Traceability in the pig production chain

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Summary
Traceability is becoming a subject of significant interest to all those involved in pig production and marketing. Until the 1990s, the purposes of farm and animal identification were primarily related to implementation of breeding schemes and health programmes. More recently, other aspects have been emphasised, especially in certain countries where consumer demand has led to the need to trace animals and animal products along the food chain. Pigs are identified principally through ear tags and/or tattoos which are the common ‘traditional’ systems. However, an important research effort has been directed towards electronic identification. Electronic identification will allow telemetric data collection for quality care in pig production. The carcasses are identified after slaughter, and the meat can also be traced back later in the process. Examples of traceability systems for pigs in various countries are described by the authors.

Keywords

Introduction

The possibility of tracing products back along the production process chain has attracted much interest in the different sectors of economy world-wide, since the 1990s. One of the reasons for this may be the trend towards obtaining commodities at the end of a long production chain in which increasingly sophisticated technologies are applied. The initial raw materials are processed in such a way that they are often hardly recognisable in the end product. In addition, the multiple steps of the process can involve different specialised companies in different locations. Since most of the production is beyond the direct control of the consumer, guarantees are being demanded in terms of food safety, protection of the environment and animal welfare. Furthermore, huge batches of standardised commodities are now produced, giving rise to an increasing potential for problems and accordingly, for complaints in case of defects.

Traceability in the food chain is currently achieving prominence as it is an essential factor in enacting food safety policy (4). Above all, traceability is required for modern animal breeding purposes and for effective generalised prophylaxis and disease control (10, 18). However, in many countries over recent years, the public has emphasised the need for the improved identification of animals and animal products, with a particular focus on meat (1). In common with other food animal production chains, the pig production and processing chain is directly affected by the desire of consumers to know more about the conditions of pig production. Pig health and welfare aspects and also pork safety are of particular interest especially
in countries in the north of the European Union (EU). A number of recent events in these countries (epizootics of swine fever, bovine spongiform encephalopathy [BSE] and foot and mouth disease [FMD]) have probably heightened public sensitivity to traceability.

The pig and the pork production chain: specific traits and impact on traceability

Biological traits

The pig (Sus scrofa) is a polytocous species. Litter size varies depending on parity and on several other factors. In turn, piglet survival depends on the nursing capacity of the sow. Cross-fostering of new-borns is common practice to equalise litter size and adapt the latter to the nursing ability of the sow. In addition, the reproductive cycle is relatively short, so that several generations of pigs are present in a given farrowing herd. This combination of traits serves to complicate the identification process. The lack of identification is especially troublesome when assessing the genetic merit of the animals through their performance. Animal scientists have broadly explored the subject and mathematical methods have been proposed to select the best breeders in the pig population. The ‘best linear unbiased programme’ (BLUP) method became very popular in the 1990s. Since the individual pig is the basic statistical element in the calculations, the need for an individual identification is obvious and this identification must be performed soon after birth and before cross-fostering. However, since the performances under examination also depend on the local farming conditions, this ‘farm’ aspect must also be considered in the models, and thus the need to identify the farms is also clear. Beyond the genetic programmes, rational herd management on a routine basis requires that sows and boars be properly identified individually. Finally, identification of pigs is not possible using only skin and hair colour.

Pig production systems

In current intensive production systems, pigs are generally ranked according to age or physiological stage, for example in the three following categories: weaning, growing or finishing pigs; pregnant or nursing sows; boars. Given that profit is the principal goal of farm managers, the holistic approach towards the pig unit tends to prevail over consideration of individual pigs. However, to better achieve this goal, the breeding pigs are considered individually for the purpose of recording reproduction results. As a consequence, pigs are individually identified even on production farms and this is the corner stone for appropriate herd management, in particular regarding culling strategy. In addition to productivity per se, health aspects can be recorded on an individual basis and integrated when a culling strategy has to be decided.

At first sight, the identification of each piglet with a unique number does not appear to be a priority on production farms. The management practices principally rely on groups of pigs. Ideally, these groups are pigs of the same age housed in specific rooms or compartments. Information recorded (feed consumption, weight gain and mortality) and prophylactic measures apply to the whole group, which is the observational unit. Thus, all the individuals of the group will be allocated the same identifying mark. The latter can be either physically borne by the animals or recorded only on a document that closely follows the pigs in the buildings where they are raised. The data can also be computerised. Group management is facilitated when a batch farrowing system is strictly adopted and when the buildings are adequately designed to avoid mixing of pigs from different batches. The method of pig identification selected will differ, depending on the type of farming encountered (breeding, rearing, multipling or fattening farms). In all cases, an official standard system of farm identification is required, which is recognised and used nation-wide. Each farm number must be unique.

The case of ‘farrow-to-finish’ operations, in which all the pigs born on the farm are kept on the same site until shipping to the slaughterhouse, is certainly the simplest one. This reduces pig movements and presents the lowest risk of disease spread in the area. In this case, only the replacement stock, which are normally produced in the most healthy herds and controlled nucleus farms or multipliers, are moved onto the commercial farms. In farrow-to-finish operations, a single identification by the farm number is sufficient to trace pigs from the slaughterhouse back to the farm.

When a trading process involves two or more partners, the situation changes. Each pig must carry the farm identification marks for each premises in which it has resided, to allow tracing from the slaughterhouse back to the farrowing farm. If a trading partner keeps the pigs in his own facilities for a period of time, this step must also be identified. This can be of paramount importance in regard to disease transmission, since pigs from several sources can be mixed before being despatched throughout the country or exported abroad.

Written documents that correlate with the identity of the pigs are required to give details of each successive location in which the pigs were kept. The objective goes far beyond disease control. Increasingly, retailers and consumers demand to know more about the pigs, especially regarding health and welfare status and above all regarding the feed supplied to the animals. Therefore, enhanced requirements for pig identification and associated documentation are emerging in conjunction with new quality control strategies.

The motivation to identify the slaughter pigs will vary, depending on the type of marketing utilised. In countries in which the pigs are sold for slaughter and payment is received immediately on the basis of live weight and conformation, and.
when the slaughtering establishment has no interest in animal identification, the farmer has little or no motivation for identifying the animals. In those circumstances, the chain of traceability is broken. Very complex tracing situations can exist, especially in countries in which very small holdings (one to ten pigs) are commonplace. Traceability may not be possible if the pigs change ownership several times between birth and slaughter and are bought on the basis of live weight and quality. Such animals present an increased risk of health problems for other producers and consumers. In several pig-producing countries, especially in Europe, quality control strategies require that pigs and pig meat be traceable back to the farm of origin, to prevent any disruption to the chain of identification. From this point onwards, the farm is normally the target of the traceback enquiry and not the individual pig.

Pig identification and telemetric data collection

Traditionally, farmers collect data from animals according to what they see, hear and feel. However, to be more cost-effective, much more data about each animal and the various production systems needs to be collected and utilised. Ear tags and tattoos are the most common identification devices used in pigs, but electronic identification and monitoring devices can be very helpful in supporting the management skills of the modern farmer. Management errors must be rapidly detected and corrected to make improvements and minimise financial losses. However, management data from different types of production systems must be analysed to determine which measures are most cost-effective. Electronic data collection and processing can be coupled with analysis of deoxyribonucleic acid (DNA fingerprinting) and antibody profile testing data for tracing animal products from the farm to the consumer. This will assist enormously in guaranteeing safe food control and providing feedback information to improve management of the production chain.

The technology

Transponders, injected or embedded in ear tags for animal identification, are remotely activated receiver-transmitters, which use a short range and pulsed echo principle at approximately 150 kHz. These devices (external or injectable transponders) are primarily used for identification purposes, and transmit the information only on request (i.e. ‘to transpond’). A basic system consists of the following three parts:

a) a tamper-proof device permanently attached or implanted, usually termed the identifier

b) an activating/reading device (both the electronic identifier and reader must have an antenna)

c) software (electronic recording and transfer of data is far more accurate than information written by hand on whatever is available at the time and later transferred to a more permanent record).

Transponders should be small, lightweight and robust, with an operational lifetime exceeding the lifetime of the animal. The protective covering of the electronic identifier, usually bioglass for injectable transponders, or plastic for ear tags, is also important. The casing must allow penetration of radio waves, and must be sufficiently strong to withstand injection or tagging and to function throughout the life of the animal and during slaughter. The device should remain in the same location from application until slaughter of the animal. For injectable transponders, the protective covering should promote encapsulation by connective tissue to prevent migration of the transponder inside the body of the animal. Identification by radio frequency technology offers a number of distinct advantages over competing technologies, for example an unobstructed line of sight is not required, in contrast to optical (e.g. bar code) systems. Radiotelemetry (a technology traditionally used for locating rather than identifying entities) employs low frequency radio signals, typically 500 kHz or below, characterised by poor directional control, but good penetration of most materials that are not metallic or ferromagnetic. The range of operation is normally determined by the following:

a) the maximum permitted field strength

b) the electromagnetic noise characteristics of the immediate environment

c) the transponder power requirements

d) the orientation (alignment) of the fields produced by the transponder and reading devices (Fig. 1).

A range of options are available in terms of the hardware and software necessary to realise the communication link (9). Communication protocols are now defined in the International Organization for Standardization (ISO) guidelines 11784 and 11785.

Electronic identification and data recording

The need for identification

Identification of farm animals was probably first introduced when animal husbandry was developed, as a means of proving ownership. In some countries, identification became compulsory, to allow tracing of animals back to the farm of origin in case of spread of notifiable diseases. This identification took the form of external marks, such as brands, back tags, bangle tags, tattoos and ear tags. The principal criteria for a good animal identification system were as follows:

– permanency

– low cost

– ease of application

– legibility at a working distance.
However, to keep animal husbandry cost-effective, improvements have to be realised with respect to genetics, health, feed efficiency, product quality and consistency, and product safety. To realise these production goals, specific new management techniques have to be applied, preferably within a total quality management system, including the hazard analysis critical control point (HACCP) concept, from production, marketing and slaughter, to consumption. New technology is now available in the meat industry that allows the sorting of individual animals into uniform outcome groups. By using digitised video images, ultrasound techniques and the standard weighing scale, integrated with electronic identification and appropriate software, animals can be managed so that many of the normal carcass discounts are avoided. In addition, some packing plants have developed electronic trolley tracking systems, which allow the tracking of individual carcasses throughout the plant, including the electronic collection of carcass data on every animal. By using electronic ear tags to link the live animal record with the carcass record in the computer of the plant, a whole-life performance record can be automatically created for literally millions of animals. The most fundamental basis of total quality management (TQM) is that the root of all variation in a product or process must be understood and must be solved. The information supply for problem solving and market orientated production can only be efficient within a concept of electronic data interchange. In the animal industry, with unavoidable variation in genetics, the root of most variation in economically important traits is the individual animal, while some of the variation can be explained by the health regime of the animal. This means that the process of animal production will never be brought ‘under control’, in TQM-terms, until tools are in place to manage the variation that cannot be otherwise explained. The variation in question is at the level of the individual animal, therefore requiring individual animal management and individual animal identification.

These production goals place additional constraints on an animal identification system. The system must use a life number, be tamper-proof, adaptable to automatic coding and modern data retrieval systems, standardised, safe for the consumer, must not damage or cause excessive pain to the animal and must remain cost-effective. Traditional identification systems are not compatible with these new technical specifications, e.g. losses of ear tags are reported to range from 5% to 60%, and external identifiers are not tamper-proof; they can be removed (12), and brands or tattoos can be damaged or can fade away. However, the principal restriction is that the animal number must be visually detected and recorded manually, which can easily introduce errors and is labour-intensive. Reading errors are estimated at 6 per 100 animals, compared to 1 per 1,000 for electronic devices (2). In addition
Field experience with electronic identification

Since the early 1990s, extensive field trials using injectable transponders have been undertaken with thousands of animals of different species. Most of these experiments were conducted in the Netherlands, France, the United Kingdom (UK), Germany, Ireland, Italy, Portugal, Spain, Canada, the United States of America (USA) and Australia. The first approach involved injecting transponders of different sizes into different body sites. This pioneering work revealed the problems of migration, losses and technical failures of transponders (12).

Transponders require a minimal reading and transmission range, which is dependent on the signal transmission range of both the reader and transponder. The power allowed determines the applied field strength to a large extent. The latter is usually determined by an agency of the central government responsible for allocating different radio frequency and power to different telecommunication systems. This may be another issue to be resolved before global standardisation can become a reality, since field strength or the level of power allocated for these devices may vary from country to country. To prevent breakage, the glass encapsulating the large transponders needs to be thicker than that used for smaller transponders (14).

Personnel experienced in the implanting technique can inject approximately 150 animals per hour. For pigs, implantation in the base of the ear (subcutaneously) appears to give the best results one year after being injected (losses < 2%, [i.e. drop-outs and technical failures]) (12). Infections should be lower than 1%. However, the skill of the person injecting the transponders determines the final overall result to a large degree. Application by inexperienced operators can increase losses up to 7%, which is unacceptable. According to the requirements of the International Committee for Animal Recording (ICAR) (11), total efficiency (including losses and dynamic reading performance) should be higher than 99%. As the transponder implanted in the animal relies on the power supply from the reader, another potential problem is the desire to use a higher field strength for reading, to compensate for the unpredictable position of the transponder antenna in relation to the antenna of the reader. Higher field strength may be unacceptable for human health reasons, or may interfere with other uses of radio waves; standardisation committees need to consider this issue (15). A solution may be to use a larger transponder with better technical performance, although this would be more expensive.

When pigs with implanted transponders are slaughtered, recovery of the transponder can be a problem. Transponders injected in the head of the animal do not remain with the carcass throughout the slaughter process. When the head is removed, the transponder is separated from the carcass. Hence, another method must be found to automatically link the carcass identity with identification of the hook that holds up the carcass before being cut into hams, loins, shoulders, etc. (17). When the transponder is not injected properly, migration or loss may occur. This leads to a loss of certainty as to whether the transponder has been recovered. To ensure that all transponders are recovered, special detectors (i.e. readers and metal detectors, in case of non-functional transponders) must be installed at the end of the slaughterline, so that carcasses can be checked if a transponder was reported at the beginning but not at the end of the line. A potential means of avoiding transponders in the food chain is the use of electronic ear tags. Losses with the current ear tags have been reported to be lower than 2% for pigs after a single tagging (Ministry of Agriculture, Belgium, 1996, unpublished findings). However, problems may occur in the slaughterline, since superficial burning of the carcass may damage the plastic ear tag or the transponder contained within. Normal recovery time from a pig carcass is from 3 sec to 5 sec. Recovery of transponders is also necessary to close the circle and thus avoid fraud. Good results were obtained by implanting pigs under the dew claw of the hind legs (J.D. McKean, unpublished findings). The transponder remained in the carcass throughout slaughter, no migration problems were encountered and if the hind feet were discarded, pork approved for human consumption could be guaranteed not to contain the transponder.

Traceability in different countries

France

Legislation regarding identification

Important new national regulations about livestock keeping, animal breeding and identification emerged in the 1960s (Decree of 19 March 1963; Law 66-1005, 28 December 1966; Decree 69-422 of May 1969; Regulation of July 1969). This provided the background for the current legislation which enables disease prevention, surveillance and eradication programmes. Later on, other national decisions were implemented (Regulation of June 1993 and Circular n° 4021, 29 April 1997) and EU Directives were enacted (64/432/CEE, 92/102/CEE, 27 November 1992, 97/12/CEE, 17 March 1997). These updated the previous decisions on the evolution of livestock farming in France and the EU and the changing technologies (3, 6). The objectives were to provide the following:

1. A clear definition of pig holdings. Geographic considerations should prevail over those associated with ownership. For example, a given owner might have two or more sites where pigs are raised (‘multisite’ system). According to the law, the farm location is where the pigs are located and not where the owner resides.
b) A compulsory declaration and a standard procedure of identification of the pig holdings. The pig holdings are officially identified by two unique numbers (Fig. 2):

- the holding number (eight to ten characters) gives the geographical location, firstly, FR for France, and then within France, using separate sequences of numerals for each administrative subdivision (departments and each parish [commune in French] within each department). These numbers are followed by the unique number assigned to each farm within the parish

- the second number is the number which is carried by the pigs (on an ear tag or tattoo). This number, termed the ‘marking number’, has five to seven characters: FR (for France), the department number and an identifier combining letters and figures

In each department (administrative subdivision of France), an official establishment is responsible for assigning the official number for the pig holdings (Etablissement Départemental de l’Elevage [EDE]). The possibility of recording the precise location of holdings through geographical data (Lambert’s co-ordinates) is currently being investigated in densely populated livestock areas.

c) A standardised procedure of identification of each sow and boar. The identification process is performed by the farmers on farms on which gilts and boars are raised (i.e. nucleus farms and multipliers). The farmers are responsible for the identification of their animals. During the suckling phase, a tattoo is placed on the right ear of the piglets. The tattoo is composed of the ‘marking number’ and an individual (‘personal’) number which is a serial number within the herd (Fig. 2). Later on, to improve legibility, this individual pig number is often placed on an ear tag. On commercial farms that produce their own replacement stock and do not sell any gilts or boars for breeding purposes, the pig holding identification of the sows and boars is not compulsory until the animals leave the farm for slaughter (culling).

d) Identification of piglets that are moved to another site. As a general rule, no pig can move from one site to another without being correctly identified. All the piglets due to move must be identified before leaving the farrowing unit (tattoo or ear tag identifying the farm, i.e. birthplace). If pigs move twice before reaching the fattening farm, the numbers of the two pig holdings must be affixed to the ears if they stay for ten days or more in those places.

e) Identification of slaughter pigs. All the pigs leaving the farms for slaughter must bear the pig holding number of the farm they are coming from. The number is appended (backslap tattoo method) behind the shoulder.

Currently, tattoos and ear tags are the most common means of identifying pigs in France. Electronic identification can be found only on farms that use automatic feeding systems. When the sows are culled and the growing pigs are finished, these animals are identified using the backslap tattoo method.

**From identification to traceability**

**Management on the farm**

In France, by far the most popular pig farming system is the integrated farrow-to-finish system. In this system, the pigs are raised until slaughter at the same location. Approximately 70% of the slaughter pigs in France come from such farrow-to-finish farms. Typically, the farms are family-owned and run (average: 150 sows; standard deviation: 70). The next most popular are farrow-to-finish farms that use a second site for some of the fattening pigs. Regardless of the system, each movement of a pig, from farm to farm, or from farm to slaughterhouse, is systematically identified.

Official accompanying documents follow the pigs during the movements. On the farm, a log book (register) is maintained and the movements are recorded, including the pig holding numbers involved, the number of pigs involved and the date of delivery. A computerised recording system is being implemented in the western part of the country, in Brittany. The system records, on a daily basis, all the information concerning piglet movements over the entire region. The programme involves both pig industry organisations and the national Veterinary Services.

To comply with the requirements of certification and/or total quality strategies, farmers must maintain extensive records on feeding and husbandry. Special events, such as interventions or treatments may occur during the weaning, growing or finishing
phases; the affected pigs must be marked in such a way that they can be recognised when delivered to the slaughterhouse.

From pig to pork

When the pigs arrive at the slaughterhouse, all the required information from the farm and related to the corresponding pigs is recorded and computerised, in particular, the pig holding number(s) and any specific incidents or interventions. The latter information is immediately taken into account in ante-mortem veterinary inspection decisions. At the slaughterhouse, the pigs are held in assigned numbered pens to avoid mixing of animals from different pig holdings. The tattoo placed behind the right shoulder on the farm is clearly readable on the carcass hanging on the slaughterline after dehairing. The quality of the on-farm identification is evaluated (penalties occur in the case of sub-standard marking). From this point, two options are available to further identify the carcass on the slaughterline, as follows:

a) After dehairing, an individual slaughter number is placed on each carcass and usually mechanically attached on the two hams or on the back of the carcass on both sides. In terms of traceability, this stage is crucial since it establishes the correlation between the farm and the subsequent processing steps. Previously, no official codification system existed for individual carcass numbering. However, all the processing companies are moving towards standardisation according to a common rule (7), the numbering indicates the day of the year (1 to 365) and the rank of slaughter of the pig on that day (1 to n).

b) When the company wants to focus on the site where the finishing pigs were raised, the pig holding number can also be written mechanically beside the slaughter number, for example on the four principal parts of the carcass (back, ham, shoulder, belly, i.e. in this case four marks on each side of the carcass).

After post-mortem veterinary inspection, the official stamp is applied on the principal parts of the carcass (brands are mechanically added in most cases). This indicates the EU references of the slaughter plant.

At the different successive steps on the slaughterline (i.e. carcass identification [slaughter number], veterinary examination, carcass leanness measurement and weighing), all the information is collected and computerised to allow automatic cross-referencing. After slaughter, a standard bulletin is issued, providing the farmer with information about each pig, including slaughter number, carcass weight, lean meat percentage and the result of veterinary inspection. An independent body is responsible for carcass weighing, leanness measurement, on-farm identification quality assessment and issuing the bulletin. Meat processing continues either in the same plant or in another plant. The goal of producing homogeneous end-products in accordance with the demands of the retailer makes the task of traceability somewhat more difficult. However, systematic labelling, rational encoding and appropriate computer usage (networks) make this possible. Usually the carcasses and then the principal pieces (prime cuts) are mechanically ranked according to characteristics (weight and lean/fat content) and according to specified requirements of the clients. Groups or batches of sorted products are established and the slaughter numbers of the carcasses of origin included in the batch are recorded. Depending on the stage of meat processing and on the strategies of the company, the identity of the supplying farm will remain visible either on the skin or on the wrapping. If not, an encoded batch number is placed on the wrapping. However, in all cases, the computer records can easily be used to identify the farm(s), firstly through the batch code number, and then through the pig slaughter numbers included in the batch.

In the case of several large batches of end-products made from a large number of homogeneous carcasses or pieces of carcasses, a list of farms of origin will be provided. Seldom does all the meat originate from the same farm.

Currently, the system is working well for fresh meat. Further efforts are being made to develop an identifying and tracing procedure for other products (e.g. pâté and sausages) in which meat from many carcasses are combined, mixed and cooked.

The Netherlands

Authorities responsible for legislation

In the Netherlands, the central authorities (Government ministries) have the overall responsibility for legislation. These different ministries are responsible for drafting and implementing the legislation in their area of responsibility. The Ministry for Agriculture, Nature Management and Fisheries is responsible for most legislation on agricultural issues. However, some aspects of food safety are the responsibility of the Ministry for Public Health, Welfare and Social Services.

Corporate Industrial Organisations (Publiekrechtelijke Bedrijfs Organisatie [PBO]) also have the authority to make legislation, termed ‘ordering competence’ (8). Legislation proposed by a PBO, as a decentralised authority, has to be approved by the central authorities, before becoming enforceable. In certain cases, the central authorities even ask the PBO to create and uphold legislation on subjects for which the central authorities are directly responsible. Execution of these latter tasks is referred to as ‘execution in co-administration’. The PBO responsible for livestock and meat is the Product Board for Livestock and Meat (Productschap voor Vee en Vlees [PVE]), which has a joint secretariat with the Product Board for Poultry and Eggs (Productschap voor Pluimvee en Eieren [PPE]), called the Product Boards for Livestock, Meat and Eggs (Productschappen voor Vee, Vlees en Eieren [PVE]).
Current legislation on identification and registration of pigs

The central authorities are responsible for the implementation of EU Directives. However, identification and registration of animals according to EU Directive 92/102/EC (5) is delegated to the PVV, to be executed in co-administration. Thus, the current legislation on identification and registration (I&R) of pigs is laid down in an Order of the PVV (16).

According to this I&R Order, pig farmers (and all owners of one or more pigs) must be registered. Each location is given a unique farm number (UFN). An owner of pigs may have farms at more than one location with different UFNs. Geographic considerations prevail over ownership to enable traceback of animals to the farm of origin as rapidly as possible in the case of an outbreak of a notifiable disease. However, in the Netherlands, the UFN also corresponds to the address of the owner of the farm in over 90% of cases.

All pigs must be ear-tagged with a unique number. The first part of this unique number is the UFN of the farm and the second part is a serial number for that pig. Piglets must be tagged within one week of weaning. Finishing pigs must be tagged with a slaughter tag on the day of slaughter or export.

Transport documents contain information about both the delivering and receiving farm (e.g. the UFN and full address) and all serial numbers of the pigs being transported. In addition, essential information about the transport organisation, the truck, the date of transport, etc., is given on these documents. According to the I&R Order, animals present on the farm must be identified and all movements of animals must be reported. All deliveries and/or receipts of pigs are reported to a central office (I&RVL Bureau), where the information is stored in a database. Deliveries and receipts must be reported by the pig farmer, the slaughterhouse organisation or the owner of an export transit holding. Pigs that are not allowed in livestock markets and thus all transport is between farms, or from a farm to a slaughterhouse, to a registered export transit holding or directly abroad. Since the supplier of pigs must be known in the system, it is not possible to receive a pig of unknown origin in the Netherlands.

The number of permitted deliveries and receipts of pigs to and from farms is limited according to the Regulation on Pig Deliveries (Regeling Varkens Leveringen [RVL] 2000) (13). This number is dependent on the location in the production chain, whether the farm is a breeding, multiplying or finishing farm, and the sanitary measures taken on the farm. This is regulated under penalty of reduction of compensation for costs of eradication measures in the case of an outbreak of a notifiable disease, such as classical swine fever. The RVL is an Order from the Ministry of Agriculture, Nature Management and Fisheries. Before pigs can be transported, the I&RVL Bureau must give permission. However, permission for transport is not needed if the pigs are transported to a slaughterhouse in the Netherlands or abroad, or if first moved to an export transit holding before being moved to the slaughterhouse. The number of deliveries of pigs to the slaughterhouse is not limited. Whether permission for the transport of animals is granted or not depends on the number of pigs already on the farms involved and the maximum number of pigs allowed on the farm.

Identification and registration: implementation of legislation and practical implications

Ear tags

The Dutch Animal Health Service issues a UFN for each farm or each separate unit on a farm. Together with a protected logo, the seven digit UFN is printed on one side of the synthetic ear tags worn by the pigs (piglets, breeding pigs and finishing pigs). Piglets have to be identified with a synthetic ear tag within one week of weaning. The protected logo is only allowed to be used on ear tags for pigs in the Netherlands. These ear tags are produced by several companies that have an agreement with the PVV. Before approval, ear tags must be tested according to a protocol defined by the Research Institute for Animal Husbandry. On the other side of the ear tag, a six digit serial number for the identification of individual pigs originating from that farm is given. Beside the numbers and the logo, the letters NL are printed on the ear tag. To locate a farm of origin, the UFN is sufficient. The individual identification can be used if traceback of the individual animal is required. For instance, if individual blood or tissue samples are taken.

Slaughter animals are also identified with a thin steel ear tag just before transport to the slaughterhouse, export transit centre or directly abroad. These metal ear tags also carry the UFN, a serial number and the logo.

Notification of transport

All transport of animals should be notified to the central database of the I&RVL Bureau. This can be performed by telephone (a voice response system) or by computer (electronic mail).

Traceback of carcasses from the slaughterhouse to the farm of origin

Slaughterhouse information collected during veterinary examinations, such as carcass traits weight, classification, meat percentage and pathological findings, is recorded per identified carcass and reported back to the farm of origin of the slaughtered pigs and/or to the insurance organisation. All pigs slaughtered are insured after the pre-slaughter inspection is performed and the animal is declared healthy (the insurance company pays compensation when slaughter findings lead to condemnation of all or parts of the carcass). In addition, over 80% of the slaughter pigs are produced as PVE/IKB (integrale keten beheersing: integrated quality control [IQC]) pigs (19), a certification programme to assure meat quality and safety, and...
within this certification, additional slaughterline information on pathological findings is communicated back to the farm of origin of the slaughter pigs and by some organisations even to the farm of origin of the piglets. During slaughter, traceback of pigs and carcasses to the farm of origin is always possible.

**Traceback of pork to the meat cutting plant, slaughterhouse and farm of origin**

Traceback of the principal parts of the carcass to the slaughterhouse is always possible, since the official mark after post-mortem veterinary inspection shows the EU reference number of the slaughter plant. Since the number of batches per slaughter day is limited, the possibility of tracing back to the farm of origin can be implemented fairly easily using a batch number.

Each meat cutting plant also has a unique EU reference number, which is, under the supervision of the national veterinary authorities (RVV), used on the products produced at that plant. The plants themselves label with additional information, such as date and time or production number, to allow further tracing.

Mandatory systems allowing traceback of all pork to the farm of origin do not exist in the Netherlands. However, some slaughterhouses and meat processing industries started to implement systems that allow traceback of the pork they produce to the slaughterhouse and the farm of origin. Some systems are based on numbers. In the case of bacon production, the products of some packers can be traced back even from a single slice of bacon. The bacon produced by these packers is marked by cutting the rind superficially in a way that gives a barcode-like pattern over the length of each piece. Every slice of the bacon is marked this way.

**Denmark**

In Denmark, pigs and pig meat are identified and labelled at two distinct stages: on the farm and at the slaughterhouse (Fig. 3). No livestock markets are involved in the chain from farm to consumer, all pigs being contracted directly to slaughterhouses in the co-operative system. Consequently, tracing stock to the farm of origin is a relatively simple process.

All livestock farms in Denmark have a herd number (termed a CHR [Centralt HusdyrbrugsRegister or Central Husbandry Register] number) which is recorded in the Ministry of Agriculture Central Animal Husbandry Register. This database holds the following information about each herd:

- CHR number
- name, address and telephone number of the owner
- name, address and telephone number of unit manager
- herd location (address)
- type of production (e.g. slaughter pigs)
- average number of animals
- name, address and telephone number of the veterinary practice responsible for the herd.

**Ear-tagging of pigs**

In Denmark, the basic rule is that all pigs must be labelled with an approved ear tag when transferred from the herd of birth (Fig. 3, M1). Exceptions to this rule are as follows:

- pigs that are ham tattooed and transported directly to a slaughterhouse in Denmark (Fig. 3, M3)
- pigs that are transported directly for destruction
- blocks of weaners that are transported without being sold (e.g. in multisite systems)
- blocks of weaners that are transported on the basis of a fixed agreement between the seller and buyer (Fig. 3, M2).

The ear tag must be approved by the Danish Veterinary and Food Administration and must include the CHR number of the herd in which the ear-tagging was performed.

**Registration by the farmers**

In all herds, details of arrival and departure of pigs are registered, including the CHR number of the supplier and the recipient of pigs. The majority of pigs in Denmark remain in the herd in which they were born. Some weaners are sold immediately post weaning. Approximately 80% of the sales of weaners take place according to long-term agreements between, for example, a producer of finishers and one or more producers of weaners. In addition to price, the delivery agreement normally also contains information on the health status of the herd of origin compiled in a health statement.

As part of the agreement, each block of pigs must be accompanied by shipping documents stating the following:

- CHR number, name and address of sender and recipient herd
- name and address of carrier
- number of animals
- date of transfer.

By only receiving weaners from one or few known weaner herds, the origin of delivered pigs can always be documented.

Approximately 20% of weaner sales take place via a pool scheme (Fig. 3, M4) where the recipient receives weaners from several producers (that can also be identified by ear tags). The weaners are sold before they are transferred, so that the recipient is always known.

In addition to the registration by the farmers, the carrier always registers the date of transport, number of animals, and sender and recipient of all pigs that are not transported directly to the slaughterhouse.
Fig. 3
Labelling and registration of pigs and pig meat in Denmark
Both types of delivery agreements are followed up by the shipping documents, thus ensuring that suppliers of weaners are always known by the recipient. Thus, it is impossible to receive a pig of unknown origin in Denmark.

Labelling of pigs sent for slaughter

The slaughterhouses only receive pigs directly from the producers. The transportation of pigs for slaughter is co-ordinated by the slaughterhouse which also enters into an agreement with each individual carrier on transportation. During transportation, the carrier must hold information on the place of departure, destination and the owner of the animals.

Before delivery from the producer, all pigs are labelled with a five-digit number (Fig. 3, M3) on each ham (EU Council Directive 92/102/EC). This number identifies the supplier to the slaughterhouse.

Registration at the slaughterhouse

During weighing, the gambrel identification number is automatically read, and the delivery number is attached to this identification number. Both numbers are stored and linked in a computer.

All data generated at the slaughterline (weight, percentage of lean meat, prevalence of pigmented hair follicles, veterinary remarks, etc.) are via automatic readings of the gambrel identification number attached to this number in the computer.

Only carcasses approved by the veterinary inspectors are sent on for cooling and cutting of the meat. Data from weighing and classification are used for sorting.

Identification after the veterinary control

After the pigs have been slaughtered, and the public veterinary inspectors have declared the meat fit for human consumption, all carcasses are stamped according to Council Directive 64/433/EC with an EU-approved authorisation number allocated to the company by the Danish Veterinary and Food Administration (Fig. 3, M5).

If the carcasses are cut up by a separate company, the meat is labelled with the authorisation number of this company, according to Council Directive 64/433/EC. If meat products are processed by a separate processing company, the products are labelled with the authorisation number of this company according to Council Directive 77/99/EC (Fig. 3, M6). If slaughter, cutting and processing are performed by the same company, only one authorisation number is used (Fig. 3, M7).

Pursuant to Council Directive 89/396/EC, meat cuttings and meat products must be accompanied by information stating to which consignment of food they belong. If a date is stated for ‘best before’ or last day of use, this information may be used as consignment identification if the date includes at least a day and a month. For goods that are not pre-packed, the information on food consignment may be stated in the accompanying shipping documents.

Meat that is pre-packed for the consumer must comply with EU Directive 79/112/EC among others, and be labelled with company name of vendor, package company or producer of the product.

Labelling of pigs and pig meat is presented in Table I.

Traceability

Meat from retail may be traced back to the cutting company by the authorisation number (Fig. 3, M6/M7).

Pursuant to the Council Directive 79/112/EC, the name of the producer or vendor must be stated on the package. Using the information on the type of product, the company stated on the package will be able to trace the origin further.

In retail packages, meat must be labelled with the EU-approved authorisation number of the company beside the consignment identification. By using the authorisation number, all fresh meat and meat products may be traced back to the company that last processed the meat (Fig. 3, M6/M7).

Table I
Labelling of pigs and pig meat in Denmark

<table>
<thead>
<tr>
<th>Location</th>
<th>Identification</th>
<th>European Union Directive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer (weaner sales)</td>
<td>Ear tag (Fig. 3, M1)</td>
<td>92/102/EC</td>
</tr>
<tr>
<td>Producer (for slaughterhouse)</td>
<td>Producer number (Fig. 3, M3)</td>
<td></td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>Authorisation number (Fig. 3, M5)</td>
<td>64/433/EC</td>
</tr>
<tr>
<td>Cutting company</td>
<td>Authorisation number (Fig. 3, M6)</td>
<td>64/433/EC</td>
</tr>
<tr>
<td>Processing company</td>
<td>Authorisation number (Fig. 3, M6/M7)</td>
<td>77/99/EC</td>
</tr>
<tr>
<td>Meat cutting</td>
<td>Authorisation number and lot label</td>
<td>64/433/EC, 89/396/EC</td>
</tr>
<tr>
<td>Meat product</td>
<td>Authorisation number, lot label and declaration</td>
<td>77/99/EC, 89/396/EC, 79/112/EC</td>
</tr>
</tbody>
</table>

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If the meat has been cut or processed at a separate company, it can be traced back to the slaughterhouse, via the shipping documents accompanying the meat (Fig. 3, M5). From the lot label or shipping documents, the slaughterhouse may trace the product to the date and time of production. Based on this information, the company may obtain more specifications for the meat (weight, lean meat percentage, etc.). Based on the product specifications, the slaughterhouse can normally trace the meat back to a group of carcasses. The number of the carcass is attached to the supplier number and on the basis of this, the meat can be traced to a group of producers.

**United States of America**

**Livestock identification**

Livestock identification in the USA has been documented in large-scale animal production industries since the late 1800s and early 1900s. Hot-iron branding was first used by cattle ranchers to indicate ownership and deter theft. Individual animal identification using ear notches was used by swine producers for registration and record-keeping purposes. These two methods are rapidly losing popularity due to concerns about inhumane treatment of animals and a decrease in product value.

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) and predecessor agencies began using ear tags, tattoos and face brands in the 1920s and instituted the use of back tags in the early 1960s. These identification methods were required by federal regulations and were successfully used to trace the movements of diseased animals during disease outbreaks and eradication programmes. For most of the 20th Century, APHIS has led the way in the development of national identification systems. The agency continues to place a high priority on livestock identification and database development.

Electronic identification methods, including bar codes and other forms of electronic identification such as radio frequency identification transponders, are becoming increasingly useful tools in herd management programmes. As these new technologies develop and become compatible with one another, they may prove to be cost-effective tools to help increase the efficiency of production. Similarly, regulatory agencies may benefit from these systems through increased accuracy and efficiency in tracing the movement of livestock and tracing food products back to the farm(s) of origin.

The primary driving forces behind the development of livestock identification systems are based on recognised public and private sector needs. They include disease control and eradication, disease surveillance and monitoring, and emergency response to foreign animal diseases, regionalisation, global trade, livestock production efficiency, consumer concerns over food safety, and emergency management programmes.

**Pig identification**

There are three ‘layers’ of pig identification systems in the USA, namely: the mandatory system, the system of the national pork producers association and voluntary systems for identity-preserved and value-added quality pork supply chains.

**Mandatory system**

The Secretary of Agriculture has the statutory authority and responsibility to determine that when any State, Territory, or the District of Columbia are affected with any contagious, infectious, or communicable disease of livestock or poultry for which, in his opinion, a quarantine should be established, notice will be given and a rule will be issued and included in the Code of Federal Regulations (CFR). Thus, the CFR contains all the rules governing the movement and handling of animals in interstate commerce for the purposes of controlling or eliminating disease in livestock. General provisions regarding the interstate transportation of animals (including poultry) and animal products are found in 9CFR 71.

Swine are required to be identified in interstate commerce as specified in 9CFR 71.19. This applies to all classes of swine, including feeder, breeder and slaughter swine.

**System of the national pork producers association**

The National Pork Producers Council (NPPC) appointed a task force for swine identification in 1984 following a pork producer delegate resolution that called for its formation. In 1985, delegates approved identification standards for all NPPC members. In 1986, the NPPC delegates moved to support the mandatory identification (see previous section entitled ‘Mandatory System’) of all slaughter pigs back to the last farm of ownership, with encouragement for sharing of health and carcass quality information with pork producers. The NPPC Swine Health Committee and Pork Value Task Force promotes electronic identification at farm level and develops pilot projects for improving production records and management, as well as for slaughter identification and traceback. This method is still in the research stage, but could be rapidly implemented when costs become low enough to ensure payback.

**Voluntary systems for identity-preserved and value-added quality pork supply chains**

A growing number of pork producer networks have either become part of existing vertically co-ordinated and value-added pork production chains or have established such production chains for defined market segments. These groups have, as a rule, a partnership with the slaughter/processing company that separates the pigs for the programme in question by groups. To ensure that the identity of these animals is carried beyond cutting the carcasses and processing the meat, the batches of the products produced from segregated carcasses are segregated throughout the production chain. Identification systems for tracing back a single piece of pork or pork product from the
Conclusion

In most pig-producing countries, sets of regulations have been in place for the identification and registration of pig holdings for many years. Demand for traceability in the pig production chain is currently increasing and a considerable effort is being made in this regard. Until now, simple systems have been used (numbered ear tags and tattoos) to identify individual animals. Effective identification is a key element for the implementation of traceability in the pig chain. Quality strategies which offer the possibility of tracing the products back to the farm are to be encouraged.

Traçabilité dans la filière porcine

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Résumé


Mots-clés

Rastreabilidad en la cadena de producción porcina

F. Madec, R. Geers, P. Vesseur, N. Kjeldsen & T. Blaha

Resumen
El tema de la rastreabilidad viene suscitando un gran interés entre todos los que trabajan en la producción y comercialización de productos porcinos. Hasta los años noventa, la identificación de las explotaciones y los animales guardaba relación sobre todo con la aplicación de programas de cría y sanitarios. Recientemente han cobrado importancia otros aspectos, sobre todo en países donde, a instancias de los consumidores, se ha planteado la necesidad de proceder al seguimiento de los animales y de sus productos derivados a lo largo de la cadena alimentaria. Para identificar a los cerdos se utilizan principalmente crotales y/o tatuajes, sistemas “tradicionales” por excelencia. Sin embargo, se han dedicado muchos esfuerzos a investigar posibles métodos de identificación electrónica, que harán posible la recogida de datos telemétricos, y con ello una mayor atención a la calidad de la producción porcina. Las canales se identifican tras su paso por el matadero, y también es posible determinar el origen de la carne en una fase posterior del proceso. Los autores ofrecen ejemplos de sistemas de rastreabilidad que se aplican a los cerdos en varios países.

Palabras clave
Carne de cerdo – Cerdos – Identificación – Legislación – Rastreabilidad.

References


