

REVIEWS

REVIEW: Swine Traceability Systems in Selected Countries Outside of North America

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ABSTRACT

Animal diseases and related food safety issues, such as bovine spongiform encephalopathy, have become concerns to many people in the last decade. With approximately one billion domesticated swine in the world, traceability is becoming increasingly important throughout the world as a way to control disease outbreaks before they have devastating effects on a country's livestock and related livestock industries. The objective of this review is to discuss swine identification and traceability systems outside North America. Some countries, such as those in the European Union, have mandatory traceability programs that require that pigs be traced from birth to slaughter and that imported products to adhere to the same standard. Countries with mandatory swine traceability programs have systems in place that can document animal movement records (premises changes), as well as animal birth and termination records. Many countries that have voluntary programs, such as Australia and Brazil, are currently trying to develop comprehensive traceability programs for swine and pork.

Key words: animal identification, animal traceability, countries outside of North America, pork, swine

INTRODUCTION

There are approximately one billion domesticated pigs in the world (FAO, 2002), with the United States, Canada, Brazil, and China as the largest swine producers. Major swine importing countries include Japan, Mexico, and Russia (USDA-FAS, 2005). Some of these countries require traceability programs for swine and pork, whereas other countries maintain voluntary programs.

Traceability is becoming increasingly important around the world for both domestic and export markets. Traceability is defined by the ISO 9000:2000 as the ability to “trace the history, application, or location of that which is under consideration” (European Commission, 2004). Although this definition seems clear, many countries have their own interpretations of what traceability means.

According to Jensen and Hayes (2006) there are different methods of traceability. One such method, known as “farm to retail traceability,” is described as being able to maintain the identity of an individ-

ual animal from the farm, through slaughter and distribution, to the consumer. To maintain farm to retail traceability, the animal is traceable from the farm through processing, with all of the cuts of a carcass kept in a container that is tracked with the animal's identification number when the carcass is cut. When those cuts are packaged they are marked with the individual carcass number and can be linked to the last farm the animal was at before the harvest chain. A second method is “batch traceability,” where the animal is traceable from the farm to the carcass, but the individual identification is lost at some point on the carcass processing line. Instead of individual identification, a batch or lot identification number is used at harvest. When batch identification is utilized, the day is typically separated so that batches contain fewer carcasses (Jensen and Hayes, 2006).

According to Liddell and Bailey (2001), transparency and assurance are equally important as traceability. Traceability, as defined by Liddell and Bailey (2001), is the ability to track the inputs used to make food products backward to their source at different levels in the marketing chain. Transparency refers to procedures and practices that are used

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Table 1. Comparison of swine population and identification and traceability systems

Country	Swine population (1,000 hd) ¹	Premises identification ²	Individual swine identification ²	Group or lot swine identification ²	Recorded animal movement ²
Argentina	1,490	V	V	V	V
Australia	2,470	V	V	V	V
Bolivia	2,488	V	V	V	V
Brazil	34,064	V	V	V	V
Chile	3,450	V	V	V	V
European Union	151,238	M	M	V	M
Japan	9,620	V	V	V	V
New Zealand	341	M	M	V	M
United States	61,449	V	V	V	V
World	984,290	—	—	—	—

¹All numbers are for cattle populations in 2006 as reported by the Food and Agriculture Organization of the United Nations (FAOSTAT, 2008).

²M = mandatory, V = voluntary.

to produce a product, and assurance is the ability to create and validate safety and quality standards at each level of the marketing chain (Liddell and Bailey, 2001). Although traceability programs are mandatory for cattle in many countries, swine or pork traceability is considerably less common.

This review describes swine traceability programs for countries outside North America. Specifically, this paper discusses 2 commonly used traceability programs: 1) birth to harvest, and 2) farm to retail. Birth, movement, and termination records and identification methods in countries with mandatory and non-mandatory swine tracing programs are discussed below.

The remainder of the paper will analyze selected countries individually, beginning with discussions on birth to harvest and farm to retail programs, and then with countries without government regulated traceability programs. Within each section of the traceability programs, a brief overview of the country's swine industry, followed by specific information about each country's traceability program is reviewed (Table 1).

This review is one of 4 reviews that describe 1) cattle identification in selected countries outside North America (Bowling et al., 2008); 2) sheep identification in selected coun-

tries outside North America (Bass et al., 2008); and 3) animal identification in North America (Murphy et al., 2008). When taken as group, these 4 reviews offer insight into animal identification and traceability throughout several countries of the world.

REVIEW AND DISCUSSION

Birth to Harvest Traceability

Some traceability programs have the ability to trace an animal from birth to harvest, including all animal location movements in between. European Union (EU), United Kingdom (UK), Denmark, and New Zealand's birth to harvest traceability programs have been described below.

The European Union, a "One Step Up, One Step Down" Traceability Program. The EU is a conglomeration of 27 member countries that operate and negotiate as a unit. The EU is the world's largest trading partner and controls one quarter of the world's wealth (Delegation of the European Commission to the USA, 2004). Traceability became a concern for the EU in the 1990s because of worries about bovine spongiform encephalopathy, animal feed contaminated with dioxin, and adulterated food products. The EU has the ability to set regulations for all

industries that all member countries must abide by, including food and agriculture (European Union, 2006). When new countries join the EU (as the Czech Republic, Hungary, Latvia, Lithuania, Poland, and Slovakia recently have), they are given time to upgrade their processing plants to comply with EU standards. Until the upgrade occurs, food can only be sold in the country in which it was produced, and has an indicator stamped on the package that shows that it does not comply with EU standards (European Commission, 2004).

Regulation (EC) No. 178/2002, which went into effect on January 1, 2005, is the legal definition and regulation concerning traceability in the EU (European Union, 2002). The regulation defines traceability as "the ability to trace and follow a food, feed, food-producing animal or substance intended to be or expected to be incorporated into a food or feed, through all stages of production, processing, and distribution" and applies to all food and feed except primary production for private domestic use or private domestic consumption. All food and feed companies are legally bound to have traceability systems (European Union, 2002).

Regulation EC 178/2002 Article 18 states that 1) all food, feed, and food-producing animal or substance are to be traceable at all times, 2) food

and feed business operators shall be able to identify all their suppliers, willing to provide that information to the authorities if asked, and able to identify all businesses they have supplied with product, and 3) food and feed that is on the market or is likely to be on the market should be labeled or identified in a traceable way (European Union, 2002). In other words, Regulation EC 178/2002 Article 18 implies the producer must know enough information (i.e., keep sufficient records) to be able to trace forward one step and trace back one step.

Article 11 of Regulation EC 178/2002 adds that all food and feed imported into the EU for placement on the market must be at least equal to the EU standards (European Union, 2002). This means that to export to the EU, a product must be traceable in the same way that products are traceable in the EU. This regulation has caused all countries that want to export pork to the EU to develop traceability programs that are compatible with the EU system.

According to Hayes and Meyer (2003), pork plants in the EU are smaller in size and use slower chain speeds than the United States, making traceability technology more easily adopted. Hayes and Meyer (2003) indicate that much of the EU pork industry sells primals or half-sides and the further processing takes place in a butcher shop, rather than processing the carcasses to retail cuts in the processing plant. This allows retailers to meet requirements by keeping information on a primal or carcass, rather than on a cut. It is difficult to find specific information on how EU processing plants are maintaining or providing traceability, so it is likely that different processing plants are using different methods to trace their product.

Although Europeans assume that their animals (and meat) are traced from "farm to retail," it is not commonly used in the EU (Jensen and Hayes, 2006). The most common form of traceability in the EU is birth to harvest traceability. Although all

EU member countries must adhere to EU guidelines, some countries, such as the United Kingdom and Denmark, have further traceability requirements or have given specific instructions on how to fulfill the EU requirements in their country.

United Kingdom. In the UK there is a mandatory traceability process that is set by the Department for Environment, Food, and Rural Affairs (DEFRA) and is described in the *Guide for New Keepers Pigs* (DEFRA, 2004). Before moving any pig to their property, a producer has to obtain a County Parish Holding number for the land where the pigs will be kept. This is a 9-digit number in which the first 2 digits refer to the county where the pigs will be kept, the next 3 digits refer to the parish in which the pigs will be located, and the last 4 digits are a unique code for the producer. The producer must obtain a general license from the local Animal Health Divisional Office and the pigs must be accompanied by a movement document, the Animal Movement License 2, for traceability. Both the buyer and seller must keep copies for their records. In addition, a copy of the Animal Movement License 2 must be sent to the local standards animal health department within 3 d of the pigs arriving at the property. The buyer must keep their copy on file for at least 6 mo (DEFRA, 2004).

To protect against new pigs disseminating disease, a standstill is triggered when the pigs arrive at a receiving property (DEFRA, 2004). Upon arrival there is a mandatory 20-d standstill period for any other pigs that may have already been on the farm and a 6-d standstill for cattle, sheep, and goats on the property. When cattle, sheep, or goats are brought onto the property, a 6-d standstill applies to the pigs already on the property. Once the pigs arrive at the property, they have to be registered with DEFRA by contacting the local Animal Health Divisional Office (DEFRA, 2004). A herdmark is then created that is comprised of 1 or 2 letters followed by a 4-digit

number. This herdmark is a unique identification to the property that is kept in a single database and can be used by inspectors for a trace back (DEFRA, 2004).

Farm records (either electronic or written) must be kept and include the following information: 1) date of movement, 2) type of identification mark, such as eartag, 3) herdmark, 4) number of pigs, 5) holding from which they were moved, and 6) holding to which they were moved (DEFRA, 2004). The movements on and off the property must be recorded within 36 h. Once a year, the maximum number of pigs that are normally present on the property must be recorded. Records are to be kept by the producer and can only be removed 6 yr after a producer ceases raising pigs. The records are to be made available to an inspector if requested (DEFRA, 2004).

DEFRA (2004) has approved several methods of identification for pigs including ear tags, tattoos, slapmarks, and temporary paint marks. If ear tags are the identification method used, they must be flame-proof plastic or metal when the pig is slaughtered, whereas ear tags for movement between holdings can be plastic. Ear tags cannot be handwritten—they must be stamped or printed and include the letters UK followed by the producer's herdmark. A tattoo of the producer's herdmark is placed on each ear (the letters UK are not needed). Slapmarks are a tattoo of the herdmark (the letters UK are not needed) that is applied to each front shoulder. For movements between holdings, a pig can be identified with a temporary paint mark that must remain legible until the pig reaches its destination. A license must also be issued by the local Animal Health Divisional Office to take pet pigs for walks on an approved route (DEFRA, 2004).

Traceability information must be collected with any byproduct or fallen stock (National Fallen Stock Company, 2006). The EU Animal By-Products Regulation requires that producers keep records for animals

that are incinerated on-farm as well as those that are sent off the farm for disposal (DEFRA, 2006). These regulations also prohibit on-farm burial of fallen stock (DEFRA, 2006).

Britain also has specific programs, such as the British Quality Assured Pork program, that have traceability standards of their own. In addition to quality and specification standards, British Quality Assured Pork program requires independent full traceability checks from the farm to the plant. They also require an independent check of the paperwork and spot checks on product in addition to the EU and UK standards (British Meat Processors Association, 2006).

Denmark. Denmark is the largest pork processing country in the EU, making up 17% of the world's exported pork (Harmann, 2006). Denmark is extremely "export focused"—about 85% of Danish pork is exported (Harmann, 2006).

In Denmark, all pig farms have a herd number from the Danish Ministry of Food, Agriculture, and Fisheries' Central Husbandry Register (Lauristen, 2006). In addition to the herd number, the Central Husbandry Register also contains the name and telephone number of the keeper, the name, address, and telephone number of the owner of the pigs, the address of the farm housing the swine herd, as well as its geographical coordinates, the species and the production type (such as weanling pigs) of animals, the average number of animals, the name, address, and telephone number of the local veterinarian tending to the herd, and the 5-figure supplier number that is applied to the pigs before they leave for slaughter (Lauristen, 2006).

According to Lauristen (2006), there is a specific chain of tagging in Denmark to which the swine producer should adhere. First, the pigs must have an ear tag before they leave their birth herd. The ear tag must have the Central Husbandry Register number on it and must have been approved by the Danish Veterinary and Food Administration. Second, the producer must record which

pigs enter and leave the farm, as well as document the use of medicine and which animals were treated. When a pig leaves the farm, it is marked on its gammon (ham) with a 5-digit number. The pig is also accompanied by a certificate that has information on the health status of the original herd, a transport document containing the Central Husbandry Register number, the name and address of the buyer and seller, the name and address of the transporter, the number of animals, and the date of transfer. Third, the slaughterhouse receives pigs directly from the producers through a contract with the transporter (Lauristen, 2006).

After slaughter and before or at weighing of the carcass, the identification number on the gambrel is automatically read and linked to the supplier number and stored in a computerized system (Lauristen, 2006). Data such as the weight of the carcass, lean meat percentage, occurrence of colored follicles, and veterinary observations are linked to the gambrel in the computerized system. These data are used to calculate the payment for the pig producer. After the veterinarian has declared the carcass fit for human consumption, the carcass is stamped with the number of the slaughterhouse, which is assigned by the Danish Veterinary and Food Administration. If the carcass is processed at a plant other than the one at which it was slaughtered, the carcass must be stamped with the slaughter numbers of both plants (slaughter and processing plants). If the animal was slaughtered and processed in the same plant, only one number is required. Following this, the meat cuts and meat products must be identified by their lot number. The retail-packed meat must be labeled with the name of the distributor or the packager (Lauristen, 2006).

New Zealand. New Zealand produces over 700,000 pigs for slaughter per year and is focused mostly on domestic trade (Ministry of Agriculture and Forestry, 2006). According to the New Zealand Food Safety Authority,

a 2005 amendment to the 1999 Animal Products Act makes an Animal Status Declaration (ASD) mandatory for every movement of a pig (NZFSA, 2006a). Prior to this amendment, only pigs that were sent to slaughter needed the required form. The forms cost A\$25.00 for 25 forms if ordered from the New Zealand Pork Industry Board or are free if downloaded from the New Zealand Food Safety Authority Web site (NZFSA, 2006b).

The ASD form has several sections (NZFSA, 2006b). The first section asks for information on the number, type, and tattoo, brand, or ear tag numbers of the pigs. This is followed by a section for the name and physical address to which the pigs are being supplied. Next, information concerning medicinal treatments, date when medication was last administered, and when the withholding period was complete is documented. The next section is concerned about animal movements. This is followed by questions about porcine somatotropin, leptospirosis control, and quality assurance programs, and whether pigs were ever fed meat, food waste, or porcine material in their lifetime. The producer must sign and date the form under the statement "I am the person in charge of these pigs and I declare that I have read and understand the requirements of this ASD for Pigs and the information is true and accurate." The ASD form requires the name of the transport company, including the driver's name and signature, the vehicle and trailer registration numbers, and the time loaded. The ASD allows the pigs to be traced from the farm until slaughter (NZFSA, 2006b).

According to the ASD form (NZFSA, 2006b), the ASD is to be completed by the person who has the authority and knowledge to answer all the questions, which could be the owner, manager, or sale-yard operator. The person who signs the ASD must keep a copy on file for one year, and the individual who receives the pigs must keep a copy of the ASD for the entire time they have the pigs and

an additional year after they leave the premises. Processing companies are required to keep their copies of the signed ASD for 4 yr from receipt of the pig. If a producer or processor receives pigs with no ASD, they must keep them separated from other pigs until the ASD arrives at the processing plant. In the event there is no ASD, the pigs must be returned to their place of origin (NZFSA, 2006b). According to the ASD form, giving a false or misleading declaration on the ASD could result in a fine of up to A\$30,000 for an individual or A\$100,000 for a company.

Farm to Retail Traceability

A farm to retail traceability program traces an animal from birth to an individual package bought at the retail level. Although there are no countries that mandate farm to retail traceability for pork, some private companies are finding marketing opportunities by having a farm to retail traceability programs in place.

One such company is Nippon Meat Packers, a meat processor and packer that produces traceable beef, pork, and chicken in Japan. Since 2004, consumers have been able to trace meat purchases from the pork package to the pig farm via the internet (Nippon Ham, 2004). Although the computer-based systems were extremely popular when introduced, they are not commonly used anymore (Clemens, 2003). Even so, customers do not want them removed and feel more confident in the product because the information is available (Clemens, 2003). Domestic pork traceability has been considered over the years in Japan, but has not been implemented as a mandatory regulation for swine.

Countries without Government Regulated Traceability

Some major pork producing countries do not have mandatory pork traceability programs. Examples include most South American countries, as well as Australia. South

American countries differ greatly in the amount of pork they produce and export. In reviewing available literature, no South American country has a mandatory swine or pork traceability program at this time. As of 2004, Argentina and Bolivia seemed to be progressing toward a national mandatory traceability program, but it is not currently mandatory (Lewis, 2004). Chilean pork producers have some ability to trace swine, although traceability is voluntary (USDA-FAS, 2006b). Chile benefits from having a vertically integrated pork industry, which simplifies traceability. Traceability is important to Chile because the EU is one of the top destinations of exported Chilean pork (USDA-FAS, 2006b).

S. Lewis (Food Traceability Report, Agra Informa Inc., Arlington, VA, personal communication) describes why he believes South America has not made much progress on traceability. First, most South American countries do not typically export to premium markets, such as the EU, United States, Canada, or Japan, that often require traceability. A second reason is that traceability is not seen as a value-added trait for the product by most South Americans, making it a less attractive trait in which to invest for companies. A third reason is that the biggest incentive for South American companies to adopt traceability is the Hilton Quota, which is a tariff-free agreement between South America and the EU for high quality beef. Even though this is a highly lucrative deal for South America and is forcing traceability for beef, it does not apply to pork. The last reason suggested by Lewis is that profitability is at a slimmer margin with swine production than it is for grazing livestock; therefore swine producers might not find it attractive to invest in traceability hardware or software.

Brazil. Brazil is a major exporter of pork. Most of Brazilian pork exports are to countries such as Russia and China, rather than to countries like the United States or the EU

because of foot and mouth disease (Orr and Shen, 2006; Talamini and Malafaia, 2006). Brazil is growing as an exporter — in 2005 Brazil's pork exports had increased over 22% in volume compared with 2004 (Orr and Shen, 2006).

Private firms in Brazil have been contracted by the government to assist with traceability (J. Stroade, Kansas State University, Manhattan, personal communication). Traceability in Brazil is for the export market, especially by the Brazilian Export Pork Meat Chain (BEPMC). Talamini and Malafaia (2006) suggest that most of the traceability is done by consumer audits or by companies hired by the importers. Pork that is in the BEPMC agreement can usually be traced to the producer level, although there is no government regulation for this. The information producers collect is often superficial and does not allow for clear identification of the exact traceability process (Talamini and Malafaia, 2006). Using the traceability, transparency, safety assurance, and quality assurance rating score of Liddell and Bailey (2001) to look at the effective implementation of the traceability, transparency, and quality assurance system, BEPMC received only 5 points out of a possible 15, receiving a zero in traceability and quality assurance. Even so, the authors point out that the framework is in place and if all the programs available were implemented, Brazil would have received 11 points on the scale (Talamini and Malafaia, 2006).

Chile. Another major pork producer quickly becoming a major pork exporter is Chile. Pork exports from Chile were 124,000 tons in 2005, up from 59,000 tons in 2002, more than doubling their exports in 3 yr (USDA-FAS, 2006c). Chile has most of the traceability framework in place to trace their swine and pork. This is because of a stable government, relative geographic isolation that helps keep the country disease-free, and a pork industry that is "efficient, concentrated, and vertically integrated" (USDA-FAS, 2006b). The larg-

est 5 producers in Chile are totally vertically integrated and account for 75% of all pork production. Chile primarily exports to Japan, South Korea, Mexico, and the EU (USDA-FAS, 2006b). Although Chile must be tracing some of these pork products because they are selling to the EU, there is no government mandate requiring traceability and it remains voluntary.

Australia. Australia is forecast to have about 2.47 million head of swine and is expected to slaughter around 5.3 million pigs in 2007 (USDA-FAS, 2006a). Pork production is limited in Australia because of low domestic feed grain production and quarantine restrictions on importing grain from other countries (USDA-FAS, 2006a). Australia's largest export market for pork is Singapore (USDA-FAS, 2006a).

In March of 2006, the Australian government allocated A\$1.2 million to help the pork industry set up a traceability program to bring the entire pork industry under compliance within 3 yr (Thornton, 2006). Australia's National Livestock Identification Scheme is used for meat traceability, animal disease or residue detection, carcass value, food safety investigations, or to investigate stolen stock. Currently, National Livestock Identification Scheme is only mandatory for sheep and cattle. Although swine are either ear-tagged or tattooed as an industry mandate to identify pigs that are sold or marketed, this is not a government mandate (MarginQuest, 2006). The National Livestock Identification Scheme is a private, centralized database that is managed by Meat and Livestock Australia (MarginQuest, 2006).

IMPLICATIONS

Swine and pork traceability programs differ greatly from country to country. This review discusses traceability programs in swine and pork that are currently being used throughout the world and provides a depiction of how swine traceability can be accomplished. Certain coun-

tries, such as those in the EU, have the ability to trace pigs all the way from the farm to the harvest and packaging of pork. In other countries, such as Chile and Japan, private companies are voluntarily tracing swine for export. Other countries, such as Australia, are in the process of creating mandatory swine and pork traceability systems.

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LITERATURE CITED

- Bass, P. D., D. L. Pendell, D. L. Morris, J. A. Scanga, K. E. Belk, T. G. Field, J. N. Sofos, J. D. Tatum, and G. C. Smith. 2008. Review: Sheep traceability systems in selected countries outside of North America. *Prof. Anim. Sci.* 24:302.
- Bowling, M. B., D. L. Pendell, D. L. Morris, Y. Yoon, K. Katoh, K. E. Belk, and G. C. Smith. 2008. Review: Identification and traceability of cattle in selected countries outside of North America. *Prof. Anim. Sci.* 24:287.
- British Meat Processors Association. 2006. BMPA Standard. Module: British quality assured pork sausage. http://www.bmpa.uk.com/_Attachments/Resources/864_S4.pdf Accessed February 16, 2007.
- Clemens, R. 2003. Meat traceability and consumer assurance in Japan. MATRIC briefing paper 03-MBP 5. <http://www.card.iastate.edu/publications/synopsis.aspx?id=496> Accessed February 18, 2007.
- DEFRA. 2004. A guide for new keepers pigs. Dept. for Environment Food Rural Affairs. http://www.defra.gov.uk/animalh/id-move/pigs/pdf/new_owner_guide.pdf Accessed February 17, 2007.
- DEFRA. 2006. Animal by-products: Disposal of fallen stock—Questions and answers. Dept. for Environment Food Rural Affairs. <http://www.DEFRA.gov.uk/animalh/by-prods/fallen/disposalqa.htm>. Accessed February 9, 2007.
- Delegation of the European Commission to the USA. 2004. The EU's global role. <http://www.eurunion.org/globalplayer/worldplayer.htm>. Accessed February 17, 2007.
- European Commission. 2004. From farm to fork: Safe food for Europe's consumers. <http://ec.europa.eu/publications/booklets/move/46/en.pdf> Accessed February 11, 2007.
- European Union. 2002. Regulation (EC) No 178/2002 of the European parliament and the council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. *Off. J. Eur. Comm.* 45:1.
- European Union. 2006. Consolidated versions on the treaty on the European Union and the treaty establishing the European Commission. *Off. J. Eur. Comm.* C321E.
- FAO. 2002. Table 95. Pig Population. In *Selected Indicators of Food and Agriculture Development in Asia-Pacific Region 1992-2002*. <http://www.fao.org/DOCREP/004/AD452E/ad452e2x.htm> Accessed October 25, 2007.
- FAOSTAT. 2008. ResourceSTAT. <http://faostat.fao.org/site/573/DesktopDefault.aspx?PageID=573> Accessed Feb. 7, 2008.
- Harmann, K. 2006. An overview of Danish pork industry and structure. *Adv. Pork Prod.* 17:93.
- Hayes, D. J., and S. R. Meyer. 2003. Impact of mandatory country of origin labeling on U.S. pork exports. National Pork Producers Council, Des Moines, IA. <http://www.nppc.org/news/stories/2003/COOLReport.pdf> Accessed July 25, 2007.
- Jensen, H. H., and D. J. Hayes. 2006. Private sector approaches to secure traceability, transparency, and quality assurance in food chains. *Int. Agric. Trade Research Consortium Symp.*, Bonn, Germany.
- Lauristen, H. 2006. Danish quality guarantee. Danish Meat Processors Association. http://www.danskeslagterier.dk/smcms/Danish_English/Danish_Quality/Index.htm?ID=1968 Accessed February 19, 2007.
- Lewis, S. 2004. Argentina bows to pressure for expanded traceability. *Food Traceability Report*. Vol. 4. <http://www.foodtraceabilityreport.com> Accessed February 19, 2007.
- Liddell, S., and D. V. Bailey. 2001. Market opportunities and threats to the U.S. pork industry posed by traceability systems. *Int. Food Agribusiness Management Rev.* 4:287.
- MarginQuest. 2006. Comparison of US, Canada, Australia animal identification systems. Informa Economics, Inc. <http://www.informaecon.com/MarginQuest.htm> Accessed February 18, 2007.
- Ministry of Agriculture and Forestry. 2006. The New Zealand pork industry. <http://www>

- maf.govt.nz/mafnet/rural-nz/overview/nzo-view011.htm Accessed February 9, 2007.
- Murphy, R. G. L., D. L. Pendell, D. L. Morris, J. A. Scanga, K. E. Belk, and G. C. Smith. 2008. Review: Animal identification systems in North America. *Prof. Anim. Sci.* 24:277.
- National Fallen Stock Company. 2006. How is biosecurity maintained whilst collections are being carried out? http://www.nfsco.co.uk/frequently_asked_questions/faqs/how_is_biosecurity_maintained_whilest_collections_are_being_carried_out/ Accessed February 9, 2007.
- Nippon Ham. 2004. Fresh meats. http://www.nipponham.co.jp/en/en.pdf/anual2004_e4.pdf Accessed February 20, 2007.
- NZFSA. 2006a. Animal status declaration form. <http://www.nzfsa.govt.nz/animalproducts/publications/forms/statements-declarations/asd/pigasdjan06.pdf> Accessed February 20, 2007.
- NZFSA. 2006b. Animal status declaration for pigs. <http://www.pork.co.nz/nzspork/NZPorkPigFORM%20final%20A4s.pdf> Accessed February 20, 2007.
- Orr, D. E., and Y. Shen. 2006. World pig production, opportunity or threat? p. 3 in *Swine Nutrition Conf. Proc.*, Indianapolis, IN. <http://www.livestocktrail.uiuc.edu/uploads/porknet/papers/MWSNC%20Proceedings-2006.pdf> Accessed May 7, 2008.
- Talamini, E., and G. C. Malafaia. 2006. Traceability, transparency, and assurance systems implementation for the Brazilian exporter pork meat chain. *Int. Food Agribus. Manage. Assoc. World Food Agribus. Symp.*, Buenos Aires, Argentina.
- Thornton, M. 2006. Australia's pork industry gets A\$1.2 million for traceability. Vol. 6. <http://www.foodtraceabilityreport.com> Accessed February 19, 2007.
- USDA-FAS. 2006a. Australia Live-stock and Products. Annual 2006. GAIN Report. <http://www.fas.usda.gov/gain-files/200609/146238981.pdf>. Accessed February 20, 2007.
- USDA-FAS. 2006b. Chile Livestock and Products. *Pork. Annual 2006.* GAIN Report. <http://www.fas.usda.gov/gain-files/200608/146208792.pdf>. Accessed February 20, 2007.
- USDA-FAS. 2006c. Livestock and poultry: world markets and trade circular archives. http://www.fas.usda.gov/livestock_arc.asp. Accessed February 19, 2007.
- USDA-FAS. 2005. World Pork Meat and Swine Trade Overview. <http://www.fas.usda.gov/dlp/circular/2005/05-04LP/porkoverview.pdf>. Accessed October 26, 2007.