

An appraisal of the Maltese national livestock database with regard to bovines

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Summary

The creation of a centralised national livestock database for the islands of Malta and Gozo is of crucial importance for the identification and traceability of bovines. It is also important for compliance with the legal obligations that followed Malta's accession to the European Union in May 2004. This paper describes how the processes of identification, registration and traceability of bovines have changed since Malta's accession. The validation and integration of data originating from different departmental sections (such as the identification and registration section), the slaughterhouse and the National Veterinary Laboratory, ensures that any discrepancies are highlighted and can be investigated. Events recorded in the database enable the compliance and eligibility of bovine producers to be cross-checked when applications for European Union benefits are made. The main drawbacks and weak points of the system include financial costs for the government department, potentially late notification of the births and deaths of newborn calves, and insufficient uptake

among bovine producers of the latest technology for notification of events such as births, deaths and movement of bovines.

Keywords

Bovines – European Union – Gozo – Identification – Malta – National Livestock Database – Registration – Traceability.

Introduction

The identification of animals has been considered important since humans first started to keep livestock. Evidence for identification of live animals by means of body markings can be found as far back as 3,800 years ago in the Code of Hammurabi (1). Marking of live animals to identify ownership was especially important for valuable livestock. Later, the use of branding had particular importance in control of livestock diseases (2).

Freeze branding and ear tagging are the methods that have traditionally been used for permanent marking of bovines on the Maltese Islands of Malta and Gozo (the third island, Comino, has no livestock). These systems were useful for two main purposes: to claim ownership of animals and to identify them during brucellosis and tuberculosis surveillance and eradication programmes. Legislation dating back to 1924 empowered the Superintendent for Public Health to order that cattle, goats and sheep be branded and wear a marked collar, ear stud or other mark for the purpose of identification (3). The same legislation also required the Director of Agriculture and Fisheries to keep a register of farms and of any persons working therein, and for every keeper to keep a farm book.

Before Malta's accession to the European Union (EU) on 1 May 2004 there was no central computerised system for storing data pertaining to bovine husbandry systems in Malta and Gozo. Any data generated by the Department of Veterinary Services (DVS) within the Ministry of Agriculture and Fisheries, such as data relating to ongoing disease surveillance programmes, were stored mainly in the form of paper records. Copies of movement permits for the movement of bovines,

ovines and caprines from one holding to another were stored in individual files for each holding. However, although these records were reasonably comprehensive, any tracing forwards or backwards of animals during epidemiological studies was a laborious process requiring analysis of paper records in several files.

During preparations for Malta's accession to the EU, the identification of bovines and the way data were stored and analysed changed radically. One of the main reasons for this change was the introduction of the national livestock database (NLD) to store, manage and analyse data.

This paper describes how identification, registration and traceability in the bovine sector have been managed in the Maltese Islands since EU accession. The paper also highlights the merits and drawbacks arising from ten years' implementation of the NLD, which is the link between the separate components of the identification, registration and traceability chain.

Present situation: plastic ear tags and herd registers

From 2002, plastic ear tags began to be used on newborn calves and to replace metal ear tags on adult bovines. The use of these tags is covered by European Commission (EC) Regulation 1760/2000 (4) and EC Regulation 911/2004 (5). To implement these regulations, Malta enacted Subsidiary Legislation 437.84 (published as Legal Notice 311 of 2 September 2005 of the Laws of Malta [6]). As a result, bovines began to be identified by an ear tag number unique to each animal and which accompanies it throughout its life. Each tag shows the two letter country code for Malta (MT), the Maltese coat of arms, a bar code, and a seven digit number, the last digit of which is a check digit. Furthermore, owners of bovines were now legally obliged, as per Regulation (EC) No. 1760/2000, to keep comprehensive records in their herd register, which should list dates of birth, deaths and movements of all bovines on the holding. The ear tag number of each calf is recorded with the identification of its mother. When animals are bought, details of the holding of origin are listed for traceability

purposes; when animals are sold, details of the holdings to which the animals are sold must also be recorded.

Traceability and the national livestock database

The issue of traceability has become more important in recent times, especially during disease outbreaks (7, 8, 9). Tracing is achieved through:

- identification of animals
- identification of premises
- tracking of animal movements (10).

From a practical point of view this requires that:

- a) all animals are permanently identified with a unique number
- b) all livestock holdings and their locations are registered
- c) herd registers are kept on all holdings
- d) records are kept of movements in and out of holdings.

One or more databases are set up to provide a link between points (a) to (d) above and to give real-time traceability of all livestock present on the holdings.

Traceability is difficult to implement and control without the necessary legislation. In Malta, Subsidiary Legislation 437.78 (11) and the previously mentioned 437.84 (6), published as Legal Notices 292 and 311 of 2005, respectively, have been enacted. These laws give power to ‘the competent authority for the territory of Malta’, in this case the Veterinary Services of Malta, to implement these rules according to EU legislation. This also ensures mandatory participation by all the stakeholders in Malta and Gozo. Anderson (9) and Stanford *et al.* (12), describing bovine identification systems in the United States (USA) and Canada, respectively, acknowledge the importance of mandatory participation by all producers, but also highlight the problems related to differing identification systems, such as ease of

use, reliability, costs, and acceptance of the system by all stakeholders.

The creation and legal basis of the national livestock database

The creation of the NLD has played a crucial role in the recording, management and analysis of livestock data. Use of the database and input of data began gradually in 2002 as a pre-requisite for Malta to join the EU.

The Commission of the European Communities subsequently recognised the fully operational character of the database for bovine animals, stating in Article 1 of Commission Decision 2004/588/EC of 3 June 2004 that ‘the Maltese database for bovine animals is recognised as fully operational from 1 May 2004’ (13).

Furthermore, Article 1 of Commission Decision 2005/415/EC of 1 June 2005 authorising Malta to make use of the system established by Title I of Regulation (EC) No. 1760/2000 states that ‘Malta is hereby authorised to replace the surveys of bovine animals provided for by Directive 93/24/EC by using the system for the identification and registration of bovine animals as referred to in Title I of Regulation (EC) No. 1760/2000 to obtain all the statistical data required to comply with the obligations arising out of the said Directive’ (14). Malta was thus authorised to replace the surveys of bovines provided for by Directive 93/24/EC by using the NLD to obtain all the statistical data required for compliance with the obligations arising from the said Directive.

The DVS, which is now the Veterinary and Phytosanitary Regulation Department (VPRD), has been responsible for managing and running the database since its implementation in 2002. As a result, the database is national and centralised, and fragmentation of data is kept to a minimum. Within the Department (VPRD), separate sections dealing with caprines and ovines, swine, poultry, equines and the National Veterinary Laboratory (NVL) all input and manage data relating to their own sections. Other government departments and

entities are given authorised access to the database, but addition or editing of data is allowed only with authorisation from the database administrator.

The NLD manages data in three main areas:

- identification, registration and traceability of animals and/or their products
- animal health records, such as for disease surveillance and control programmes
- production information, which is particularly useful to producers and breeding organisations.

Data relating to the first two areas are used mainly by government departments involved in veterinary affairs and in managing payments of EU livestock premiums. Data listed in the first area are also used by the National Statistics Office (NSO) of Malta, which is responsible for drawing up the yearly cattle census, the NSO Cattle Survey (15), in accordance with Commission Regulation (EC) No. 1165/2008 (16).

Producers and breeding organisations can be allowed access to data in the third area. The database is structured in such a way that the entities that use it are able to request programmes they need from the database developers. Producers can also be authorised to use certain online applications such as visualisation of data relating to their herd or to apply for animal movement permits. Additional facilities for breed societies and production-recording agencies allow recording of lactation data, individual milk tests and phenotype classification, for example. Currently, the NLD is not being used to manage data in the third area.

Training of departmental staff and stakeholders

Apart from setting up the database and making sure that the information technology (IT) infrastructure and legislation was in place, training of all departmental staff and stakeholders in the bovine sector was necessary. Internally organised training of official veterinarians (OVs) and staff involved in data entry began in 2002.

Veterinary support officers (VSOs) responsible for tagging bovines were trained in how to attach the EU-approved ear tags and manage the necessary paper work. Bovine producers were instructed on their legal obligations, on how to keep records in their farm register, and on how to liaise with the Department regarding notification of births, deaths and movements. The OV's were trained in how to audit data in herd registers and how to carry out a random or targeted census to verify that data held in the database reflected the actual population status on the holdings.

Recording data in the national livestock database

The NLD is of value only if the data cover all the bovine holdings and their respective herd populations in Malta and Gozo. For such a system to be comprehensive, the following data are collected:

- registration of all holdings containing bovine herds in Malta and Gozo
- registration of all ear tags applied to bovines
- registration of all movements of bovines from one holding to another, to a slaughterhouse or to a temporary exhibition.

Registration of all holdings containing bovine herds

All bovine holdings are required by law to be registered with the Malta DVS as in article 3 (1) (a) of Subsidiary Legislation 437.78. The scope of this law is to implement the rules found under the following EU laws: Directive 92/102 (17), Decision 89/153 (18), Directive 91/496 (19), Regulation 3508/92 (20), Directive 90/425 (21), Directive 88/661 (22) and Directive 64/432 (23).

All bovine holdings in the Maltese Islands are registered on the NLD, irrespective of the area of production or the numbers of animals. Apart from being given unique codes, the longitude and latitude of the holdings are also recorded in the database. In the ten-year period under review, 1 January 2003 to 31 December 2012, 358 active holdings were registered in Malta and 61 in Gozo, a total of 419.

These include both dairy holdings and non-dairy holdings, the latter mainly keeping bovines for fattening and slaughter. The non-dairy holdings are normally family run and operate on a part-time basis. Active holdings are defined as those having an average of at least one bovine on the holding throughout the ten-year period under review.

Among the 126 dairy holdings registered in Malta, 89 (71%) had fewer than 100 bovines; among the 232 non-dairy bovine holdings, 216 (93%) had fewer than 20 animals. In Gozo, among the 49 dairy holdings registered during the ten-year period under study, 27 (55%) holdings had fewer than 100 bovines; among the 12 non-dairy bovine holdings, all (100%) had fewer than 20 bovines on the premises (Table I). Even though the smaller holdings keep very few bovines, their registration is nevertheless required for traceability purposes, as they are also involved in the buying and selling of stock.

Registration of all bovine ear tags

Ear tagging of bovines on the Maltese Islands is carried out by VSOs from the Department. Whenever an animal is born, the owner must inform the Department within seven days of the birth, as per article 7 (1) (b) of Subsidiary Legislation 437.84 of the Laws of Malta. The VSOs tag the animal within a required 20-day period, as per article 4 (2) of the same law. When an animal is tagged, the farmer signs a form to confirm details of the event and the team returns the form to the office. Data are entered that same day or the following working day and include the ear tag number, breed, sex, date of birth, the holding number, and the identification of the dam.

When an animal loses an ear tag, the owner informs the Department and a new tag with the same number is ordered from the manufacturer. When this arrives at the Department, VSOs visit the holding, verify that the old tag is missing and re-tag the animal. The event is recorded in the database. Records are kept on the number of times an animal is re-tagged and on the number of re-tagging events at any particular holding. If the number is deemed high, the holding is flagged and if necessary an OV can be sent to investigate.

A total of 57,336 bovine births were registered during the study period: 38,255 in Malta and 19,081 in Gozo (Table I).

Registration of movements of bovines between holdings or to a slaughterhouse

Movement permits are required whenever bovines are moved from one holding to another. This is not required when bovines are transported from the holding directly to the slaughterhouse, although a pre-slaughter form containing the details of the animals is required and must be presented on arrival. The importance of tracking animal movements on and off holdings is understood; one of the first tasks when serious contagious diseases are discovered is to trace animals backwards and forwards from the index holding. It is therefore important that all animal movements are registered and that the information is entered in the database as soon as possible after the movement has taken place.

Whenever a producer wants to introduce or remove bovines from a holding, a movement permit must be requested beforehand. The ear tag number of the bovine/s to be moved is given, together with the holding registration number of the buyer and the seller. An OV will make the necessary checks in the database and verify that all details are correct. If movements are temporarily blocked because of infringements or disease, this is flagged in the database and the movement permit cannot be issued by the OV. If there are no objections to the movement, a permit is issued by the Department and given to the producer. After the movement has taken place, a copy of the permit signed by both the buyer and the seller must be returned to the Department within seven days, as per article 7 (1) (b) of Subsidiary Legislation 437.84 of the Laws of Malta, and the movement is then confirmed in the database.

In the ten-year period under review, a total of 22,610 movements between premises were registered: 19,712 originating in Malta and 2,898 originating in Gozo (Table I).

When bovines are transported from a holding to a slaughterhouse in Malta or Gozo, the pre-slaughter form is presented on arrival, the ear tags are registered and the relevant details are automatically entered in the database. Ante-mortem and post-mortem inspection findings are recorded in the database directly from the slaughter line, thus ensuring in real time that the number of bovines registered for any particular holding on any day reflects the true situation. This is also important during an official census or inspection, when the OV can download the list of animals present on that day and cross-check for any discrepancies during the inspection. This ensures full compliance by livestock holders in notifying the Department of any births, deaths or movements in or out of the holdings.

The number of bovines registered as slaughtered during the period under review was 50,044 at the abattoir in Malta and 1,566 at the abattoir in Gozo, giving a total of 51,610 (Table I). These figures also include emergency slaughtering. The big discrepancy between the figures for Malta and Gozo reflects the fact that the Gozo slaughterhouse was closed for re-structuring during most of the ten-year period.

Analysis of the national livestock database system on the Maltese Islands

The NLD of the Maltese Islands is under the control of the VPRD. The Department has a main office in Malta and one in Gozo. The database is managed from the Malta office, and the Gozo division is linked via the Internet. The database is hosted on the Microsoft SQL Server and is located on a central server managed by the government IT services. The central server uses resources from the pool maintained for all government servers; these are protected against power interruptions and, in case of catastrophic failure, a second independent pool is maintained in a different location, allowing all operations to continue without interruption. In addition to the standard data backup procedures of the government IT service, an automatic backup of the database is generated on an independent disk drive every night. These backups are periodically copied to DVD ROM and

stored in a secure location. There is thus a copy of the database for every day since 2004. The database is used to validate subsidy claims, and occasionally the backups are required by auditors for verification that claims were correctly processed.

All data collected in Gozo are entered by Department officials at the Gozo office, and the central server in Malta is updated in real time. Use of a single database is an advantage, ensuring that the limited resources of the islands can be used efficiently and that fragmentation of resources and personnel is kept to a minimum. Moreover, this system is possible because of the relatively small numbers of holdings and bovine populations in the islands. During the ten-year period under review, the average yearly bovine population registered on all active holdings in Malta was 12,114 and in Gozo 5,664, giving an overall average of 17,778 bovines.

Data are stored in three main registers:

- premises register
- producers register
- animal register.

There are no practical limits to the number of registers that can be maintained in the database and these can be increased or decreased as required.

Filters can be used to limit the large volume of records to very specific subsets of data. This is especially useful whenever data are compiled for survey or census purposes. Filters can also be applied to records according to the different types of premises, producers, species, age, etc. Moreover, user-defined reports can be produced in the form of rich text format files. Reports such as results of disease surveillance tests, monthly slaughtering reports and lists of calves born per month can be produced in this format.

The volume of data stored and the potential implications of loss, theft or tampering mean that security and auditing of the system are of key importance. As a result, a number of precautionary measures are in place to reduce the risk of such events. All users having access to the

database are registered by the database administrator, and access is by means of a user name and password that must be authenticated to the government computer network. The level of permission for each user to control and edit data is determined by the database administrator. All data entry is recorded, together with the date, time and workstation used. Any edited or deleted records are retained by the database and the date and time of such amendments are recorded with the username and workstation. Furthermore, all connections to the database are recorded, including the date and time of connection, disconnection, the username and workstation. A number of servers are located in secure areas in separate locations in the island to ensure that a backup of the database is available in the event that any one location is damaged or destroyed completely.

Premises register

The premises register includes details of all holdings where animals are kept. The data fields include:

- premises code (a unique code by which each holding is identified)
- producer name
- premises type (describes the type of activity carried out; in the case of bovines, this refers to dairy herds and non-dairy herds)
- location, i.e. the town in which the holding is located (during the review period, active bovine holdings were registered in 48 towns in Malta and 12 in Gozo, giving a total 60 throughout the Maltese Islands) (Table I)
- longitude and latitude of the holding (this enables production of maps showing exact locations when disease outbreaks are investigated).

Slaughterhouses and quarantine areas are also registered within the premises register. Other variables can be created so that events such as inspections, disease incidents and herd tests can be recorded for each type of holding. Events can be recorded in the database as ‘done’ or

‘scheduled’, and action lists for events scheduled during a specified time period are issued to the responsible OV or VSO. Lists of events, such as the number of brucellosis or tuberculosis tests carried out during a specified period of time, can also be produced for evaluation by Department managers or directors.

Producers register

The producers register holds data on the persons or firms legally responsible for the livestock. In most cases one producer is associated with each holding but in certain instances, such as a partnership between family members, more than one producer is associated with each holding. In some cases, a producer may be associated with any number of holdings.

The data in this register include:

- unique producer code, i.e. the identity card number of the owner/s
- producer name/s
- address and contact details.

Animal register

The animal register records details of individual animals according to species and includes their complete movement history. Moreover, the database can record batches of animals, such as a batch of poultry or a litter of pigs, coming from a common source. Batches can be split into sub-batches that can be recorded independently of each other. A sub-batch inherits the movement and event history of its parent batch. Up to ten generations of split batches is currently supported, and batches can be split to individual animal level if required, such as for carcass classification data. If the animal products derived from animal batches are marked with the final sub-batch code, the product can be traced back through all movements to the first registration of the original parent batch.

The data in this register include:

- i) Premises number

ii) Species

iii) Breed

iv) Sex

v) Date of birth

vi) Age

vii) 'Present from' date: The date when the animal entered the premises or its date of birth if born on those premises; if the animal was bought, it is the date when the animal was introduced into the herd

viii) Origin: This field allows a comment relating to the 'present from' field described above. If the animal was born on the holding, the comment is 'birth'; if it was bought, the comment shows the code of the premises from which it was bought; if it was imported from an EU country, the comment is 'IMP-EU'. If for any reason the origin of the animal on the holding cannot be verified by its birth or purchase, the comment 'First' is inserted in the field until further investigations are made

ix) 'Left on' date: The date on which a particular animal left the holding

x) Destination: The destination of an animal on leaving the holding. The comment can show a premises code to denote that it has been sold; the comment 'AM' means that the animal was taken to a slaughterhouse; the comment 'dead' indicates that it has been registered by the owner as having died on the holding. During the ten-year period, 6,410 bovine deaths were registered on holdings in Malta and 3,967 in Gozo, giving a total of 10,377 (Table I).

Several lists can be produced from the above data. The most common are those showing all the animals present at specified premises and between specified dates, and those showing the animals registered to specified producer/s irrespective of the premises at which they are kept. Moreover, the parentage and offspring of different livestock species can be recorded for an unlimited number of generations.

It is also possible to link registers together and to link a particular animal identification with other information such as the dam and sire and any offspring produced.

A list of movements on and off the premises is another option available; such lists are used during epidemiological studies when disease outbreaks are investigated and rapid tracing of animals is required.

Use of the database enables determination of the number of holdings active on a particular date or during a particular time frame, together with the number of bovines and the average population on any particular holding, and all the relevant data on any particular date or during a particular time frame.

The data management section

The data management section of the NLD is the main interface of data management and analysis. It is used to issue the various reports requested on a day-to-day basis by managers or OV's of the Department and also for audit purposes and statistical reporting. The structure of the section, together with a brief description of the contents of each register, is shown in Table II.

Lists and reports section

The lists and reports section includes the action-list register and the reports register. The structure of the section and a description of each register are shown in Table III.

Between 1 January 2003 and 31 December 2012 a total of 8,421 premises events were registered on bovine holdings: 6,703 events on holdings in Malta and 1,718 in Gozo. Moreover, a total of 423,417 bovine events were registered during the same period: 272,473 in Malta and 150,944 in Gozo (Table I).

A tabular summary can be constructed to show cross-tabulation according to month, administrative unit, premises, species, breed, sex

and destination, for example. A specified period of time can be chosen and data will be generated accordingly.

Integration of data between the National Veterinary Laboratory and the Identification and Registration Section

The NVL and the Identification and Registration Section (I&R), which both fall under the VPRD, share information and data via the database. This step is very important since integration of data and further checks are carried out whenever data from the laboratory are added to the database.

When the OV or the VSO visit a holding for testing, such as testing for tuberculosis, brucellosis, leukosis or bluetongue, a field sheet is printed showing the identification numbers of the bovines present on the holding. The field sheet also contains labels with identification numbers and corresponding bar codes for the bovines present on that date. The labels are attached to the sampling tubes during testing, and any labels that are not used, or bovines whose identification is not on the field sheet, are noted. The OV or VSO will then notify I&R and investigations can be initiated.

The samples, together with a copy of the testing sheet, are returned to the NVL, where the identification number of each bovine is entered on the respective test template folder according to the test being carried out. Once the results are obtained, these are imported to the relevant file and then transferred to the database. Results of tuberculosis testing are entered directly in the database by the OV.

Where enzyme-linked immunosorbent assay (ELISA) tests are used, the test template and the results are automatically updated to a file at the NVL. After this is checked, it is sent to the database. If any test results are positive, the health status of the animal and the relevant holding are updated accordingly. E-mails are also sent by I&R to the relevant OVs to inform them of any positive cases so that the necessary action can be taken.

Comparison of the Maltese national livestock database with cattle tracking systems in other countries

The impact of EU accession on the traceability system of the Maltese bovine husbandry sector has been considerable, as the system has moved from an incomplete, paper-based system to a centralised, computerised system. As a result, traceability from farm to fork in the bovine sector is now possible. This is a significant achievement; in some countries, such as the United States (USA), one of the biggest challenges is coordinating and linking different animal and meat traceability systems (24).

Although the database is not unique to the Maltese Islands, as a database is required by all EU member states, some aspects of the management, funding and day-to-day running of the system are different from those in other EU member states. Livestock databases are also used in non-EU countries where the bovine industry is economically important, e.g. Australia, Canada, Switzerland, the USA, Japan, South Korea, Argentina, Brazil and New Zealand (25). The main objective remains the traceability of bovines and in some cases, as for the Maltese Islands, other livestock species. The extent of this traceability, the specifications of the different systems and the way they are operated may differ from country to country.

Different scenarios regarding responsibility for the management of databases are present. For example, in Malta and Gozo the government is responsible, and this is also the case in Great Britain (GB) and the Netherlands (25). However, in Denmark and Finland the databases are managed by private companies (26). The system in Australia is a joint industry–government partnership (25).

In Malta, the database is funded by government; this is similar to the situation in GB. In Switzerland, the funding for setting up the system was provided by the government but the operating costs are covered by the users of the database (25). In Denmark (26) and the Netherlands (25) the database is funded by the farmers.

Another difference between the Maltese Islands and other countries is that in Malta the bovine keepers do not order ear tags from the approved manufacturers themselves, as happens in other countries such as GB (27). In Malta, the tags are ordered directly by VSOs at the Department and the VSOs then tag the calves with no cost to the keepers. When the cost of the tags, the salaries of officers responsible for tagging, and the cost of transport and fuel are taken into consideration, it is estimated that the cost of each ear tag is approximately €7.00.

In the Maltese Islands, the keeper is obliged by law to inform the Department of any births of calves within seven days of the birth, and the calves are tagged no later than 20 days after birth. Movement must be notified within seven days. This notification and tagging period is different in some other EU member states. For example, in the Netherlands, ear tagging and notification of births, including stillbirths, must be done within three days of birth, and movement of animals must be reported within three days (25). In GB, dairy farmers must tag calves within 36 hours of birth, whereas beef farmers must tag their calves by 20 days of age; any calves dying before these deadlines do not need to be tagged. Movement of bovines must be reported within three days (27). In Malta and Gozo the movement notification is a joint one, where details of both buyer and seller are provided on the notification. This is also the case in the Netherlands (25). In GB the buyer must report movement into the holding and the seller must report movement out; however, this has led to an increase in the number of incomplete movement histories (26).

The way data are submitted to the database can also vary between countries. In Malta, births, deaths and movement are entered in the database after paper records have been submitted. Paper records are similarly used in other countries, such as GB, but they increase the chance of errors during the input phase. Electronic submission for direct input of data is preferable and leads to fewer errors (25). In the Netherlands, paper records have been replaced by submission of data via the Internet or through interactive telephone systems (25). In Switzerland, users are required to check their own data and report

back any errors or discrepancies so that action can be taken to ensure that the database contains only accurate data (25).

In Malta and Gozo, only staff from the Department input data directly into the database. This is similar to the situation in Northern Ireland, where staff of the Department of Agriculture input data supplied by farmers at markets, slaughterhouses and local offices (26). In other countries, such as Denmark, Finland and Germany, data input is carried out by private companies or farmer associations (26). Where the number of slaughterhouses and animal markets is very large, the chances of error in data submission are increased. The risk of error is reduced in the case of Malta and Gozo, where there is only one slaughterhouse on each island and there are no animal markets.

The extent to which data can be accessed by third parties also varies in different countries. In the Maltese Islands, access to the database is restricted, although bovine keepers can access data relating to their own holding. In Switzerland, data in the database are made available to industry-related organisations, thus maximising data use and generating revenue. In contrast, in South Korea and Japan, consumers are able to access online information on the specific animal from which a beef product is derived (25). This is key, as the importance of animal traceability systems lies in providing consumer confidence in food safety and in helping the authorities to control animal disease outbreaks (28). In fact, many of the traceability systems in countries such as GB, Canada, Switzerland, Japan and South Korea were implemented or gained additional importance following the bovine spongiform encephalopathy epidemic and the consequent lack of consumer confidence in beef and beef products (25). The farm-to-fork traceability system in countries such as Japan is comprehensive; the final beef product can be traced back to the individual animal by means of its ear tag. Moreover, DNA samples are taken from each carcass to verify trace-back when required (28).

Malta is a small country and distances between holdings are relatively short, thus the primary driving force for maintaining accurate data in the Maltese database is the risk associated with the introduction of a

serious contagious disease. In such a scenario, once discovered, the ability to identify all at-risk animals and premises as fast as possible is of utmost importance. This has been recognised as important in other countries, such as the USA (29). In Malta, the link between the database and the NVL is important in the rapid identification, registration and traceability of bovines. In this respect, reducing the notification period of birth, deaths and movement in the Maltese Islands to three days, as in some other EU member states, may be beneficial. The Maltese database also stores and manages data on a number of other livestock species, such as sheep, goats, poultry, pigs and horses, which is advantageous from an epidemiological point of view.

The compliance of bovine keepers with the regulations is crucial and can only be achieved through incentives and disincentives (25). In Malta and Gozo the main incentive is that the system of identification of bovines is entirely funded by the government. EU subsidies are only available if there is compliance with all the relevant laws, and the database is used to validate these subsidy claims. The main disincentives are the possibility of fines, the imposition of movement restrictions, and loss of EU subsidies if compliance is lacking.

Discussion

Merits of the system

Golan *et al.* (24) describe the importance of breadth, depth and precision in traceability systems in food supply. These authors describe breadth as the amount of information recorded, depth as how far back or forward the system can track, and precision as the degree of assurance by which the system can accurately recall the movement of a particular product. These three factors can be applied to the Maltese database, as its usefulness and reliability depend on the breadth, depth and precision of the information recorded. The amount of information recorded, apart from covering legal obligations, provides accurate representation of livestock actually present on bovine holdings, thus giving breadth to the system. The links between different data registers, together with the type of data collected,

provide the depth required of the system. The precision of data collected permits accurate traceability of bovines from the time they are born and ear tagged until time of slaughter. The creation of a single centralised database, managed by officials working within the same Department, has a number of advantages. These include:

i) Greater efficiency

ii) Savings on the cost of data entry

iii) Improved reliability and greater accuracy of information, as staff follow common guidelines on the entry of data

iv) Staff responsible for data input may also make farm visits and liaise with producers, which leads to a holistic concept of the system and enables staff to be aware of incongruences or pitfalls in the collection and input of data

v) Department officials are responsible for ordering ear tags and tagging the livestock, thus ensuring better traceability; the flow of information from the date the ear tag is ordered to the moment it is applied to the animal is under the direct control of the Department

vi) The Maltese Islands have a total land area of only 316 km² (30), and the short distances between holdings make for greater efficiency and economic viability. The ear tagging team in Malta travels over the whole island from a central position, and large distances would render this system uneconomical. An ear tagging team is also present in Gozo to ensure that tagging takes place within the stipulated time

vii) Ear tags are applied by staff from the Department and do not need to be posted or distributed to farmers beforehand, as happens in the United Kingdom, for example (31). This reduces the chance of tags being misplaced, applied to animals not registered in the database, or used in any other fraudulent manner

viii) Notification of births, deaths or movements of bovines can be carried out very easily. The Department is located in the same area as the slaughterhouse in both Malta and Gozo; thus, producers who visit

the slaughterhouse on a weekly basis can easily notify Department staff of these events. Notifications can also be made by phone or e-mail, ensuring that the Department has an accurate picture of the animal population on all holdings at all times on both islands. This is particularly important for rapid tracking of animal movements in the event of any contagious disease, since the distances between holdings are relatively small

ix) The transport of animals to the slaughterhouse is also recorded, to keep records of populations on holdings up to date. All slaughtering records are entered in the database directly from the slaughterhouse floor. If the ear tag and last holding location do not match with what is listed in the database, the event is flagged up and the carcass will not be released for human consumption until the event is investigated by Department officials. This chain of events occurs within a very short time frame as only one slaughterhouse is present on each island and both are linked to the database. Furthermore, slaughtering of cattle takes place once a week and this facilitates investigation of any queries

x) Recording of activities on holdings, such as inspections of animal health and welfare, and respect of environmental and hygiene regulations by Department officials are all recorded in the database; thus, these events can be used to cross-check the compliance and eligibility of producers applying for EU benefits

xi) Herd tests that are due are scheduled in the database, ensuring that managers within the Department can subsequently verify that the scheduled tests have taken place

xii) Integration of data generated by the NVL permits continuous validation of data entered by I&R; any discrepancies will be evident and appropriate action taken

xiii) Systems are in place to reduce manual input of large amounts of data. For example, in tuberculosis testing, where the OV inputs results on the field worksheet, records of negative results are entered by default and only the results of positive or inconclusive tests need

manual entry. Any positive results, animals not tested, or anomalies in animal movement records are flagged up and can be acted upon by the OVs.

Drawbacks and weak points of the system

As in all database systems there are a number of drawbacks and weak points. These include the following:

i) When the barcodes on the ear tags are covered with dirt, they can be rendered unreadable by the barcode scanners. In such a case, the number must be entered manually, thus increasing the chance of error

ii) Producers do not contribute financially towards the cost of ear tagging; the costs are met solely by the Department, except when very frequent re-tagging is flagged up

iii) The ear tagging teams are Department staff members and their salaries are paid by government; no contribution is made directly by the livestock producers

iv) Producers do not tag their calves themselves; therefore, if they do not keep an accurate and timely record of births, errors can arise in registration of birth dates and identification of the dam. This is especially the case as a period of seven days is allowed for notification and up to 20 days for application of the ear tag. Nevertheless, this would still remain a weak point of the system even if tagging were carried out by producers themselves

v) The highest risk of death in calves occurs during the first four weeks of life (32), and producers may not necessarily notify the Department of a calf death if its birth has not been notified and it has not been tagged. When collected data are used subsequently to calculate perinatal mortality rates of young calves, the real number will be underestimated. The lack of notification of such events has been described in England (33)

vi) Some producers lack computer skills or may lack Internet connectivity on their holdings; as a result they cannot efficiently notify the Department of any births, deaths or movements of bovines

vii) The large quantity of data in the national database, generated during the period under review, could be used to analyse production on each individual holding, but neither the producers nor their cooperatives are currently making efficient use of the information available.

Conclusions

The reality of livestock production in the Maltese Islands, and specifically the bovine production system, may be unique in that the majority of holdings are relatively small. Bovine traceability was present to some extent, based mainly on paper records, and this study has described the ten-year transition from pre-EU accession to the post-EU accession period during which the centralised NLD was developed. The creation of the database has resulted in better identification, registration, traceability and accountability of livestock present on holdings, together with more efficient use of all the animal health data generated on a daily basis. It is now possible to have a day-by-day breakdown of all bovines present on every registered holding in both Malta and Gozo. Moreover, apart from the benefit of being able to trace food back to the source, thus guaranteeing food safety and quality, the implementation of the database can lead to other benefits such as improvement in supply management, and differentiation and marketing of certain products (24).

The merits of the system should be kept in mind whenever any changes to the system are required. The drawbacks and weak points also need to be studied and ways to overcome the problems should be sought. The advantages and disadvantages discussed may be useful to other countries during the preliminary phase of implementation of a livestock traceability system. The further education and training of livestock owners is crucial in tackling the problems mentioned above. If the main stakeholders understand the importance of collecting and

analysing accurate data in a timely manner, this will lead to a more comprehensive and efficient use of the database.

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Table I
Summary of the main groups of data generated for the bovine sector over a ten-year period, 1 January 2003 to 31 December 2012

Main bovine data groups	Malta	Gozo	Total
Number of towns where active bovine holdings are registered	48	12	60
Number of holdings registered as active milk producers	126	49	175
Number of active holdings keeping bovines for fattening and slaughter	232	12	244
Average number of bovines on active milk-producing holdings	10,395	5,609	16,004
Average number of bovines on active fattening holdings	1,719	55	1,774
Number of events registered on bovine premises	6,703	1,718	8,421
Number of events registered for bovines	272,473	150,944	423,417
Number of bovine births registered	38,255	19,081	57,336
Number of EU imports registered	3,105	453	3,558
Number of bovine mortalities registered on holdings	6,410	3,967	10,377
Number of bovines slaughtered (including emergency slaughter)	50,044	1,566	51,610
Number of bovine movements to other holdings	19,712	2,898	22,610
Number (%) of active milk-producing herds with average herd size < 100 bovines	89 (71%)	27 (55%)	116
Number (%) of active milk-producing holdings with average herd size > 100 bovines	37 (29%)	22 (45%)	59
Number (%) of active holdings keeping bovines for fattening and slaughter with average herd size < 20 bovines	216 (93%)	12 (100%)	228
Number (%) of active holdings keeping bovines for fattening and slaughter with average herd size > 20 bovines	16 (7%)	0	16

Table II
Summary of the data management section with descriptions of each register

Data management section	Type of register	Contents of register
Animal data section	Animal register	Lists of bovines on holdings, with date of birth, origin, movement, etc.
	New animal registrations	Lists of births and importations from European Union or third countries
	Sire register	Details of sire (of use to producers for pedigree purposes)
	Embryo donors register	Details of embryo donors (not currently in use by the Department)
	Census of unregistered animals	Details of any unregistered animals discovered during inspections and pending investigations
Other registers section	Premises register	Details of premises
	Producers register	Details of producers
	Staff register	Lists all staff involved in data collection and management Links data input with the person carrying out the action
	Veterinary register	Lists all official veterinarians involved in inspections and official testing
	Benchmark groups register	Benchmarks (not used for bovine data collection)
	Transport register	Details of livestock transporters together with data on vehicles used
Event recordings section	Animal movement register	Details of all movement permits issued
	Abattoir records register	Details of animals slaughtered, with data on date of slaughter, fate of carcass, classification, etc.
	Linear classifications register	(Not currently in use for bovine data collection)

Table III
Summary of the lists and reports section with descriptions of each register

Lists and reports section	Sub-register	Contents of register
Action-list register	Scheduled premises events	Details of events such as testing and inspections carried out on each holding
	Scheduled animal events	Details of events such as tests scheduled or carried out on each animal
Reports register	Events file	Details of premises and animal events grouped by type of activity, month, premises, operator, etc.
	Registrations & exits file	Details of all registered animals on each holding and data on the fate (died on farm, slaughtered etc.) of every registered animal
	Movement file	Details of all animal movements on and off the holdings. Important in tracing back and forward during epidemiological studies. Editing of data in this section is restricted
	Population file	Summarises data on the population of each holding according to the needs of the database user