Development of innovative meat production process and methodology[1]

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Abstract

According to EU regulation 2016/429, EU-members are obliged to have an Identification & Registration (I&R) system for animals. These systems contain a lot of data on individual animals such as bovine, sheep and goats or on groups of animals such as pigs and poultry. In the Netherlands, the Netherlands Enterprise Agency (RVO) is responsible for the Dutch systems.

Monthly data on the number of animals slaughtered including the total meat production and the yearly organic meat production are already being delivered to Eurostat. Experiences with the current method raised questions about the quality of some of the data used. With the new Statistics on Agricultural Inputs and Outputs (SAIO) regulations we want to improve the quality of the data on meat production, distinguish for organic slaughtered animals and conventional slaughtered animals and explore the possibilities of using data from the I&R systems.

The work we have done so far has given us more insight into the usability of the existing registers and also into building a system for calculating the production of different types of meat. Currently, the system for the bovine meat production is being tested and the system for goats and sheep meat production is being built. Meanwhile, preparations for the development of the system for calculating pork production are in full swing.

The presentation will focus on two topics:
1. The experiences we had with the use of I&R registers for statistical purposes. Since every EU-member state has similar I&R systems (see article 109(1) of the EU regulation 2016/429) these experiences might be valuable.
2. The methods used for calculating the meat production for the different types of animals and for organic meat production.

Keywords: registers, agricultural statistics; SAIO regulation; meat production; organic farming; data collection; Identification & Registration and EU regulation 2016/429.

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1. Introduction

The European Union's Regulation on Statistics on Agricultural Input and Output (SAIO, Regulation (EU) 2022/2379) establishes a comprehensive framework for agricultural statistics covering five divers subject areas [1]. One of these areas is animal production. The SAIO Regulation contains new requirements for agricultural statistics across Member States. Next to quality demands on the delivered data, there are also demands for new data, for example on organic farming.

Eurostat already receives monthly and yearly statistics on the number of slaughtered animals and meat production as well as the yearly organic meat production. However, with the SAIO entering into force on the 1st of January 2025 it was the right moment to reflect upon our current method.

Currently, the number of total slaughtered animals are based on data delivered by the Dutch Food and Consumer Product Safety Authority (NVWA). The data include the total number of slaughtered animals per category of animal species for every slaughterhouse. The organic slaughtered animals and meat production are estimated every year. This estimation is based on the organic animals for meat production as reported in the yearly agricultural census.

Both described methods for calculating these statistics are used for more than a decade. There are two reasons why we would like to explore a different method of calculating the number of slaughtered animals and the total meat production [2]:

1. Experiences with the current method have raised questions about the quality and the completeness of the data.
2. We would like to develop a method that, next to the calculation of the total meat production, also calculates the number of total slaughtered organic animals as input for the meat production statistics and to improve the comparability between total and organic meat production.

This project is part of the MAS2023 project (Modernization of Agricultural Statistics 2023) that is co-funded by the European Commission. The MAS2023 project is a collaboration between the national statistical institutes of France, Germany and the Netherlands. It comprises of six sub-projects, one of which is the subject of this paper. The project on meat production is a Dutch project. Germany is not involved and France has an advisory role.

2 The use of registers

In this paragraph we will look at some general points of the use of register data and translate that to the registers we are using. Administrative data are data collected for administrative purpose by organizations that are not part of the Statistical office, thus the data is not targeted for use in official statistics [3]. Statistics Netherlands (CBS) has legal access to registers held by government institutions. If these registers contain data that CBS needs, CBS is obliged to use these data and not, for example, to collect the data via a survey.

The registers used

Input for the new system will be the data from the Identification & Registration (I&R) system. According to EU regulation 2016/429, it is mandatory for EU member states to have an I&R system for animals [4]. The I&R systems play an important role when diseases break out that pose a threat to public health and need to be contained. These systems contain a lot of data on individual animals or groups of animals. Examples of the data are, date of birth, location of residence as well as slaughter date and location of the slaughterhouse. There are different I&R systems for bovine, pigs, poultry, sheep and goats and horses. The Netherlands Enterprise Agency (RVO) is responsible for the Dutch I&R systems.

A second source is the register of Skal Biocontrole (Skal). This is the organization responsible for the certification of organic farms as well as the organizations that process yields from those organic certified farms. We use this data to check whether the animals come from a certified farm and are slaughtered at a certified slaughterhouse. By combining the I&R data and the data from Skal it is also possible to find the former locations where bovine, sheep and goats have stayed by using the unique location ID called UBN. So, we can check for how long the animals have stayed at certified locations. The third source we are using contains information on registered slaughterhouses, which includes an address and an UBN.

When used for statistical purposes data can be used directly or indirectly. When used directly it is used for calculating the output and when used indirectly these data play an auxiliary role in the production process [3]. The I&R register and Skal register are used directly while the additional data on the slaughterhouses are used indirectly as a check on whether the slaughterhouse is still active.

What to check before the use of register data

We need to check if the observed variables cover the targeted variables. In our case the animals that are slaughtered for human consumption. The I&R contains information from birth until death of the animal including the reason of death for example slaughtering.

Another thing to check is whether the population of the register includes the statistical population we are working with [3]. The I&R bovine covers the entire population of bovine in the Netherlands. For our statistics we only need the data of that part of the population that has been slaughtered in a certain month. Also, the Skal data contains our sub-population. We are only looking at farmers that are certified by Skal as organic. Although our statistical population is part of the whole population in both sources, we still need to be aware of coverage problems in the form of over-coverage and under-coverage.

Noteworthily, the population of animals that have been slaughtered at the slaughterhouse might also contain animals that have not been slaughtered. The reason for this is that before the animals are slaughtered a veterinary check has to be done and could lead to the rejection of animals for slaughter. Those rejected animals are not part of our statistical population. The problem arises when this is not filled in correctly. A way to check this, is by checking if all variables needed to confirm that the animal has been slaughtered at the slaughterhouse are indeed complete and correct in the data.

Then there is also the issue of temporary coverage [3]. With the current system, temporary coverage is a problem since it takes four months to finalize the number of slaughtered animals. In the new system this might be an issue as well. But since the I&R data need to be updated

within a defined period (e.g. for bovine three working days) we hope that it will take two months at the most to finalize the data.

Although the purpose of the register makes it clear that the data in the system should be correct and complete, it is not sensible to assume that it is. So, it is still necessary to check for errors and missing data. An example of common missing data is the date of birth of animals that were imported. An example of an error is a bull that has a date of calving (the date of birth of the first calf of a cow).

Some issues can be resolved. For example, with errors where a bull (sex is male (M)) with a calving date is registered, the sex is automatically corrected to female (F). These errors will also be reported to RVO, so they can improve the data. Another example is when the date of birth and sex are missing, but a date of calving is available, then the sex becomes F (and the category cow). When there is too little information to classify the bovine animal, we decided to resolve this later in the process by dividing this group using the known population. In the process no data is removed, only automatically corrected and serious errors being reported to RVO.

When we load the input file the data is checked and corrected if possible. None of the records are removed.

Not one I&R system but multiple

For the calculation of the number of slaughtered animals and meat production the I&R system is crucial. Since some of the I&R systems hold information on individual animals that have been born and/or moved, including dates, we can determine the number of slaughtered animals per month and/or year. For bovine, sheep and goats, this information is registered on the individual level, therefore they can be tracked through time to each location. It also means there is information on the animal itself: when the animal was born, whether it was male or female, and in case of cows: when she had calved. Subsequently, the datasets are quite large, especially for the bovine registration, which can be as large as 3 million individuals per year.

Other I&R systems register on the level of groups of animals. For example for pigs, the information is per truck load, which means individuals cannot be tracked. However, when pigs are moved (to a slaughterhouse), the move is registered by the farmer and the receiving party must register the arrival of the pigs and this information can be extracted. This includes the exact slaughterhouse the pigs have been moved to, where they came from and how many animals were in the truck. For the locations the UBN is used. The next table illustrates some of the differences between the I&R systems.

Table 1: Differences between I&R systems of bovine, sheep and goats and pigs [5].

Differences I&R	*Bovine*	*Sheep and goats*	*Pigs*
Level of registration	Individual animals	Individual animals	Number of animals per truck load (group)
Registration within	Birth and other changes within 3 days	Birth: dairy goats within 7 days & sheep and other goats within 6 months. Other changes within 7 days	Birth is not registered but pigs need to be earmarked within 3 months after birth. Delivery and removal of pigs within 2 working days. For removal to slaughterhouse a special earmark is needed.
Former locations	Available	Available	Available

How are the three data sources linked

Crucial for linking the data sources we use are the UBNs. This is a unique location ID that is necessary for example for farmers with cattle, slaughter location, and locations where cattle is brought together like a cattle market. These UBN's will be linked to the agricultural locations and using the farm ID to the agricultural census, which holds the address. The address usually holds the street name, house number, house number additions, postal code and place of residence. Only the postal code and house number are used to link to the register of Skal, holding the organic certificates of each company, farm and location where the animals are slaughtered. By combining the data from the I&R system with the data from the register from Skal, the number of organic animals can be calculated. Combining the way described above allows for the most reliable linking of sources since a unique ID is not available in all sources.

3 Comparing the current and intended new system

To give more insight in the reasons why we wanted to build a new system for the meat production we will describe the current system and after that the intended new system.

3.1 Process scheme current system

Currently, the number of total slaughtered animals is based on data delivered by the Dutch Food and Consumer Product Safety Authority (NVWA). The data we receive are the total number of slaughtered animals per category of animal species for every slaughterhouse. These data are checked. If a slaughterhouse did not report any slaughtered animals, we attempt to check if the slaughterhouse is still active. If so, the missing data is imputed. For bovine animals, there is only data on the number of calves and adult bovine animals. The adult bovines are distributed pro rata into cows, heifers and bulls. For this we use percentages we receive from RVO. Calves are distributed pro rata into younger and older calves, for which percentages received from SBK kalf, the trade association for the Dutch veal sector, are used. Then the total number of slaughtered animals is calculated. The total amount of the meat production is calculated by multiplying the total amount of slaughtered animals with the average carcass weights. The carcass weights we receive from RVO.

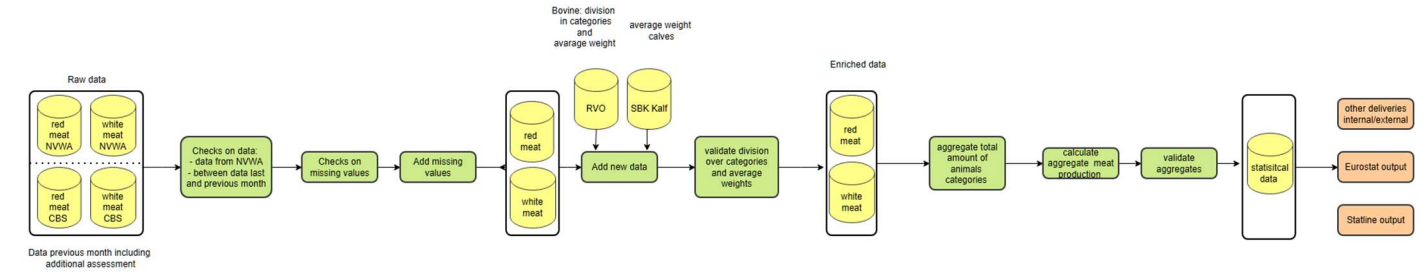

Figure 1: Process scheme of the current system used for calculating the meat production

The organic slaughtered animals and meat production are estimated every year. This estimation is based on the organic animals for meat production as reported in the yearly agricultural census. The figures are multiplied by a factor that differs for the type of animal. This gives the estimated total number of animals slaughtered per animal category in a year. For calculating the meat production these totals were multiplied with estimated carcass weights based on expert information.

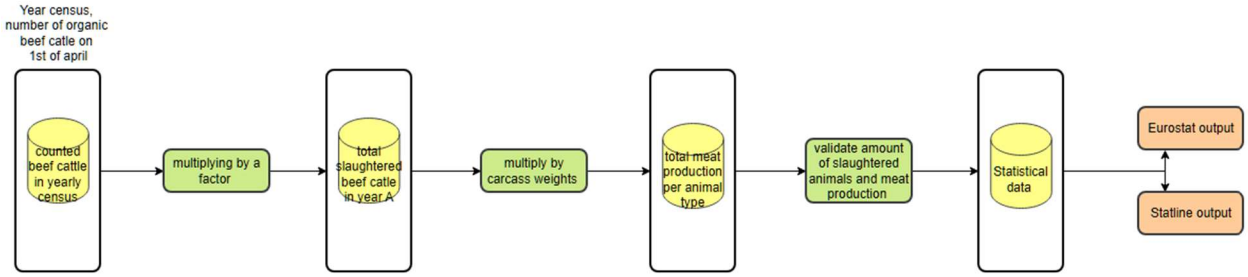

Figure 2: Process scheme of the current method used for calculating the organic meat production

3.2 Process scheme intended new system

The process scheme for the new system consists of a main process and two sub-processes. One sub-process is designed for classifying bovine animals into age and sex categories. The second sub-process is designed for classifying animals as organic. The first sub-process is specially designed for bovine and the second sub-process is applicable for all animal categories.

Sub-process for classifying bovine animals into categories

From the I&R register the following information is known for a bovine animal: date of birth, sex, date of calved and date of slaughter. Using this information it is possible to determine age and to classify a bovine animal into one of the following categories: bulls, cows, heifers, calves and young cattle (see figure 3). If a bovine animal has calved, but information on date of birth and sex is missing, the animal is classified as a cow. For the remaining cases a bovine is classified as unknown. This last group is divided into the categories later in the process using the ratios calculated based on the known population.

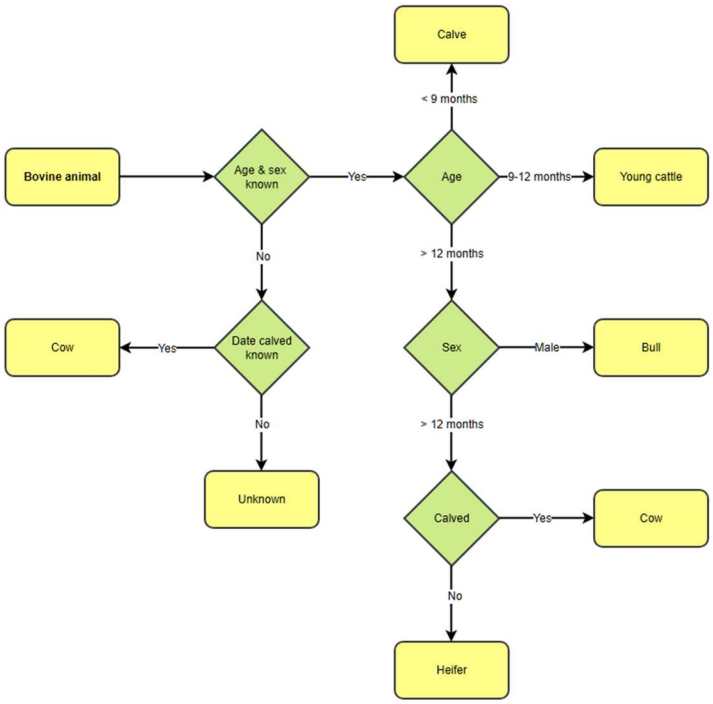

Figure 3: Logical decision scheme to classify a bovine animal according to age, sex and if a cow has calved or not.

Sub-process for classifying animals as organic

As shown in figure 4, a bovine animal is classified as non-organic when slaughtered in a regular slaughterhouse even if it is an organic animal. If a bovine animal is slaughtered in an organic certified slaughterhouse, the age of the animal is checked. Animals younger than 1 year are classified as organic if the animal has stayed his/her whole life at organic certified farms. Bovine animals older than one year are classified as organic if they have stayed at organic certified farms for the last year. The remaining animals are not classified as organic.

To classify bovine animals as organic or conventional the following assumptions are made: A) The check to determine whether animals are located at a location certified as organic only applies only to livestock farms and not for livestock staging areas (these are ignored). B) If the life number is unknown the animal is classified as conventional. C) Locations where bovine animals can stay should be certified as organic for the whole time the animal stayed at that location.

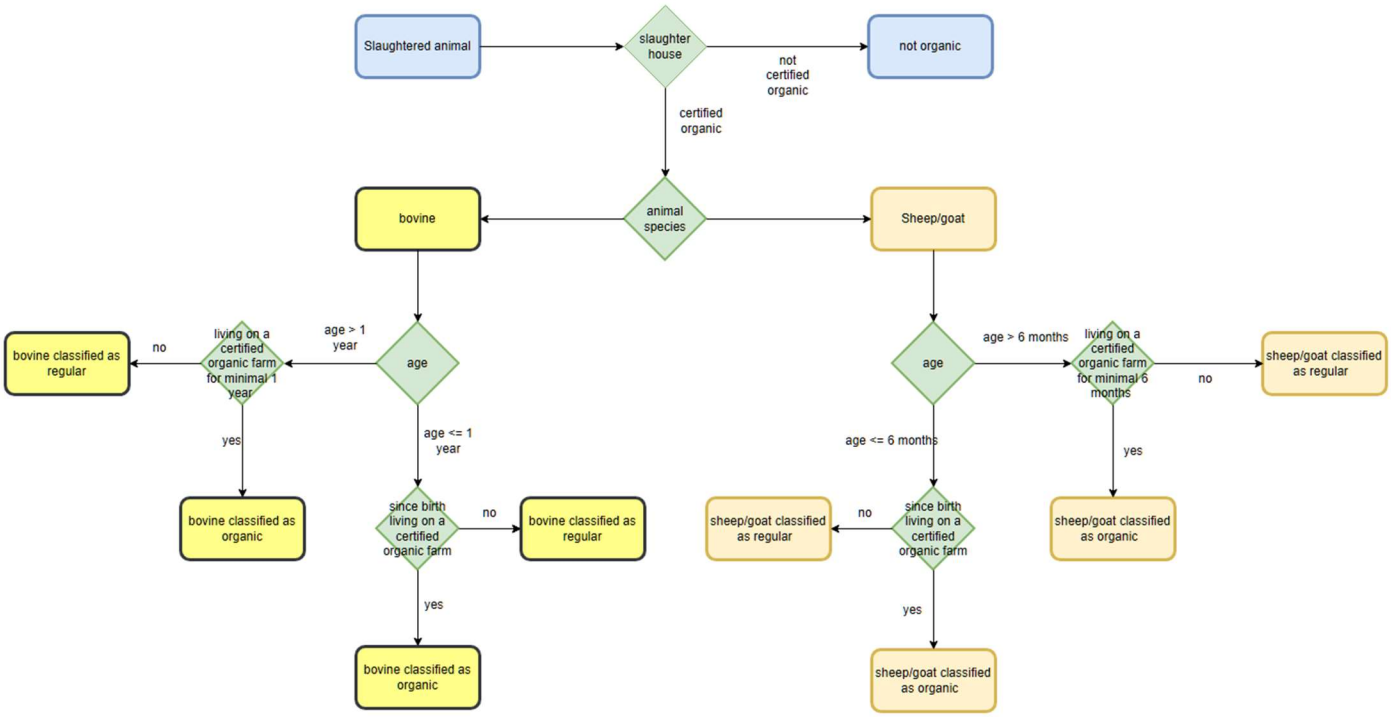

Figure 4: Logical decision scheme to classify bovine animals and sheep and goat as organic or regular.

Main process scheme

The above two classification schemes are incorporated into the scheme described in figure 5. In short, raw data (I&R bovine animals and I&R slaughterhouse locations) enters the system and a check on the data is performed. This is a simple check to verify whether the data conform to expectations (correct number of columns, correct naming columns, etc.).

Next, this data will be used to update our SQL database consisting of three tables. One table on bovine animals (sex, date of birth, etc.), a second table on the locations where animals stayed and a third table on the locations itself (address, type of location). These tables will be checked on errors and if needed corrections are applied. Each table contains a key-variable that can be used to join these tables.

Then the age of the animal is calculated based on date of birth and the slaughter date. If the age of the animal is known, it can be classified as described in figure 3. The table on locations will be enriched with address using information from the agricultural census and addresses provided by RVO. To see which locations are organic certified the SKAL database will be used. The dataset on locations can be joined with the dataset on animals, making it possible to classify an animal as conventional or organic using the scheme described in figure 4.

With this enriched data the number of slaughtered animals for every animal category per slaughterhouse is calculated. And that is input for the calculation of the meat production. For this we use average carcass weights that we receive from RVO.

The results will be checked and made ready for publication on our website, delivery to Eurostat, and delivery to departments within CBS.

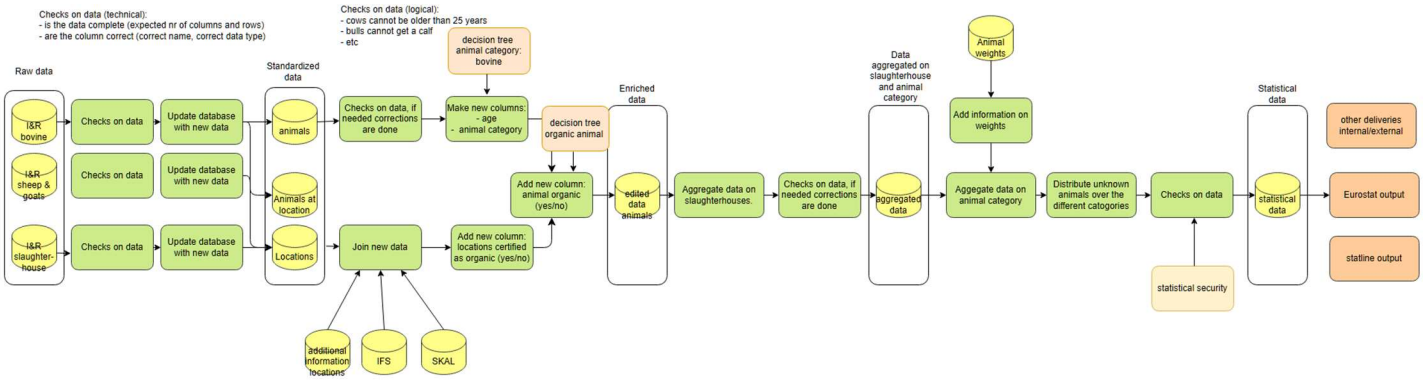

Figure 5: A schematic representation of the steps performed to make statistical data from raw input data (I&R bovine) into aggregated on bovine animal type and if the animal can be considered organic or not.

Table 2: overview of the differences between current and intended new system

	Current system	Intended new system
Animals included	Bovine, pigs and poultry.	Bovine, sheep and goats. Pigs and poultry will be added.
Data source	NVWA (number of animals slaughtered per slaughterhouse and type of animals). RVO (percentage of animal categories and average carcass weight). SBK Kalf (percentage young and older calves)	RVO (data on animals slaughtered and the slaughterhouses). Skal (data on organic certified livestock farms and slaughterhouses).
Level input data	Slaughterhouses and types of animals.	Animal (individual or group)
Storage data	SQL database with around 15 tables.	SQL database: the tables from the old system plus 3 extra tables.
Organic data can be calculated	Not part of the system, is calculated separately.	Yes, is part of the system.
Methodology	After checking the input data and imputing missing data, the data is aggregated to totals that are multiplied by the percentages for the animal categories (age and sex). The new totals are multiplied by average carcass weights.	After checking the input data and identifying the organic animals and categories (age and sex), the data is aggregated at the level of slaughterhouses and animal species and categories and then aggregated into totals.
Imputation (maybe) necessary	For the slaughterhouses where no data is received.	Probably not necessary
Degree of automation	Checking whether a slaughterhouse is still active and if so, imputation of missing data is done manually.	The aim is total automation.
Period before figures become final	4 months (for 3 months the data delivered to Eurostat are provisional. The 4th month the data are final.	Not sure yet but less than 4 months. Expectation is 2 months at the most.

4. Discussion and conclusion

Currently, we are using a source on slaughtered animals that contains room for improvement. For example, the percentage used for the classification of the bovine animals is not very accurate. To be specific, the percentage for heifers was fixed every month. Another disadvantage of the current system is that it takes four months to finalize the data. Additionally, with the data we receive from the NVWA it is not possible to calculate the number of slaughtered organic animals

and the organic meat production. So, the organic animals were not included in the system and estimated separately, which makes a comparison of the statistics impossible.

With the intended new system we have tackled these problems. Because we have data on the date of birth and the sex of the animals, the classification of the animals is more accurate. Additionally, the rules for the I&R system (changes need to be filled in within defined period), makes it possible to finalize the data sooner than 4 months. The use of I&R and Skal also makes it possible to align the methods for the meat production totals and organic and compare the meat statistics for the whole population with the organic population.

- During the development of our new system, we ran into several issues. Most notable being the time it takes to process the data in the new system compared to the current system. With the current system our input file is small since it only contains several thousand entries. The data for the new system however is not aggregated. This has caused an immense increase in processing time since every single entry is checked for errors. We are still searching for a solution to these performance issues, especially since more animals will be added to the system, which may cause additional performance issues.

- Testing the system and running it in parallel with the current system is important to assess the results of the new system. The assessment is done mostly by comparing interim and end results of the current and intended new system. We tried to develop software for comparing the results of both systems. Here we ran into the issue that our new and current data suppliers use a different identifying variable for the slaughterhouses. This meant that initially it was hard to compare the data on the level of slaughterhouses between the two systems. This is solved by creating a link table that pairs different identifying variables per slaughterhouse.

- This is not a complicated statistical operation. However, it is important that what is calculated in the intended new system is comparable with what is calculated in the current system as it might cause a time series break. There are many reasons for a time series break. For example, one data source is more complete then the other source or there may be differences in definitions. In this case it does not look like there are differences in definitions, but there is a difference in level of input data with namely slaughterhouses vs individual animals. Although, the intended process still includes the data at slaughterhouse level, it is possible there are differences. The parallel running we will be working on the coming months, will give us insight in the results and a possible time series break.

- We have been working with the I&R system for the bovine animals. This system has some advantages compared with the other systems. The bovine animals are registered individually within 3 working days after being born. That means that (nearly) every bovine animal in the Netherlands is registered. That seems almost like the perfect register for statistical production. So, working with this I&R system was an advantage to get experience with the system. However, the other I&R registries, except for the system on

sheep and goats, are very different from the bovine I&R system. For example, the pigs registry is based on groups of animals, which will have its own new challenges.

Although working with I&R registries has proved to be challenging, it shows much promise on data quality and timeliness as well improving the method for the whole populations and the organic population, ensuring they are similar and comparable.

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