "family farming" has long been accepted in farm economics research, see, e.g., Warren (1920), Scoville (1947) and Nordiska Jordbruksforskarens Förening (1983). A related concept in the German language is "Bäuerlicher Landwirtschaft," see Neander (1983). Terms like these also have a central position in the agricultural policy debate in Sweden. However, as pointed out by Swedborg (1980), it is noteworthy that the exact meaning of the terms has never been clarified. Even if such a clarification is not immediately necessary, the frequent references to the concepts may indicate a potential need for new statistics. A development project has therefore been proposed.

7.3. Part-time farming

Despite the political efforts in the post-war

period to promote full-time farming, part-time farming has become much more common. As in other Western countries, see Martens (1980), what is called "dual job holdings" or "multiple job holdings" are now very frequent all over Sweden.

However, from the statistical point of view, part-time farming has not been studied to any great extent in Sweden. For that reason Statistics Sweden now cooperates with other government authorities in a special project. The aim is to develop and systematize concepts, definitions, and classifications for part-time farms as well as part-time farmers, and to describe the structure and the importance of part-time farming.

7.4. Agricultural infrastructure

Modern farms are highly dependent on their infrastructure, by which we mean "the financial, institutional, and social surroundings which influence the development, survival, and production of the farms." That tentative definition was presented by a special working party appointed to study how the agricultural infrastructure can be illuminated by agricultural statistics.

As for variables, the statistics may, for instance, refer to the availability of (for the farm as such and for the people living there) communications, slaughterhouses, dairies, machine stations, distributors of seed and fertilizers, shops, schools, medical care, etc. Variables related to the labour market, such as manpower supply on one hand and off-farm job opportunities on the other, may also be included.

No decision has yet been taken to develop regular statistics on the agricultural infrastructure. Meanwhile, a compendium containing available official and other statistics will be issued.

8. Development Projects: Short Notes on Some Additional Topics

Although new methods, new techniques, and new subject matter areas are very important to the development of official statistics, most progress is certainly a result of new ways to combine procedures used before. For the sake of balance some projects of this character will be briefly mentioned. In addition some methodological studies not presented elsewhere will be named.

New types of labour force statistics for agriculture based on telephone interviews has been introduced, see Hedqvist (1982).

Postal surveys on farmers' assets and liabilities have been carried out.

An ad hoc study of field irrigation in agriculture has been performed in two steps. First, data on the availability of irrigation installations were collected by the Farm Register. Then, from those farmers who reported such installations, details regarding irrigated crop areas, irrigation techniques, types of water resources, etc., were collected by mail. It may be added that this way of collecting statistical data, or variations of it, has over the years been used on a number of occasions for studying "rare items." An alternative approach to the study of such items in agriculture has recently been presented in this journal by Fesco, Tortora, and Vogel (1986).

Horticultural statistics have been reorganized and expanded. Among other things this has meant that Censuses of Horticulture are now regularly taken at three-year intervals. This is a higher frequency than before.

In Sweden, animal husbandry statistics have traditionally been very limited, at least in comparison with crop husbandry statistics. This is so in spite of the fact that most of the farm income normally stems from meat and milk production. Also in the development work presented here only limited proposals have been made; they refer, for instance, to

the present and future structure of animal husbandry.

New statistics on taxes and other transfers (family allowances, housing grants, etc.) have been compiled in connection with the Survey of Farmers' Assessed Incomes, Expenditures, Net Earnings, etc.

For the period up to 1955 historical agricultural statistics have been published in a separate volume by Statistics Sweden (1959). In the preparatory work for an updated edition, special emphasis will be placed on the quality of the statistics, in particular with regard to comparability over time. Problems involved have been discussed by Ribe (1982).

Special methodological studies have been made regarding existing or potential statistics on:

1. owner and holder relationships,
2. tenancy conditions,
3. building construction,
4. gross changes in the area of arable land (i.e., in areas reclaimed or taken out of use).

9. Final Comments

In the history of Swedish agricultural statistics, major changes have been caused by, e.g., new statistical needs, new economy measures, new organizational structures, or – rather often – the introduction of new statistical methods and techniques. The work presented in this paper does not have a monolithic background but can be characterized by the ambition to progress through a large number of limited efforts (made with due regard to existing financial restraints).

10. References

Most of the references given here have been included because of their methodological content. This also applies to the official statistical reports referenced.

Tabular results from the statistical work described in this article can, in most cases, be found either in the Yearbook of Agricultural Statistics or in the Statistical Reports series ("Statistiska meddelanden" with a sub-series for agricultural statistics). Both are published by Statistics Sweden.

A bibliography on Swedish agricultural statistics 1950 – 1974, including tabular presentations as well as methodological descriptions and studies, was published by Statistics Sweden (1975).

Borglund, D., Jorner, U., Medin, K., Olofsson, P.O., and Polfeldt, T. (1984): Sifferfabrik eller statistikverk – det statistiska synsättets betydelse för statistiska centralbyrå. (Figures factory or statistical office – the importance of the statistical approach for Statistics Sweden. In Swedish.) *Statistisk tidskrift* (Statistical Review), 22 (3), pp. 171 – 176.

Budsjettnemnda for jordbruket (1986): Modellbruksberegninger. Regnskapstall for 1984. Fremregnede tall for 1985 og 1986. (Calculations for farm models. Estimates for 1984. Projections for 1985 and 1986. In Norwegian.) Mimeo.

Dalenius, T. (1957): Sampling in Sweden. Contributions to the Methods and Theories of Sample Survey Practice. (Diss. Uppsala.) Stockholm/Uppsala.

Duncan, J.W. (Ed.) (1978): Statistical Services in Ten Years' Time. Pergamon Press.

Fesco, R., Tortora, R.D., and Vogel, F.A. (1986): Sampling Frames for Agriculture in the United States. *Journal of Official Statistics*, 2 (3), pp. 279 – 292.

Hägerstrand, T. (1955): Census Returns, Air Photographs and Data-processing Machines. A project for Combination. (In Swedish with summary in English.) *Svensk geografisk årsbok* 31, pp. 233 – 255.

Hedqvist, L. (1982): Labour in Agriculture – A New SCB Survey. (In Swedish with sum-

mary in English.) *Statistisk tidskrift* (Statistical Review), 20 (3), pp. 157 – 172, 232 – 234.

Hedqvist, L. and Rösiö, G. (1984): Time Spent on Reporting Data to Agricultural Statistics. (In Swedish with summary in English.) *Statistisk tidskrift* (Statistical Review), 22 (4), pp. 339 – 344, 399 – 400.

Hedqvist, L. and Rösiö, G. (1985): Development Work in the Agricultural Statistics of Statistics Sweden. (In Swedish with summary in English.) *Jordbruksekonomiska meddelanden* 1985:9, pp. 336, 338 – 346.

Hedqvist, L. and Thorburn, D. (1978): Development Trends in Agricultural Statistics from the Central Bureau of Statistics. (In Swedish with summary in English.) *Jordbruksekonomiska meddelanden* 1978:7 – 8, pp. 206 – 207, 208 – 217.

Ikonen, J. (1985): Use of Calculations of Production Costs and Bookkeeping Results in the Follow-up of Farmer's Incomes. Paper presented to Finnish-Hungarian-Polish seminar, November 1985.

Jönrup, H. (1976): Sampling and Estimation Processes of the Objective Crop Yield Estimation in Sweden. *Statistisk tidskrift* (Statistical Review), 14 (5), pp. 402 – 412.

Jorner, U. (1979): Type Classification of Agricultural Enterprises – A Way of Extracting More Information from Collected Data. (In Swedish with summary in English.) *Statistisk tidskrift* (Statistical Review), 17 (6), pp. 439 – 452, 483 – 484.

Larsson, G., Medin, K., and Wilson, B. (1987): A Farm Bookkeeping Survey as Part of Official Agricultural Statistics: The Case of Sweden. *Statistical Journal of the United Nations Economic Commission for Europe*, 4 (3), pp. 245 – 257.

Martens, L. (1980): Part-time Farming in Developed Countries. *European Review of Agricultural Economics*, 7 (4), pp. 377 – 393.

Medin, K. (1965): Crop Yield Estimation and Crop Insurance in Sweden. Review of

- the International Statistical Institute, 33(3), pp. 414 – 442.
- Medin, K. (1983): The Introduction of Probability Sampling in Swedish Acreage and Livestock Statistics in 1950. A Note on the Background and Later Developments. Essays in Honour of Tore E. Dalenius. *Statistisk tidskrift (Statistical Review)*, 21 (5), pp. 19 – 25.
- Medin, K. (1984): Timeliness in the Production of Official Statistics. *Statistisk tidskrift (Statistical Review)*, 22 (1), pp. 5 – 15.
- Medin, K. (1985): The Farm Register Approach in Sweden – Principles and Potentialities. *Bulletin of the International Statistical Institute*, Vol. LI, Book 2, pp. 13.2.1 – 15.
- Medin, K. and Larson, B. (1964): The New System for Agricultural Statistics. II. Automatic Control and Correction of Primary Data. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 2 (6), pp. 393 – 403, 466 – 467.
- Medin, K. and Wilson, B. (1974): Farm Structure in Figures. A Study in Statistical Methodology. *European Review of Agricultural Economics*, 1(4), pp. 461 – 481.
- Medin, K. and Wilson, B. (1985): Measuring Changes in the Size and Type of Farms – Some Swedish Data. Paper presented to poster session at the XIX International Conference of Agricultural Economists in Malaga 1985 arranged by the International Association of Agricultural Economists.
- Neander, E. (1983): Zur Abgrenzung, Charakterisierung und Bewertung bäuerlicher Landwirtschaft. *Berichte über Landwirtschaft. Zeitschrift für Agrarpolitik und Landwirtschaft*. Herausgegeben vom Bundesministerium für Ernährung, Landwirtschaft und Forsten, 61(1), pp. 67 – 78. (In German)
- Nordiska Jordbruksforskarens Förening (1983): Familjelantbrukets framtid. (Scandinavian Association of Agricultural Scientists: Future of the family farm. In Scandinavian languages.) NJF-utredning/rapport nr 11. (See also *Nordisk jordbruksforskning* 1983:3, pp. 454 – 462 and 1983:5, pp. 791 – 792.)
- Polfeldt, T. (1977): Reexamination of the Area Checking Surveys. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 15 (3), pp. 202 – 218, 269 – 271.
- Ribe, M. (1982): On Republication of Old Agricultural Statistics. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 20(1), pp. 5 – 23, 61 – 62.
- Rösiö, G., Tillgren, U., and Loman, J. – O. (1979): Crop Forecasts Based on Weather Observations. (In Swedish with summary in English.) *Jordbruksekonomiska meddelanden* 1979:1, pp. 8 – 9, 10 – 24.
- Scoville, O.J. (1947): Measuring the Family Farm. *Journal of Farm Economics*, Vol. XXIX, pp. 506 – 519.
- Statistics Sweden (1936): Le recensement général agricole de 1932. (In Swedish with summary in French.)
- Statistics Sweden (1959): Historical Statistics of Sweden II. Climate, Land Surveying, Agriculture, Forestry, Fisheries – 1955. (In Swedish with foreword, table headings, etc. in English.) Stockholm.
- Statistics Sweden (1975): Bibliografi över den svenska jordbruksstatistiken 1950 – 1974. (Bibliography of Swedish Agricultural Statistics 1950 – 1974. In Swedish.) Promemorior från SCB, 1975:8.
- Statistics Sweden (1976a): Objektiva skördeprognoser. Utredningsrapport. (Objective Crop Yield Forecasts. Report. In Swedish.)
- Statistics Sweden (1976b): Komparativ studie av jordbruksstatistiken i de nordiska länderna och övriga Västeuropa. (Comparative Study of Agricultural Statistics in the Nordic Countries and the Rest of Western Europe. In Swedish.) Mimeo.

- Statistics Sweden (1978): Utvecklingslinjer i SCBs lantbruksstatistik. (Development Trends in Agricultural Statistics from Statistics Sweden. In Swedish.) Mimeo.
- Statistics Sweden (1983): Information about the National Swedish Farm Register. Mimeo.
- Statistics Sweden (1984a): The 1981 Agriculture Census. Special Studies into Type of Farming and Structure in Cropping. (In Swedish with summary in English.) Statistiska meddelanden J 1984:18.
- Statistics Sweden (1984b): Den rumsliga redovisningen i areell statistik. Idéprome-moria framtagen av en särskild arbets-grupp. (Spatial Reporting in Area Statistics. Memorandum on ideas presented by a special Working Party. In Swedish.) Mimeo.
- Statistics Sweden (1985a): Utvecklingsinsat-ser inom SCBs lantbruksstatistik. (Devel-opment Efforts in Agricultural Statistics at Statistics Sweden. In Swedish.) Mimeo.
- Statistics Sweden (1985b): Projections of Structural Changes up to the Year 2000. Number of Holdings by Size Group, Type of Holding and Region. (In Swedish with summary in English.) Statistiska medde-landen J 30 SM 8504.
- Statistics Sweden (1985-86): Analys av skörde-variationer – med utgångspunkt i de objektiva skördeuppskattningarna. Delrapporter 1–2 från förstudie. (Analyses of Crop Yield Variations – Based on the Objective Crop Yield Surveys. Progress reports 1 – 2 from preliminary study. In Swedish.)
- Statistics Sweden (1987a): Type of Farming on the 13th of June, 1985. (In Swedish with summary in English.) Statistiska medde-landen J 30 SM 8603.
- Statistics Sweden (1987b): Structural Changes in Agriculture 1985–1986. Longi-tudinal Data. (In Swedish with summary in English.) Statistiska meddelanden J 30 SM 8702.
- Statistics Sweden (1987c): Objective Crop-Yield Surveys in Sweden. Memoranda Series: 1987: 1.
- Statistics Sweden (1988): The Swedish Crop Insurance System. Principles and Methods. Mimeo.
- Swedborg, E. (1980): Lantbrukspolitik för 80-talet. (Agricultural Policy for the 1980s. In Swedish.) Stockholm.
- Söderlind, T. (1982): Development of the Swedish Objective Crop Yield Surveys. (In Swedish with summary in English.) Statis-tisk tidskrift (Statistical Review), 20 (2), pp. 103 – 121, 143 – 145.
- Thorburn, D. (1980): Forecasting the Agri-cultural Structure Using Empirical Transi-tion Matrices. European Review of Agri-cultural Economics, 7 (4), pp. 413 – 432.
- Thorburn, D. (1981): Projections by Means of Longitudinal Studies and Transition Matrices. (In Swedish with summary in English.) Statistisk tidskrift (Statistical Review), 19 (3), pp. 189 – 201, 238 – 239.
- Thorburn, D. (1983): Forecasting Aggregate Time Series Using Empirical Transition Matrices. Scandinavian Journal of Statis-tics, 10, pp. 35 – 39.
- Typologigruppen (1979): Klassificering av de svenska jordbruksföretagen efter driftsin-riktning och driftens omfattning. (Com-mittee on Farm Typology: Classification of Swedish Farms by Type of Farming and Size of Business. In Swedish.) Lantbruks-ekonomiska samarbetsnämndens sektors-grupp. Mimeo.
- Typologigruppen (1982): Typklassificering av jordbruksföretag. Resultat och slutsat-ser från försöksverksamheten. (Commit-tee on Farm Typology: Type Classification of Farms. Results and Conclusions from the Test Studies. In Swedish.) Lantbruks-ekonomiska samarbetsnämndens sektors-grupp. Mimeo.
- Upton, G.J.G. and Fingleton, B. (1985): Spatial Data Analysis by Example. Vol. 1. John Wiley & Sons.

- Warren, G.F. (1920): *Farm Management*. The Macmillan Company, New York.
- Widén, M. – L. and Åstrand, H. (1975): *Agricultural Statistics of the Future*. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 13 (3), pp. 224 – 243, 268.
- Wilson, A.G. and Bennett, R.J. (1985): *Mathematical Methods in Human Geography and Planning*. John Wiley & Sons.
- Wilson, B. (1967): *The New System for Agricultural Statistics. V. Manual Routines*. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 5 (1), pp. 36 – 46, 64 – 66.
- Wilson, B. (1974): *Classification of Agricultural Enterprises*. (In Swedish with summary in English.) *Statistisk tidskrift (Statistical Review)*, 12 (2), pp. 145 – 153, 179 – 181.
- Wilson, B. and Jorner, U. (1984): *Strukturprognoser inom jordbruket – praktiska och teoretiska aspekter*. (Forecasting the Agricultural Structure – Practical and Theoretical Aspects. In Swedish.) Report from the research conference on longitudinal studies arranged by Statistics Sweden in Norberg, October 1984, pp. 77 – 80.
- Zarkovich, S.S. (1977): *Sample Surveys for Area and Yield Statistics*. Bulletin of the International Statistical Institute, Vol. XLVII, Book 3, pp. 440 – 452. (With discussion pp. 453 – 461).

Received June 1987

Revised December 1987