



MAPPING DATA ECOSYSTEMS AND ASSOCIATED REGULATORY FRAMEWORKS

NORDFORSK DigiVet Project

WORK PACKAGE 1

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Glossary of Terms

Abbreviation	Definition
AFBI	AgriFood and Biosciences Institute
AHDB	Agriculture and Horticulture Development Board
AMR	Antimicrobial Resistance
APHA	Animal and Plant Health Agency
ASF	African Swine Fever
BEK	Bekendtgørelse. Ministerial Order implementing laws in Denmark
CDB	Central Database for Bovine animals
CHR	Central Herd Registry (Det Centrale Husdyrbrugsregister, Denmark)
CPH	County parish holding number (Great Britain)
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DCB	Danish Cattle Database
DEFRA	Department of Environment, Food and Rural Affairs (Great Britain)
DK	Denmark
DVFA	Danish Veterinary and Food Administration
EASSA	European Antimicrobial Susceptibility Surveillance in Animals
EC	European Commission
EU	European Union
ECDC	European Centre for Disease Control
EFSA	European Food Safety Authority
FAIR	Data principles: findability, accessibility, interoperability, and reusability
FAO	Food And Agriculture Organisation
FSA	Food Standards Agency
FOTA	Swedish database of antimicrobial sales from pharmacies
GB	Great Britain
GMP	Good Manufacturing Practices
HACCP	Hazard Analysis and Critical Control Points
HM	Her Majesty
ICAR	International Committee for Animal Recording
LBK	Lovbekendtgørelse: Ministerial Order implementing changes to laws in Denmark
NI	Northern Ireland
PIGiS	Pig Grading Information System
PLATS	The Central Registry of Establishments (Sweden)
QMS	Quality Meat Scotland
QVR	QMS Wholesome Pig Scotland scheme quarterly veterinary reports
RASFF	Rapid Alert System for Food and Feed
RYK	Registrerings- og Ydelseskontrollen. Danish Registration and Milk recording organization, responsible for, amongst others, recording of cattle in Denmark
SBA	Swedish Board of Agriculture
ScotEID	Scottish EID Livestock Traceability Research
SFS	Svensk författningssamling. Swedish Code of Statutes (official law of Sweden).
SRUC	Scotland's Rural College
SVA	Swedish National Veterinary Institute
UCPH	University of Copenhagen
UK	United Kingdom
UN	United Nations
VMD	Veterinary Medicines Directorate
WHO	World Health Organisation
WOAH	World Organisation for Animal Health

Executive summary

- The aim of the Nordforsk project is to foster digital innovation through the construction of open-source, reusable resources.
- In this report we seek to map the current availability of livestock-related data in 3 partner nations (UK, Denmark and Sweden).
- We utilise 3 case studies with profound societal implications: antimicrobial resistance and foodborne illness have direct impact on public health, and exotic diseases such as African swine fever have potentially devastating impacts both on the domestic livestock industry and international trade.
- Our ultimate objective is to “identify and compare enabling factors for data digitalisation, and the data ecosystems that have emerged in different countries for the purposes of animal health contingency planning. This involves exploring the regulatory frameworks and social factors and will be co-produced with key stakeholders to explore aspirations and goals for future digitalisation of livestock-related data.”
- Desktop reviews and selected stakeholder interviews were conducted by members of the Nordforsk Digivet team to identify actors, institutions and infrastructures, data sources and availability, data intelligence architectures, and routes of communication and data sharing and preservation within the UK, Denmark and Sweden.
- The information collected leads to an emphasis in this report primarily on data acquisition, aggregation, and useage, with limited emphasis on coordinated data management, sharing or return value to the data provider or beneficiary.
- The work in this report highlighted a number of key challenges:
 - There are significant differences with respect to coordination and use of these disease-related data between countries.
 - Data collected may not necessarily be for the purposes for which it is used in these systems (e.g., antimicrobial use and sales data) which limits epidemiological interpretations.
 - Data quality in all three countries may be variable and dependent on who is inputting the data (and resource/incentives associated with this work), and how the data is transferred or shared.
 - Integration of different data types varies between countries.
 - Legislative barriers are likely to be a key inhibitor for data sharing, particularly across public and private organisational boundaries.
 - The responsibility for data collection for endemic diseases falls mainly to sector specific industry organisations. These data may not necessarily be findable, interoperable or accessible.
 - There appears to be limited information on benefits or return value of data to stakeholders. This is an area which will be explored further in subsequent work packages within the Digivet project.

Introduction

The aim of the Nordforsk project is to foster digital innovation through the construction of open-source, reusable resources.

In this report we seek to map the current availability of livestock-related data in 3 partner nations (UK, Denmark and Sweden), in order to lay the groundwork for future analyses of the current needs of industry and government stakeholders using a series of workshops. We utilise 3 case studies with profound societal implications: antimicrobial resistance and foodborne illness have direct impact on public health, and exotic diseases such as African swine fever have potentially devastating impacts both on the domestic livestock industry and international trade. The cases are united by a need to develop strategies to improve data-driven support for surveillance and disease control in order to ensure the continued supply of safe food. Foodborne illness, including salmonella, impacts approximately 1 in 10 people globally each year, and is often transmitted via eggs, dairy, meat, and other animal products (ECDC et al., 2017). The evolution of antimicrobial resistance (AMR) is a major problem in both human and animal health and slowing the increase of AMR has been identified as a modern grand challenge (ECDC et al., 2017). African swine fever (ASF) was selected as the example disease based on its current importance (i.e., it has wiped out a significant proportion of Chinese pork production causing significant hardship (WHO, 2016), and in particular the economic risk it poses to European pig production (Wang et al., 2018).

The analytical solutions that we aim to deliver as a result of the project will contribute to a more effective and resilient digital data infrastructure, which will benefit the management of animal health worldwide. We seek to develop standardised data specifications and programming interfaces for use within the context of veterinary preparedness and disease control in Scotland, Denmark and Sweden, use our professional networks to promote their use for similar purposes by researchers in other countries, and also make them available more widely to allow any government or industrial body to hold similar data in a way that is easily and consistently accessible. Key to this will be compliance with the FAIR principles of data usage: making data findable, accessible, interoperable and reusable. This will have benefits within the veterinary public sector, by adding value to the available data, increasing the benefit-to-cost-ratio of acquiring information for decision making, and therefore making the most efficient use of public resources. Promoting the use of data FAIRness for methodological applications in our field will also contribute towards uptake of these principles in related fields, such as human medical research, aquaculture, and arable crop disease epidemiology.

Significance

As stated in our original project proposal for NordForsk funding: “The ethical responsibility for maintaining human and animal health is fundamentally societal, but specific tasks relating to monitoring, maintaining, and acting on data are disseminated across various government and industry bodies. Related data are gathered and held separately by a variety of entities (both public and private), standards and systems are not consistent across nations, and social and political realities vary substantially by disease and region. However, rapid detection and response to relevant threats is only possible if there are effective and resilient surveillance systems with the capacity to detect, assess and disseminate disease intelligence. There is an urgent need to collate and characterise the relevant data being collected across the Nordic countries and the UK in order to identify shortcomings and opportunities for improving data accessibility and interoperability and to contribute software tools and metadata libraries that will facilitate international collaboration, support disease prevention and preparedness, and underpin a wide range of future research in animal and human population health.”

Purpose

The purpose of this report “is to provide a comprehensive description of the present-day data ecosystems and pipelines for data analytics for animal health contingency planning that have emerged in countries under different regulatory frameworks.”

This project is concerned with the following focal question:

What policies relating to livestock data are currently implemented across the Nordic countries, what improved data practices and processes can help to solve existing challenges, and what further innovations & interventions are required in order to guarantee our future supply of safe food that is farmed with minimal use of antimicrobials within a robust population of livestock?

Our objective is to “identify and compare enabling factors for data digitalisation, and the data ecosystems that have emerged in different countries for the purposes of animal health contingency planning. This involves exploring the regulatory frameworks and social factors and will be co-produced with key stakeholders to explore aspirations and goals for future digitalisation of livestock-related data.”

Approach

Desktop reviews and select stakeholder interviews were conducted by members of the DigiVet team to identify actors, institutions and infrastructures, data sources and availability, data intelligence architectures, and routes of communication and data sharing and preservation within the UK, Denmark and Sweden.

Mapping the current data ecosystems and associated regulatory frameworks: 3 case studies

Antimicrobial Use and Resistance

At an international level there is collaboration between the World Health Organisation (WHO), Food and Agricultural Organisation of the United Nations (FAO) and World Organisation of Animal Health (WOAH) to improve coordination between human and animal surveillance, but within Member States the two sectors are distinct and regulated independently of each other. Surveillance, if undertaken, is implemented separately by each sector, without harmonisation or standardisation of approach. In some countries, technical and financial constraints, such as lack of existing public health infrastructure, access to diagnostic technologies and changing public attitudes towards public health mean that surveillance is poor. However, the Antimicrobial Resistance Multi-Stakeholder Partnership Platform has recently been launched by the FAO, WHO, UN Environment Programme (UNEP), and the World Organisation for Animal Health (WOAH) to try to improve global coordination of the challenges relating to antimicrobial resistance ¹.

The most complete public health data on antimicrobial consumption and resistance are available from the EU, where regional surveillance systems in human health are well-established and supported by legislation (Decision no 2119/98/EC). Surveillance networks monitor variations in antimicrobial consumption and resistance over time and place and contribute to the Antimicrobial Resistance and Healthcare-Associated Infections programme at the European Centre for Disease Control (ECDC).

¹ <https://www.who.int/news/item/18-11-2022-quadripartite-launches-a-new-platform-to-tackle-antimicrobial-resistance-threat-to-human-and-animal-health-and-ecosystems>

European countries are obliged to have national surveillance systems for testing certain food-borne microbes and other bacteria for AMR. Nevertheless, intra-community comparisons are still difficult because of differences in animal populations, processes of sample collection, “sample numbers, bacterial isolation and laboratory methodology” (de Jong 2009). At a supranational level, the European Centres for Disease Control (ECDC) and Food Safety (EFSA) coordinate the European surveillance programme for zoonoses and food-borne bacteria (Regulation (EC) No 178/2002). The European Antimicrobial Susceptibility Surveillance in Animals (EASSA) programme has also been measuring AMR trends since 1999 and has highlighted the importance of monitoring before and after regulatory interventions such as the ban on the use of antimicrobials for growth promotion use (de Jong et al. 2012). It emphasises the need for standardised approaches to data collection, organism identification, susceptibility testing and laboratory techniques (de Jong 2009).

Key European Legislation and Governance Bodies

- Decision No 2119/98/EC Of The European Parliament and Of The Council of 24 September 1998 Setting Up A Network for The Epidemiological Surveillance and Control Of Communicable Diseases In The Community. (1998) Official Journal of the European Communities L 268/1
- Regulation (EC) No 178/2002 Of The European Parliament and Of 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. (2002) Official Journal of the European Union L31/1
- The EU Feed Additives Regulation 1831/2003/EC banned the use of antibiotics as growth promoters from 2006.
- The European Medicines Agency is the lead organisation for collecting data on the sale of veterinary antimicrobial products in member states, as specified in Decision 2013/652/EU.
- The European Surveillance of Veterinary Antimicrobial Consumption project established in 2009 collects information on the use of antimicrobials in member states primarily through sales data.
- In 2020 the EU Farm to Fork Strategy set out an objective of a 50% reduction in EU sales of antimicrobials in livestock and aquaculture by 2030.
- Regulation (EU) 2019/4 on medicated feed and Regulation (EU) 2019/6 on the manufacturing and supply of veterinary medicinal products came into effect in 2022. These regulations ban the routine use of antimicrobials and prophylactic and metaphylactic use, unless in exceptional circumstances. Prophylactic use can only be applied to individual animals, rather than groups of animals.

A. United Kingdom

Governance

In the UK, the use of antimicrobials in farm animals is regulated by the Veterinary Medicines Regulation 2013. This covers the manufacture, supply, sale and use of antimicrobials. Antimicrobials can only be prescribed by a veterinarian when the animal is under the veterinarian's care and when they have carried out a clinical assessment of the animal (HM Government, 2013). Following Brexit, imports of pharmaceuticals from the EU to the UK must receive authorisation as of June 2021 (HM Government, 2021).

The Veterinary Medicines Directive (VMD) is the executive agency of the Department of Environment, Food and Rural Affairs (Defra), which is responsible for enforcing legislation, monitoring the sale of antimicrobials and antimicrobial (AM) resistance, and advising government

ministers on updating AM policy. The VMD operates across the 4 countries in the UK (Veterinary Medicine Directorate, 2021).

The UK will not implement Regulations (EU) 2019/4 and 2019/6 following their exit from the European Union in 2020. The UK government will carry out a public consultation on changing the UK's laws on antimicrobial use, including consideration of the new EU rules.

The UK government set out a five year action plan for tackling antimicrobial resistance in 2019 which aims to reduce the need for antimicrobials, optimise the use of antimicrobials and invest in innovations in the supply chain (HM Government, 2019). This was updated in 2022 (HM Government, 2022). The mechanisms for bringing about change in antimicrobial use in the farm animal sector are primarily through industry rather than government initiatives. The UK government commissioned a report on antimicrobial use in the livestock sector, called the O'Neill report, published in 2016 (O'Neill, 2016). The report recommended the establishment of an industry task force to set targets for reducing antimicrobials in the livestock sector. In response, the Responsible Use of Antimicrobials in Animals Alliance (RUMA), an independent group made up of industry bodies, established the Targets Task Force in 2017 (RUMA, 2017). The Targets Task Force set targets for reductions in antimicrobials use by sector for 2020 (RUMA, 2020). It updated its targets in 2020 and set out an action plan for achieving them. The strategy to achieve these targets includes additional training for vets and the creation of a network of Farm Vet Champions.

Animal health is a devolved area of government meaning that the devolved administrations in Scotland, Northern Ireland and Wales also create their own strategies and policy. The Scottish Government set out an animal health and welfare strategy in 2016 (Scottish Government, 2016). In 2015 the Scottish Animal Health and Antimicrobial Resistance Group was formed with the aim of providing leadership on antimicrobial use in the Scottish livestock sector. The group is made up of industry and government bodies who meet 3 times a year. A sub-group, the Scottish Veterinary Antimicrobial Stewardship Group (SVASG) aims to develop a strategy for antimicrobial management in livestock. The Welsh Government launched a strategy for antimicrobial resistance in animals and the environment in 2019 (Welsh Government 2019) and an Animal and Environment Antimicrobial Resistance Delivery Group to implement the strategy. In Northern Ireland a One Health strategy was launched for tackling antimicrobial resistance in 2019 (Department of Health, DAERA and Food Standards Agency, 2019).

Surveillance² and Data-sharing

The VMD publish annual reports on antimicrobial usage data from some sectors as well as sales data (VARSS Annual Report). Many antimicrobials are authorised for use in several animal species, so it is difficult to get an accurate picture of use by animal species from sales data alone. The VMD works with livestock sectors to gather use data for different species. Usage from over 95% of pig farms is recorded through electronic medicine book (eMB-Pig) for pigs launched by the Agriculture Horticulture Development Board (AHDB pork) in 2016. Usage data from the poultry meat sector comes from the British Poultry Councils' Antibiotic Stewardship scheme and covers 90% of the UK sector. Usage data from the laying hen sector comes from members of the British Egg Industry Council Lion code and covers 90% of the sector. Antibiotic usage for the game bird sector comes

² We use an adapted version of the World Organisation on Animal Health definition of surveillance as any data used or that could be used in future for the purposes of surveillance i.e. for the purposes of "monitoring [animal and human health], disease trends, facilitating the control of disease or infection, to provide data for use in risk analysis, for animal or public health purposes, and to substantiate the rationale for [sanitary measures](#)."

from the Game Farmers' Association and covers 90% of the sector. Data on antibiotic usage for the aquaculture sector comes from the Scottish Salmon Producers' Organisation and the British Trout Association and covers 100% of both sectors. The VMD collect usage data in the beef and dairy sectors from a smaller sample of farms, gathered through the FarmVets Systems software which extracts sales data from veterinary practice management systems. The sample represents 34% of UK dairy farms and represents 10% of the Great British (GB) beef sector. Sheep industry usage data is collected from a convenience sample of 0.05% of UK farms.

The AHDB launched an online Medicine Hub in January 2021 which aims to appeal to beef and dairy individual farms to input their antimicrobial use data so they can track and benchmark their own use. The Medicines Hub also aims to import data from other sources such as farm software and veterinary practices. The ultimate aim is to link the Medicine Hub data with national compulsory animal traceability systems and to use the data in the VMD annual report.

The Red Tractor scheme is an industry led quality assurance and food safety certification scheme in England, Wales and Northern Ireland (NI) run by industry bodies. In 2018 the Red Tractor changed their guidance on antimicrobial use to stipulate that dairy and beef farmers have to carry out an annual review of antimicrobial use with their vet; highest priority critically important antibiotics must only be used as a last resort under veterinary direction, including a sensitivity or diagnostic test; and it is recommended that one member of staff carry out training on antibiotic handling and administration (Red Tractor Assurance, 2018). The Red Tractor scheme is less common in Scotland, and the Quality Meat Scotland (QMS) scheme covers a higher proportion of beef farmers. The QMS rules state similarly that the farmer should collate antibiotic use every year and highest priority critically important antibiotics should only be used as a last resort.

Producers who are on 'supermarket aligned' contracts may be subject to different rules about their antimicrobial use which are a condition of their contract. Similarly, some processing companies are introducing additional rules about the of antimicrobials.

B. Denmark

Governance

Complementary to the EU regulation (2019/6 (EU)), a Danish regulation exists. This is the law on medicinal products (LBK 99, 2018), which covers production, market authorisation and distribution (including packaging) of medicinal products for both humans and animals; it covers more or less all products and the entire chain from producers to patients (including animals).

The law on the animal owners use of medicines for animals (BEK 927, 2022), the law on veterinarians (LBK 1523, 2020) and the law on veterinarians' prescription and use of veterinary medicine (BEK 2542, 2021) set out requirements for both the animal owner and the veterinarian regarding AMU. In general, only authorised veterinarians are allowed to prescribe antimicrobials, and this should be done conscientiously and prudently. A pivotal point in the prescription of any product is the cascade rule described in Articles 112, 113 and 114 of 2019/6 (EU):

Step 1: choosing a product approved in Denmark or EU for specific animal species and indication; otherwise,

Step 2: choosing a product approved for another animal species or indication; otherwise,

Step 3: choosing a product approved for humans or a product approved in another country (and subsequently also on delivery agreement from the Danish Medicines Agency); otherwise,

Step 4: magistral preparation of a medicinal product, based on derogation from the Danish Veterinary and Food Administration, if the product is not listed.

Herd owners can under specific circumstances be allowed to use antimicrobials to their animals if the herd veterinarian has made an initial diagnosis and prescription based on a herd diagnosis and conditional on the existence of a veterinary advisory service contract with the prescribing veterinarian and the herd owner. The herd veterinarian is required to keep a record of all treatments and report these to the authorities. Farms with a usage of antimicrobials above a certain threshold level (relative to the size of the farm) are at risk of being provided with a “Yellow card”. This initiative was put in place to reduce the level of antimicrobial usage in the country.

Surveillance and Data-sharing

All antimicrobial usage on farm-level is reported to [VetStat](#), which is the Danish Veterinary and Food Administration database on authorised veterinarians, practices, veterinary advisory service contracts and consumption of veterinary medicines and coccidiostats in Denmark.

C. Sweden

Governance

In addition to Regulations (EU) 2019/6 and 2019/4, there are also Swedish regulations on the sales and use of antimicrobials. According to Regulation (EU) 2019/6, veterinary medicinal products with antimicrobials are “prescription only medicines”. Only veterinarians are allowed to prescribe antimicrobials to treat animals (HSLF-FS 2021:75) and according to SJVFS 2019:32 as amended in 2022:1 on the veterinarian’s ordinations of medicinal products and use of medicinal products, the veterinarian should always consider the problem of resistant bacteria when choosing antibiotic treatment. From the latter regulation also follows that veterinarians are not allowed to ordinate some antibiotics critical in human health care. Preventive measures are also taken through other Swedish regulations on animal health and welfare, disease control and hygiene, as healthy animals do not need antibiotics (SBA, 2022^b). In 1986 Sweden banned the use of growth promoting antimicrobials (SFS 1985:295 with amendments).

In Sweden, only pharmacies may sell veterinary medicinal products to end-users. Animal owners and veterinarians buying for use in own practice (requisitions) are considered as end-users. All pharmacies are obliged to report all sales of medicinal products to the eHealth Agency (SFS 2009:659 as amended by 2021:130). The regulations SFS 2021:1129 and SFS 2021:1132 controls how information and data on sales of medicinal products for animals are registered at the eHealth Agency and shared to some other parts, such as SBA and the Swedish National Veterinary Institute (SVA).

Surveillance and Data-sharing

Data that is currently shared by the eHealth Agency to SVA and SBA is confidential and protected according to law SFS 2009:400 and regulation SFS 2009:641 as amended.

Sales of antimicrobials from pharmacies: The Swedish eHealth Agency maintains the register of pharmaceutical sales (FOTA). Veterinary medicinal products are sold at pharmacies, either directly to animal owners with prescriptions from veterinarians or sold to veterinarians (requisition for use in own practice) (Swedres-Svarm, 2020). Sales on distance is allowed (LVFS 2009:10), both to animal owners and to veterinarians.

For both prescriptions dispensed and requisitions, the following information should be transferred to the eHealth Agency (SFS 2009:659 as amended by 2021:130):

- Name of the product
- Formulation

- Strength
- Package size
- Number of packages sold
- The veterinarian's professional registration code
- Animal species (only for prescriptions)

For sales on distance, the postal code of the buyer should also be transferred. Some other information on prescriptions for animals should also be transferred as from January 2022.

The prescription data transferred to the eHealth Agency contains information on animal species, and as from January 2022 the organisational number of a farm, but currently not the reason for the prescription (indication). At the time of the sales on requisition, the pharmacies do not know for what species the veterinarian will ultimately use the products for and therefore, no such information can be transferred from that source.

Data on sales by species given on prescriptions is representative for use in dogs, cats, and pigs, as most of the consumption is bought on prescription. Cattle and horses are to a larger extent treated by the veterinarian in connection with a visit. In those cases, the veterinary medicinal products used have been bought by the veterinarian for use in own practice (requisition).

Annually SVA and the Public Health Agency of Sweden publish a report, "Swedres-Svarm" on Swedish antibiotic sales and resistance in humans and animals. Data on sales from the eHealth Agency is one of the data sources in the report (Swedres-Svarm, 2020).

Use of antimicrobials on farms: The Animal health database (Vet@data/DAWA) is administered by SBA and could provide more information about use of antimicrobials, to complement the data on requisition sales. However, it is currently not possible to link specific treatment records to the requisition sales data and there are, as mentioned, problems with data quality and omitted reports. Currently in the case of antimicrobials, this database is mainly used by Växa Sverige to monitor reported treatments of antimicrobials to dairy cows, not to monitor antimicrobial use.

Changes in data ecosystem: To comply with article 57 of Regulation (EU) 2019/6, the Swedish systems for reporting antimicrobial sales and use will be changed to improve data acquisition and quality. The precise nature and long-term impact of these changes is not yet known.

Other data sources: The Poultry health control programme (covering more than 98% of the broilers in commercial production) requests that all treatments of broilers, parents and grandparents are reported to the Swedish Poultry Meat Association (Swedres-Svarm, 2020). Each year aggregated numbers of flocks treated with antibiotics and total number of slaughtered flocks is published on a website (Swedish Poultry Meat Association, n.d.) and in the report Swedres-Svarm.

Medicated feed for antimicrobial treatment of fish is always traded from other Nordic countries. The premixes used for this feed are not sold from Swedish pharmacies, and thus not included in the data on sales stored at the eHealth agency. However, the veterinarian coordinating health services for farmed fish report prescriptions of veterinary medicines for fish annually to SBA (Swedres-Svarm, 2020).

Table 1 – Existing data sources potentially of relevance for monitoring sales and use of veterinary medicinal products with antimicrobials in Sweden.

Data description	Data producer	Data owner	Data user	Purpose of the data
The register of pharmaceutical sales (prescription and requisition sales at pharmacies) (FOTA)	Pharmacies	eHealth Agency	eHealth Agency, SBA, SVA, International organisations / agencies, Other authorities (human medicine)	Analysis and reporting of sales of veterinary medicinal products
Animal health database (Vet@data/DAWA)	Veterinarians	SBA	SBA, SVA, Växa Sverige, Researchers, Veterinarians, County administrative boards, Animal owners	Monitor the animal health situation in Sweden and use it as a basis for preventive measures
Antibiotic treatment of broilers	Farmers/ Vets	Swedish Poultry Meat Association	Swedish Poultry Meat Association, SBA, SVA	Monitor the use of antibiotics
Prescriptions of medicated feed for fish	Vets	District Vets (practising) employed by SBA	SBA, SVA	Reporting prescriptions of antimicrobials and antiparasitics for farmed fish

Salmonella

The World Health Organisation (WHO) recognises the importance of salmonella as one of the four key global causes of diarrhoeal diseases in humans, and since 2004 has worked with the FAO as part of the International Food Safety Authorities Network (INFOSAN) to facilitate implementation of risk management strategies and exchange of information on disease outbreaks between member countries. There are also a series of requirements for food producers and operators set out by the European Union (EU) food hygiene legislation that are relevant to the control of food-borne zoonotic diseases such as salmonella in EU member states. These are developed by the European Food Safety Authority (EFSA) in conjunction with the European Centre for Disease prevention and Control (ECDC), and implemented by EU member states (as well as the UK). In addition, EFSA and ECDC monitor data reported by EU member states on the occurrence of zoonotic infections and food-borne outbreaks in humans, including salmonella. However, the implemented methods for investigating outbreaks of disease and collection of samples from humans differ between countries.

EFSA also maintain a series of general regulations and guidelines regarding the control of salmonella in poultry ³. These consist primarily of targets for reductions in salmonella prevalence, but also cover requirements for use of antimicrobials and vaccines as well as restrictions on import of live birds and eggs. Of particular interest are the special guarantees for salmonella in Sweden, Finland, Denmark and Norway, which recognise the lower salmonella prevalence in poultry in these countries and provide a mechanism of ensuring that salmonella is not imported from other EU member states. This includes a requirement for extended monitoring showing the absence of salmonella in a source population before consignments can be imported into these countries. There is less emphasis at EU level on control of salmonella in other livestock species including pigs and cattle, although a series of cost/benefit analyses covering salmonella control in pigs has been provided by the European Commission ⁴.

Key European Legislation and Governance Bodies

- Regulation (EC) 2160/2003 on the control of Salmonella and other specified food-borne zoonotic agents.
- Directive 2003/99/EC on the monitoring of zoonoses and zoonotic agents.
- Commission Decision 2007/407/EC of 12 June 2007 on a harmonised monitoring of antimicrobial resistance in Salmonella in poultry and pigs.
- Commission Decision 2007/516/EC of 19 July concerning a financial contribution from the Community towards a survey on the prevalence and antimicrobial resistance of Campylobacter spp. in broiler flocks and on the prevalence of Campylobacter spp. and Salmonella spp. in broiler carcasses to be carried out in the Member States.
- Commission Decision 2008/55/EC concerning a financial contribution from the Community towards a survey on the prevalence of Salmonella spp. and Methicillin-resistant Staphylococcus aureus in herds of breeding pigs to be carried out in the Member States.
- Special guarantees for Sweden, Finland, Denmark (table eggs) and Norway:
 - Council Decision 95/410/EC regarding poultry intended for slaughter
 - Commission Decision 2004/235/EC regarding laying hens
 - Commission Decision 2003/644/EC regarding breeding hens
 - Regulation (EC) No 1688/2005 regarding certain meat and eggs

³ https://food.ec.europa.eu/safety/biological-safety/food-borne-diseases-zoonoses/control-salmonella_en

⁴ https://food.ec.europa.eu/system/files/2016-10/biosafety_food-borne-disease_salmonella_fattening-pigs_slaughtouse-analysis-costs.pdf; https://food.ec.europa.eu/system/files/2016-10/biosafety_food-borne-disease_salmonella_fattening-pigs_slaughtouse-analysis-costs.pdf;
https://food.ec.europa.eu/system/files/2016-10/biosafety_food-borne-disease_salmonella_breeding-pigs_salm-cost-benefit.pdf

A. United Kingdom

Governance

Salmonella is classified as a statutory disease in the UK, which means that any salmonella occurrence identified as part of disease monitoring in any animal species in the UK (excluding Northern Ireland) must be reported to the Animal and Plant Health Agency (APHA), who will then decide if a statutory disease investigation is warranted and take further action as necessary. All salmonella isolates identified at any laboratory in the UK must also be forwarded to a reference laboratory for characterisation, including resistance profiling. The relevant reference laboratories are as follows:

- Animal isolates identified in England and Wales are sent to the APHA laboratory in Weybridge
- Human isolates identified in England and Wales are sent to the UK Health Security Agency laboratory in Colindale
- Human and animal isolates in Scotland are sent to the Scottish Salmonella, Shigella & *C. difficile* Reference Laboratory (SSCDRL)

Information on movement of cattle is maintained by the British Cattle Movement Service in England and Wales, and ScotEID in Scotland. These systems are intended to be fully equivalent, and provide the ability to trace all cattle movements in the UK at individual animal level.

Surveillance and Data-sharing

Regular summaries of the number of reported cases of salmonella in livestock are routinely released via reports from APHA ⁵. Salmonella is a statutory organism, so the reported number of isolates should be a close match to the number of isolates identified at a laboratory. However, these data are ultimately collected via passive surveillance, which can be expected to give a substantial self-selection bias: the overall occurrence is therefore likely to be under-estimated.

Information on individual cases is routinely shared between reference laboratories/agencies in Scotland and England/Wales if epidemiological links are found between isolates, and informal information-sharing meetings happen regularly between responsible agencies in England, Wales and Scotland. All information is held at an individually identifiable level by these authorities, and can be used as part of statutory follow-up disease outbreak investigation as necessary. This includes epidemiological disease outbreak investigations where patient-level information on travel history and home address may be combined with phylogenetic analysis of salmonella isolates in order to identify likely routes of transmission. However, individually identifiable data on human isolates is not released by these agencies for outside use. Farm-level data concerning isolates identified in livestock (including cattle) are not made publicly available but may be shared with researchers as part of specific research projects.

Relevant data for investigating occurrence of the cattle-adapted *Salmonella* Dublin on cattle farms include information on the specific organism isolated (including resistance profiling), on-farm reports of clinical disease, and movements of animals to/from the farm that may be important in transmission of the organism between farms. Of these, only the former is collected and aggregated at a national level. On-farm investigation of disease outbreaks does occur on a farm-by-farm basis, and depending on the agency responsible for the investigation a number of data sources may be available. For example, clinical information from cattle herds may also be collected by an investigating veterinarian as part of on-farm investigations, and combined with information on the salmonella isolate from in-house laboratory testing as well as information fed back from the relevant reference laboratory in order to inform control strategies on the herd. In Scotland, much of this

⁵ <https://www.gov.uk/government/publications/salmonella-in-animals-and-feed-in-great-britain>

outbreak investigation is done by Scotland's Rural College (SRUC), who also have direct access to animal movement data via ScotEID and therefore have the ability to link outbreaks on different farms either as part of a regional control programme or for the purposes of research. However, these investigations are typically done on a farm-by-farm basis, and there is no centralised register storing this farm-level information across the UK.

B. Denmark

Governance

Animals: Salmonella control is governed by different national legislation depending on the animal species. Vaccination is not used in Denmark for any animal species. Investigation is required upon clinical suspicion of salmonellosis in animals and any finding of Salmonella, regardless of serovar, is notifiable. If clinical salmonellosis is present, the property in question will be put under official veterinary supervision by the veterinary authorities until the clinical outbreak has waned and restrictions can be lifted.

Table 2. Danish salmonella control measures listed by species.

Species	Control Measures
Poultry	<p>Strict control measures are taken to eliminate infection or contamination and culling of the whole flock followed by thorough cleaning and disinfection is frequently the control option of choice. The following legislation is relevant to control of salmonella in poultry (in Danish):</p> <ul style="list-style-type: none"> - BEK nr 499 af 23/03/2021 (Bekendtgørelse om bekæmpelse af salmonella i konsumægproducerende høns og opdræt hertil) - BEK nr 1425 af 30/11/2018 (Bekendtgørelse om kritisk resistent salmonella hos fjerkræ, kvæg og svin) - BEK nr 782 af 02/06/2020 (Bekendtgørelse om bekæmpelse af salmonella i rugeægproducerende høns og kalkuner samt opdræt hertil) - BEK nr 1819 af 02/12/2020 (Bekendtgørelse om forholdsregler vedrørende salmonellose hos fjerkræ samt salmonella og campylobacter i slagtefjerkræ m.m.)
Pigs	<p>Control actions depend on serological levels and culling of infected farms is not used. The following legislation is relevant to control of salmonella in pigs (in Danish):</p> <ul style="list-style-type: none"> - BEK nr 1079 af 01/06/2021 (Bekendtgørelse om salmonella hos svin) - BEK nr 1425 af 30/11/2018 (Bekendtgørelse om kritisk resistent salmonella hos fjerkræ, kvæg og svin)
Cattle	<p>Control of salmonella in cattle is not directed by EU-legislation. In cattle (which is used for a case study in the DigiVet project) there is an ongoing surveillance and control programme. This programme was initiated in late 2002, and the overall prevalence of test-positive farms has decreased markedly since the initiation, see http://www.kvaegvet.dk/ (in Danish).</p> <p>The programme targets Salmonella Dublin (serogroup-D) and is mainly based on antibody-ELISA testing of bulk-tank milk samples from all dairy herds every 3 months, and blood samples collected over time either at the abattoir or from animals in the non-dairy herds.</p> <p>The programme is governed by the Danish Veterinary and Food Administration (DVFA), but the daily administration is carried out by industry, i.e., SEGES Innovation. Frequent updates to the legislative orders are driven by requests from farmer, veterinarians and organisations that are treated in a working and a steering committee under the DVFA.</p>

Species	Control Measures
	<p>The programme places all test-positive cattle herds and herds with risky contacts to other farms in Level 2. Farms in Level 2 are subject to official veterinary supervision and will receive visits from the veterinary authorities every 6 months. They have restrictions on movement of animals and obligatory control measures including receiving veterinary advice. If there is no documented effect of the control measures (test-negative calves in obligatory sampling rounds every 3 months), the farms in Level 2 can be ordered to get additional veterinary advice from another veterinarian, who has been approved by the veterinary authorities to provide veterinary consultancy about Salmonella Dublin control.</p> <p>All test results from the programme and surveillance levels appointed to the farms over time are gathered in the Danish Cattle Database together with herd demographics, production and milk quality data, and data about treatments and other disease surveillance results. The data are used by farmers and local veterinarians in herd health consultancy, and by researchers in projects aiming to support the programme. Sometimes the surveillance data are merged with other data sources such as animal movement data, data from the Central Husbandry Register, milk quality or production data and/or use of medicine to answer specific research questions in support of the control efforts.</p> <p>The following legislation is relevant to control of salmonella in pigs (in Danish):</p> <ul style="list-style-type: none"> - BEK nr 1493 af 06/12/2022 (Bekendtgørelse om salmonella hos kvæg og visse andre husdyr) - BEK nr 1425 af 30/11/2018 (Bekendtgørelse om kritisk resistent salmonella hos fjerkræ, kvæg og svin) - BEK nr 1688 af 18/12/2018 (Bekendtgørelse om godkendelse af dyrlæger til at foretage påbudt veterinærfaglig rådgivning med henblik på bekæmpelse af Salmonella Dublin på kvægejendomme)

Feed: DK follows the EU regulation (Commission Regulation (EU) 142/2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive. This among others refers to Regulation No 183/2005 of the European Parliament and of the Council of 12 January 2005, laying down requirements for feed hygiene through national implementation.

Feed-producing companies are obliged to effectively prevent and control salmonella bacteria in feed, according to national legislation (BEK nr 999 af 25/05/2021, Chapter 4).

Feed (with some exceptions) for chickens, hens and turkeys must be heat treated to 81 °C. Samples must be collected in the production of feed and all salmonella isolates from feed or environmental samples must be serotyped. Upon detection of salmonellae (no matter which serotype) the feed must not be sold unless heat treated and documented free from salmonella.

Some serotypes are considered dangerous (risky) to humans or animals. If these are detected the feed is considered dangerous (risky). For example, the finding of *Salmonella* Dublin in feed for cattle or the finding of *Salmonella* Cholera suis in feed for pigs are usually interpreted as the feed being dangerous. Feed that is assessed as dangerous must be withdrawn from the market. Commercial feed for cattle and pigs is also frequently heat-treated. The production of feed is supervised by the DVFA.

Food: Any finding of *Salmonella* spp. in food is notifiable and a contaminated food product is considered unfit for human consumption. Detection of *Salmonella* spp. in food items can lead to withdrawal of batches of food products from the market. Laboratories analysing samples taken by authorities are obliged to send isolates of *Salmonella* from positive food samples to Statens Serum Institut (SSI, Copenhagen, Denmark) for serotyping.

Humans: Salmonellosis in humans is notifiable and an overview of registered human cases are collected and communicated as interactive graphics by SSI (<https://statistik.ssi.dk/>, under Laboratorieanmeldelser: <https://statistik.ssi.dk//sygdomsdata#!/?sygdomskode=SALM&stype=9&xaxis=Aar&show=Graph&datatype=Laboratory>).

One study has made a comparison of *Salmonella* Dublin strains detected in food, humans and animal sources, and found that there is a large overlap between these strains suggesting that many human cases arise from domestically produced beef (Kudirkiene et al., 2020).

Surveillance and Data-sharing

Premises and movement data: All cattle holdings, all cattle and all cattle movements and events are recorded in the central herd registry, Det Centrale Husdyrbrugsregister (CHR), which is accessible online (<https://chr.fvst.dk/>). Here you can search individual farms, their owner, active species, number of cattle and information on individual animals (e.g., birth, death, calvings, breed), along with veterinary status on regulated diseases such as *Salmonella* Dublin. An example of holding information is shown in Figure 1, and animal information in Figure 2. The CHR is owned by the Danish Veterinary and Food Administration, and the information is required to be provided by farmers according to the Danish law on keeping of animals (LBK 9, 2022). The data are managed by an external company, and a copy of the data exist in the Danish Cattle Database (DCB), which is hosted by SEGES Innovation P/S (Aarhus N, Denmark), which is the farmers' primary agricultural knowledge and innovation centre in Denmark. All cattle farms in CHR are regularly tested for *Salmonella* Dublin (four times per year on bulk tank milk; non-dairy farms tested using other schemes on slaughter animals). Test information is stored on herd-level in the DCB and status information (i.e., Level 1 or Level 2) is transferred to CHR.

On farm and other data sources: The Danish Cattle Database (DCB) also includes data on milk recordings from dairy farms that are part of the milk recording scheme, RYK (by November 2022, this included approximately 2042/2353, or 87% of the herds (<https://www.ryk-fonden.dk/>). In the milk recording scheme, information on individual cows' milk yield, fat and protein percentages etc. are recorded according to ICAR standards (<https://www.icar.org/>). Furthermore, individual animals' data on *Salmonella* Dublin, paratuberculosis, pregnancy tests and others can be stored in the DCB, along with veterinary treatment recordings and data. The treatment recordings on medicinal products are transferred to VetStat (see above).

Forside | Om CHR | Kontakt

[Ejendomme](#) | [Besætninger](#) | [Ejere og Brugere](#) | [Aquafarms](#) | [Forsyningskæder](#) | [Kvæg](#) | [Kvægpas](#) | [Besætningsliste](#) | [Flytningsdokument](#) | [Flytteliste](#) | [Dyrevelfærd](#)

Find ejendom

Hvad
 eller
Hvor

Fandt 1 ejendom

CHR nr.	Adresse	By	Postnr.	Postdistrikt	Kommune	Dyrearter	Placering
15247	Hestetofte 1 A Stårby 4735 Mern	Stårby	4735	Mern	Vordingborg		Se på kort

Adresse Hestetofte 1 A
Stårby
4735 Mern
 Veterinærenhed Veterinærenhed Øst
CHR-afdeling CHR-afdelingen, Seges
 Aktive dyrearter

Fandt 2 besætninger

CHR nr.	Besætningsnr.	Besætningstype	Må dyr omsættes	Ophørt	Dyr i a
15247	15247	Malkekvægsbesætning	Ikke relevant	16. dec. 2008	

Ejer	Bruger	Ejendom
Jakob Saxmose Nielsen	Jakob Saxmose Nielsen	CHR nr.: 15247
Hestetofte 1 A	Hestetofte 1 A	Hestetofte 1 A
Stårby	Stårby	Stårby
4735 Mern	4735 Mern	4735 Mern
Vis besætninger	Vis besætninger	Vis besætninger
		Vis på kort

> 15247	15247	Svin, produktionsbesætning	Ikke relevant	05. jul. 1998	
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Figure 1. Example of a farm in the Danish CHR. The farm with CHR-number 15247 is located in the address Hestetofte 1 A, 4735 Mern. The owner is given for the dairy herd (“Malkekvægsbesætning”) and additionally a pig farm is given. The dairy herd ceased production on 16 December 2008 (and the pig herd on 5 July 1998). It is not relevant to move animals from these herds, but they are both green, because there are no veterinary issues. They would have been red, if the herd was in Salmonella Dublin Level 2



Forside | Om CHR | Kontakt

Ejendomme | Besætninger | Ejere og Brugere | Aquafarms | Forsyningskæder | **Kvæg** | Kvægpas | Besætningsliste | Flytningsdokument | Flytteliste | Dyrevelfærd

Find kreatur

Hvad

Hvor

Hvor

Fandt 1 kreatur

CKR-nr.	Race	Køn	Født	Må omsættes	CHR nr.	Besætningsnr.	Besætningstype
52068-06719	Dansk Jersey	Ko	03. jul. 2015		52046	52046	Kviehotel

Ejer Oosterhof I/S Lintrupvej 38 6660 Lintrup Reklamebeskyttet Vis besætninger	Bruger Oosterhof I/S Lintrupvej 38 6660 Lintrup Reklamebeskyttet Vis besætninger	Ejendom CHR nr 52046 Mejlbyvej 1 6660 Lintrup Vis besætninger Vis på kort	Salmonella Dublin niveau Moders CKR-nummer	Niveau 1 siden 23-06-2018 52068-06222
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Indenlandske flytninger

Dato	CHR nr. fra	Besætningsnr. fra	CHR nr. til	Besætningsnr. til	Årsag	Nation til/fra
26. okt. 2022	52068	52068	52046	52046	Indgang	
26. okt. 2022	52068	52068	52046	52046	Afgang levebrug	
21. jul. 2021	52046	52046	52068	52068	Indgang	
21. jul. 2021	52046	52046	52068	52068	Afgang levebrug	
03. jun. 2021	52068	52068	52046	52046	Indgang	
03. jun. 2021	52068	52068	52046	52046	Afgang levebrug	
02. jul. 2020	52046	52046	52068	52068	Indgang	
02. jul. 2020	52046	52046	52068	52068	Afgang levebrug	
14. maj 2020	52068	52068	52046	52046	Indgang	
14. maj 2020	52068	52068	52046	52046	Afgang levebrug	

Biologisk mor til

Fødselsdato	Recipientmoders CKR-nr.	CKR-nr.	Kælvning nr.	Køn	Tilstand	Nuv. ejendom	Nuv. besætning
01. aug. 2021		5206808441	5	Kvie	Levende kalv	52068	52068
10. jul. 2020		5206808063	4	Ko	Levende kalv	52068	52068
01. aug. 2019			3	Ukendt	Aflivet som spæd		
11. aug. 2018		5206807499	2	Ko	Levende kalv	52068	52068
22. jun. 2017		5206807209	1	Ko	Levende kalv		

Figure 2. Cow-level information in the Danish CHR. Cow no. 5206806719 is a Danish Jersey born on 3 July 2015; she was at the time of this screenshot located in a heifer hotel (“Kviehotel”), holding no. 52046. She has been moved a number of times between holding no. 52068 (where she was born) to 52046, where she has probably been in the dry period. She has calved five times, to four females and one calf of unknown sex (euthanised shortly after birth). The four daughters are listed. On the date of the screenshot (4 Nov. 2022) she could be moved, hence the green marking, as the herd has been in Salmonella Level 1 since 23-06-2018 (and there are no other veterinary issues precluding movement).

C. Sweden

Governance

Animals: Investigation is required upon clinical suspicion of salmonellosis and any finding of *Salmonella*, regardless of serovar, is notifiable. Action is taken to eliminate the infection or contamination except in cases of findings of *S. diarizonae* serovar 61:(k):1,5(7) in sheep. Vaccination is not used in Sweden. The *Salmonella* control programme is governed by the Swedish Act on Zoonoses (SFS 1999:658) and its regulations. The aim of the programme is that animals sent for slaughter and animal products should be free from *Salmonella* (SVA, 2020^a).

Feed: Control of animal feed is an integrated and essential part of the control programme for *Salmonella* in primary production. The feed business operator is responsible for producing *Salmonella*-free feed. Poultry feed must be heat treated according to the legislation. A major part of cattle and pig commercial feed is also heat-treated. The production of feed is supervised by the Swedish Board of Agriculture (SBA) which carries out announced and unannounced inspections at feed mills and pet food producers. The control of *Salmonella* in feed is regulated in national legislation (SJVFS 2018:33) as well as in an EU regulation (Commission Regulation (EU) No142/2011) (SVA, 2020^a).

Food: Any finding of *Salmonella* in food is notifiable and a contaminated food product is considered unfit for human consumption. However, there is one exception, which is *S. diarizonae* serovar 61:(k):1,5(7) in sheep meat, as this serovar is not considered to be of public health importance (LIVFS 2005:20). Laboratories analysing samples taken by authorities are obliged to send isolates of *Salmonella* from positive food samples to the National Reference Laboratory for serotyping (LIVFS 2005:21) (SVA, 2020^a).

Humans: Salmonellosis in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with amendments, SFS 2013:634). Laboratory confirmed cases include cases with samples that are only positive by PCR i.e., where no isolate has been obtained (SVA, 2020^a).

Surveillance and Data-sharing

Animal registers (cattle): As a complement to EU regulations, the Swedish regulation SJVFS 2021:13 controls registration of farms, approval, traceability, movements, and imports and exports with regards to animal health. Holdings with cattle must be registered and approved by SBA. The cattle must be tagged, within 20 days from birth, or earlier if the animal is moved. Events, such as births, movements and deaths must be reported to SBA for each individual animal within seven days from the event. Farmers are also obliged to keep records of the reported events and documentation on medical treatment and responsible veterinarian, cause of treatment, deaths and causes of death (SBA, 2022^a).

Premises and movement data: Data on registered holdings and cattle movements and events are registered and administered at SBA in the Central Registry of Establishments (PLATS) and the "Central Database for Bovine animals (CDB). For herds enrolled in the national milk recording scheme, managed by the company Växa Sverige, all reporting to the Central Database for Bovine Animals is done via the Database for Dairy Herds (SVA, 2020^b).

In the database PLATS each holding is assigned a unique identification number (holding number). It is required that the animal holder registers all information and all changes that occur at the holding place. It is the animal holder's responsibility to fulfil the requirements and register according to the rules (SVA, 2020^b).

The purpose of the register CDB is to enable efficient tracing of a contagious disease, verification of the country of origin of a meat product as well as control and administration of cross compliance (SVA, 2020^b). Data is also used for research and other projects. Through agreements, parts of the

registers PLATS and CDB are transferred to and stored at SVA. Some of the data is also shared with different companies or organisations within the agricultural sector, e.g., Växa Sverige, the company “Farm & Animal health” and more.

The main national coordinating organisation for dairy and beef production is Växa Sverige (approved according to SJVFS 2009:29). The organisation is responsible for the official milk recording scheme and lineage recording for dairy cows (Kodatabasen, managed according to ICAR’s recommendations). The Database for Dairy Herds includes milk recordings, calvings, cullings, inseminations, registrations from claw trimmings and disease recordings from SBA for all animals at the dairy farm. It forms the basis for the development of different management tools used by the farmers, advisers and veterinarians. It is also a valuable tool for research on topics such as feeding, animal health and genetics. Approximately 70% of all dairy herds in Sweden, covering approximately 73% of the dairy cows, are included in the official milk recording scheme (SVA, 2020^a).

On farm and other data sources: Apart from the official milk recording scheme, Växa Sverige also administer a voluntary programme of subscription of bulk milk tank sampling, “Healthy Cow” (FriskKo). The samples are taken four times per year and are analysed for antibodies for *Salmonella* and other diseases. Some additional sampling is also offered to farms connected to the official milk recording scheme. Within Healthy Cow the farms are also offered veterinary advice in case of positive results from the sampling (Växa Sverige, n.d.).

To improve biosecurity and prevent disease spread there is also a voluntary biosecurity programme for cattle (“Smittsäkrad besättning nöt”), administered by Växa Sverige, with support of the regulation SJVFS 2015:17 from SBA about voluntary health control programmes for domestic animals. Through the programme, the herd health veterinarians conduct visits to the farms on a regular basis to help the farmers improve the biosecurity. There are also courses for the farmers within the programme. For higher steps in the programme measures must be taken regarding hygiene and cleaning routines, when purchasing animals, when handling carcasses, when receiving visitors, in the storage of feed, and more. The connected farms get higher economical compensation for measures and restrictions undertaken in case of a *Salmonella* outbreak (Växa Sverige, 2020).

All veterinarians working with production animals are obliged to report treatments with veterinary medicinal products and vaccination of individual food producing animals to SBA (SJVFS 2019:25 last amended 2022:2), where treatments must be reported within a month from the journaling, but no later than three months from the actual treatment (SBA, 2021). The data is stored in the Animal health database (Vet@data/DAWA) administered by SBA. The original purpose of the database was to monitor the animal health situation in Sweden (SVA, 2020^b). However, there are deficiencies in the reporting which lead to omitted reports and data quality issues. Also, the development of the current database was originally adapted to dairy cattle which has led to some functionality issues for other species (SBA, 2019). Data from Vet@data/DAWA is available to veterinarians, county administrative boards and animal owners, but only data regarding the own reports, county or farm. Some information from the database is also shared with other parts, such as SVA, Växa Sverige and researchers. This data could be used to get more information on occurrences and treatments of *Salmonella*.

SVALA is the Laboratory Information Management System used at SVA to record and manage laboratory data for all samples analysed at the laboratory, covering both domestic and wild species. The database includes information about animal owners, animals, samples, test results and geolocation. Samples analysed include samples from veterinary practices, different surveillance programs and others (SVA, 2020^a). Customers who sent their samples to SVA for analyse have the right to get access to their results in SVALA, but otherwise the data is not shared further.

Surveillance of feed, production animals, abattoirs, and food: The surveillance of *Salmonella* in animal and food consists of scheduled sampling, sampling upon disease suspicion, voluntary

sampling, and sampling to follow a confirmed case. The sampling is conducted at feed mills, farms, abattoirs, cutting plants, food companies, veterinary clinics, during necropsy and when trading and importing food or animals. There are also various measures that will be taken in the case of *Salmonella* findings. All suspected isolates of *Salmonella* from feed, food and animal sources are sent to SVA for confirmation, serotyping, resistance testing, and further typing (SVA, 2020^b).

Feed: In the control programme for feed, the emphasis is on control of feed raw materials, the heat treatment process, and preventive measures to avoid recontamination of heat-treated feed. Suspected feed-borne infections are also investigated. Raw feed materials are the most important risk factor in feed production. In the domestic legislation, feed materials are classified according to the empirical risk of being contaminated, and high-risk feed materials must test negative for *Salmonella* contamination before being used in feed production. All consignments of intra-community traded or imported compound feed for cattle, pigs, poultry and reindeer and feed materials classified as a risk must be sampled and tested for *Salmonella*. The sampling plan is designed to detect a *Salmonella* contamination in 5% of the batch with 95% probability (SVA, 2020^a).

The purpose of the surveillance is to ensure the absence of *Salmonella* in the production lines as well as in the feed mill environment. A safety management system is applied in the processing line according to HACCP (Hazard Analysis and Critical Control Points). The management system covers several specific GMP (Good Manufacturing Practices) requirements, according to the Swedish legislation. A minimum of five samples from feed mills that manufacture compound feedstuffs for poultry and a minimum of two samples from those manufacturing compound feedstuffs for other food-producing animals must be collected in the processing line on a weekly basis. These samples are analysed at SVA (using the latest version of EN-ISO 6579-1) and any finding of *Salmonella* is reported to SBA. The feed manufacturers also take additional samples from the processing line and the feed mill environment as part of their own process quality control (SVA, 2020^a).

Findings of *Salmonella* in intra-community traded or imported feed materials and compound feeds are reported in the Rapid Alert System for Food and Feed (RASFF) (https://ec.europa.eu/food/safety/rasff_en). Measures are always taken when *Salmonella* is detected in feed samples. Extended sampling and cleaning are done in the production line if *Salmonella* is detected in the weekly surveillance (SVA, 2020^a).

Farms and production animals: The *Salmonella* control programme for cattle includes a compulsory and a voluntary component. In the compulsory programme *Salmonella* testing is performed in all calves <12 months of age that are submitted for necropsy. *Salmonella* testing is also performed in conjunction with necropsies if an infection is suspected based on macroscopic findings. All imported animals are also tested and on clinical suspicion, any herd or single animal should be tested for *Salmonella* (SVA, 2020^b).

If *Salmonella* is suspected in an animal, a veterinarian is obligated to take samples and implement measures to prevent further transmission. When *Salmonella* is detected, the laboratory must notify SBA and the County Administrative Board. When detected in a food producing animal, the County Veterinary Officer informs the official veterinarian at the abattoir involved. When *Salmonella* is confirmed on a farm, the holding is put under restrictions (except in cases of finding of *S. diarizonae* serovar 61:(k):1,5(7) in sheep), an epidemiological investigation is performed and a plan to eradicate *Salmonella* from the holding is defined. Animal movements to and from the holding are stopped (SVA, 2020^a). Other measures are also taken.

The voluntary part of the programme is the biosecurity programme and the “Healthy Cow” programme, mentioned previously.

Food, abattoirs and cutting plants: Control of *Salmonella* is an important part of in-house quality control programmes in many food enterprises in Sweden. All findings must be reported to the

competent authority. Between 500 and 1000 samples per year are tested as part of official sampling by local authorities at food enterprises, other than slaughterhouses and cutting plants. Isolates of *Salmonella* from samples of food taken by authorities are always sent for serotyping at the National Reference Laboratory for *Salmonella*, at SVA (see Legislation). Although there are no legal requirements, laboratories most often also send isolates for confirmation from samples taken by food business operators. Serotyping and in some cases whole genome sequencing of these isolates is funded by SBA, provided that the food business operator agrees that the results are made available to the national authorities. Data from 2007 and onwards are stored in the database SVALA at SVA (SVA, 2020^a).

According to the Swedish *Salmonella* control programme, samples from intestinal lymph nodes and swabs from carcasses are taken from cattle. Sampling at each slaughterhouse is proportional to the annual slaughter volume. The total number of samples taken is calculated to detect a prevalence of 0.1% in the animals sent for slaughter, with 95% confidence level in cattle, pig, and poultry carcasses at a national level. Altogether, approximately 21 000 samples from cattle, adult pigs, fattening pigs, and poultry are collected at abattoirs annually. At red meat cutting plants, approximately 5000 samples are taken annually from meat residues (SVA, 2020^a).

The samples within the control programme are analysed by commercial laboratories. Up to 10 samples are allowed to be pooled into a pooled sample. If *Salmonella* is detected in the pool the samples included in the pool are analysed separately. Food business operators are obliged to take swab samples from carcasses of sheep, goats, and horses at slaughterhouses for analyses of *Salmonella*, according to the regulation (EC) 2073/2005 on microbiological criteria for foodstuffs. The results of these analyses are not yet collected by the competent authority. In Sweden, the corresponding requirements of swab sampling of carcasses of cattle and pigs and sampling of neck skins of poultry carcasses are replaced by the sampling within the *Salmonella* control programme (SVA, 2020^a).

In case of *Salmonella* findings, products released on the market will be withdrawn and contaminated products will be destroyed or sent for special treatment to eliminate the *Salmonella* bacteria, except for *Salmonella diarizonae* serovar 61:(k):1,5(7) in sheep meat. Findings in imported consignments are reported in the RASFF system and the consignments will be returned to the country of origin, destroyed, or sent for special treatment as applicable. RASFF is also used for informing about contaminated Swedish food products released on the EU market or within Sweden. In food enterprises where *Salmonella* has been detected, appropriate follow-up measures will be applied, such as careful cleaning and disinfection and environmental sampling (SVA, 2020^a).

Table 3. Existing data sources of relevance for surveillance of *Salmonella* in Sweden.

Data description	Data producer	Data owner	Data user	Purpose of the data
Central register of holdings (PLATS)	Farmers	SBA	SBA, SVA, Växa Sverige, Farm & Animal Health, Other companies and abattoirs (cattle)	Fulfil requirements to keep records of holdings
Central Database for Bovine animals (CDB)	Farmers	SBA		Mainly for the ability to do tracing of a contagious disease

Data description	Data producer	Data owner	Data user	Purpose of the data
Database of dairy herds / official milk recording scheme	Farmers	Växa Sverige	Växa Sverige, Farmers, Advisers, Veterinarians	Management tools for farmers
Animal health database (Vet@data/DAWA)	Veterinarians	SBA	SBA, SVA, Växa Sverige, Researchers Veterinarians, County administrative boards, Animal owners	Monitor the animal health situation in Sweden and use it as a basis for preventive measures
Laboratory data of analysed samples (from different laboratories)	Laboratory staff	Depends on the submitter of the sample	SVA, Other laboratories, Customer	Surveillance
Laboratory data of analysed <i>Salmonella</i> isolates, from laboratory at SVA (SVALA)	Laboratory staff	The submitter of the sample	SVA, Customer	For confirmation, serotyping, resistance testing and further typing.

African Swine Fever (ASF)

The WOAH Terrestrial Animal Health Code 2021 Chapter 15.1 sets out surveillance and control measures for notifiable disease (i.e., diseases that are required by law to be reported to government) such as African swine fever. This includes a “a formal and ongoing system for detecting and investigating cases of ASF” (article 15.1.29) as well as control and eradication.

ASF is a highly infectious disease of pigs and wild boar. Transmission occurs through direct and indirect routes including contact with infected pigs, their faeces or other body fluid, fomites on people, vehicles and equipment, infected pig meat products or by products and via ticks. The UK, Sweden and Denmark are currently free from the disease. However, the distribution of ASF in Europe is spreading with cases detected in Moldova, Romania, Russia and Ukraine. More recently cases were detected in Germany in 2021, Italy in 2022 and Northern Macedonia in 2022 (Daera 2022). Due to the combination of this high morbidity and the extremely high mortality (>95%) observed in domestic pigs, ASF is considered a major threat to the livestock sector. Following introduction of the disease into a previously free country, economic losses can be expected not only due to direct loss of animals on infected farms but also at a national scale due to the lost revenue resulting from movement restrictions and an inability to export animals to other countries during an

outbreak. This is particularly important for Denmark, which exports between 10-15 million live pigs per year ⁶.

Key European Legislation and Governance Bodies

- Council Directive 2008/71/EC established a system of registration and identification for pigs.
- Commission delegated regulation (EU) 2020/687 provides general rules for prevention and control of certain listed diseases in the EU e.g., specifying sampling frames (Annex I), monitoring periods (Annex II), size of protection and surveillance zones (Annex V), prohibitions (Annex VI), risk mitigating treatments (Annexes VII and VIII), and duration of measures in the protection and surveillance zones (Annexes X and XI, respectively).
- Regulation (EU) 2021/605 lays out special control measures for African swine fever based on the “Animal Health Law” (Regulation (EU) 2016/429) legal framework.
- The EU Council Directive 2008/71/EC on registering the movement of pigs is implemented into law
 - in Northern Ireland through the Pigs (Records, Identification and Movement) Order (Northern Ireland) 2012;
 - in Scotland through the Pig (Records, Identification and Movement) (Scotland) Order 2011;
 - in England through the Pigs (Records, Identification and Movement) (England) Order 2011; and the Pigs (Records, Identification and Movement) (Wales) Order 2011.

A. United Kingdom

Governance

The EU Council Directive 2008/71/EC on registering the movement of pigs is implemented into law in Northern Ireland through the Pigs (Records, Identification and Movement) Order (Northern Ireland) 2012; in Scotland through the Pig (Records, Identification and Movement) (Scotland) Order 2011; in England through the Pigs (Records, Identification and Movement) (England) Order 2011; and the Pigs (Records, Identification and Movement) (Wales) Order 2011.

African swine fever and classical swine fever are notifiable diseases in the UK, regulated by the Diseases of Swine Regulations 2014. ASF is notifiable so the regulation states that a person who suspects the presence of the disease in a domestic or feral pig must notify the Animal and Plant Health Agency (APHA). A veterinary inspector must then inspect the premises. If the veterinary inspector suspects the presence of disease, they must take samples from the carcass and the environment. If disease is confirmed then further actions are taken on the premises and suspected contact premises to eliminate the disease and prevent its spread.

The African swine fever (Imports Controls) Order 2022 covers the import of porcine products into GB. It stipulates that no porcine products may be imported from countries subject to transitional import arrangements, unless they meet the requirements of the legislation. Under the Northern Ireland Protocol, NI remains in the sanitary and phytosanitary zone as the EU.

Surveillance and Data-sharing

Premises and movement data: An agricultural census is carried out each year in each country in the UK by the devolved administrations which identifies premises which hold pigs. The census is based on a sample of the population and every 10 years a full census is carried out. Pig owners must also

⁶ <https://lf.dk/tal-og-analyser/statistik/svin/eksport-af-levende-svin>

notify their local Animal and Plant Health Agency office of pigs on the premises and obtain a herdmark for the holding.

The movement of pigs between premises is recorded in Scotland on the ScotEID database, in England and Wales on the eAML2 system administered by AHDB and APHA and in Northern Ireland by DAERA. It is a legal requirement to register pig movements 3 days before they take place. The APHA produce periodic livestock population density maps for researchers based on the eAML2 and ScotEID data and share the movement data directly with researchers.

Passive surveillance data: Passive surveillance is carried out throughout the UK of samples submitted to veterinary laboratories for detection of new and emerging disease and for general awareness of health status in the pig industry. In Scotland SRUC Veterinary Services collect data for passive disease surveillance for the Scottish government through the Scottish Government Veterinary Services Programme. Data is collected from submissions from veterinary practices from clinical samples or post-mortem data. The data are stored in the laboratory information management system. The data is only accessible from SRUC vet services laboratory. The client's name and address are stored with the data (and CPH if included), type of holding, age of animal, class of livestock, animal batch identifier and individual identifiers for mature pigs. Data are stored for 20 years. An estimate of 20% of producers are covered by this passive surveillance system. SRUC produce monthly and quarterly surveillance reports from the data for the Scottish government and industry.

In England and Wales passive surveillance is carried out through Veterinary Investigation Diagnosis Analysis database (VIDA) programme based on diagnostic testing and post-mortem examinations at 6 Veterinary Investigation Centres and several other post-mortem partner providers. The data are used by Surveillance Intelligence Unit within APHA and also made available to public via GB pig disease surveillance dashboard. The data are used to produce quarterly reports on disease surveillance and emerging threats for government and industry in Great Britain.

In Northern Ireland disease surveillance is carried out by the Agri-Food and Biosciences Institute (AFBI), which is an arms-length body of the Department of Agriculture, Environment and Rural Affairs (DAERA). Surveillance is based on diagnostic and post-mortem examinations of submissions to AFBI laboratories. Quarterly disease surveillance reports are prepared for government and industry and AFBI contribute to a yearly island of Ireland surveillance report with Animal Health Ireland.

ASF and CSF are notifiable diseases so a person who suspects the presence of the disease in a domestic or feral pig must notify the Animal and Plant Health Agency. A veterinary inspector must then inspect the premises. If the veterinary inspector suspects the presence of disease, they must take samples from the carcass and the environment. Duplicates are then created and ASF is tested for at APHA's Pirbright facility and CSF at Weybridge. A population of around 400 wild boar exists in the Forest of Dean in England (Forestry Commission England 2022) and a population of wild boar and feral pigs in Scotland (Nature Scot 2022). Rangers and land managers are also tasked with reporting dead wild boar for testing of ASF and CSF.

Active surveillance data: The Food Standards Agency in England and Wales; Food Standards Scotland and the Food Standards Agency Northern Ireland are responsible for administering ante and post mortem abattoir inspections in line with retained EU legislation. Meat Hygiene Inspectors and Official Veterinarians carry out ante and post mortem assessments of every pig entering the abattoir for diseases with significance for public and animal health. Data are digitised and stored by the relevant devolved authorities.

Active surveillance of pig carcasses in abattoirs is carried out by veterinary assessors every quarter as part of the Wholesome Pigs Scotland administered by the industry funded body Quality Meat

Scotland (QMS) scheme in Scotland. Wholesome Pig Scotland abattoir surveillance data are analysed by the Scottish Rural College (SRUC) who produce quarterly report that is provided to the farms involved through their QMS client ID. This data is not owned by SRUC, and it is not entered in SRUC epidemiology database. This data is held at pig, batch, farm and national level.

Abattoir surveillance is carried quarterly in England through the Pig Health Scheme administered by the industry funded body AHDB. Pig Health Scheme abattoir data is stored on AHDB's Pig Hub against the slapmark. Reports are sent to participating farmers to benchmark their data. There is no equivalent in Wales because of the small number of pig farms in Wales.

Abattoir surveillance is carried out in Northern Ireland through the voluntary pig health scheme administered by the industry funded body Pig Regen Ltd. Producers can access their carcass data and benchmark their performance through the Pig Grading Information System (PiGIS) run by the Agri-Food and Biosciences Institute (AFBI). Processors also have access to their producers' data.

Sero-surveillance of pigs for CSF is carried out at artificial insemination centres which are licenced for the export of semen, in accordance with EU Directive 90/429/EC.

The Great Britain ASF and CSF control strategy states that there is no disease surveillance of CSF or ASF in feral pigs (wild boar) in Great Britain in the absence of a disease outbreak (Defra et al., 2020).

As part of the QMS Wholesome Pig Scotland scheme quarterly veterinary reports (QVR) are carried out by private veterinarians on farm to report on certain health and production parameters and declare the perceived health status of the farm for 6 diseases. An estimated 95% of farms in Scotland are enrolled in this scheme. Wholesome Pig Scotland and QMS are the data owners. SRUC maps Scottish pig disease status based on the abattoir data and QVRs. These maps are shared with the Scottish Pig Industry Network. The maps are used by vets to be aware of the risk of disease spreading in particular areas. Farms features on the map could be identifiable, so the maps cannot be shared more widely because of issues with confidentiality.

As part of the Red Tractor scheme in England, Wales and Northern Ireland private vets carry out quarterly veterinary reports on pig health and production parameters. Vets input the quarterly veterinary reports in paper form to the farm's Certification Body. The Certification Body update certain details such as slap mark or pig numbers in their system against the member if anything has changed since the last report was submitted. The data is not used for benchmarking.

Participation in the Real Welfare Scheme run by AHDB is a requirement of the Red Tractor and Whole Pig Scotland assurance schemes across the UK for producers with pigs over 50kg. Pigs are assessed for 5 welfare measures 2-4 times a year by private vets who are members of the Pig Veterinary Society. Outcomes are reported back to producers and producers can benchmark their data against other farms. Data is stored by AHDB. Red Tractor, QMS and AHDB do not have access to the data of individual producers, but AHDB produce reports on welfare metrics from the anonymised data covering multiple years.

The Welsh pig association Menter Moch Cymru run a benchmarking scheme for Welsh pig keepers called Manage to Measure. Farmers input financial and productivity key performance indicators online and receive a benchmarking report.

AgroSoft Ltd is a pig production management software that signed a deal with QMS in 2020 for 3 years to make their software available to pig farmers in Scotland and return benchmarking reports of performance data to participating farmers.

The APHA carry out on-farm inspections to verify cross compliance on farms claiming payments under the Common Agriculture Policy. Inspections are carried out by veterinary staff or animal health officers on animal welfare, facilities and disease treatment on 1% of eligible farms annually. The majority of farms are chosen because of complaints received or suspected contravention of

animal welfare legislation, or retention of a bovine viral diarrhoea persistently infected animal in Scotland, and 20% of inspections are random.

Table 4. Pig data in the UK.

Data description	Country	Data producer	Data owner	Data user	Purpose of the data
Agricultural census	All devolved administrations	Devolved administrations	Devolved administrations	Devolved administration, scientists	Identify premises which hold pigs.
eAML2 movement data	England, Wales	Producers	AHDB	AHDB, APHA scientists	Fulfil EU requirement to record animal movements
ScotEID movement data	Scotland	Producers	ScotEID	ScotEID, APHA scientists	Fulfil EU requirement to record animal movements
DAERA movement data	Northern Ireland	Producers	DAERA	DAERA, APHA,	Fulfil EU requirement to record animal movements
Scottish Government Veterinary Services Programme	Scotland	Producers, private vets, labs	SRUC	SRUC	Passive animal health surveillance for government and industry.
APHA and SRUC Veterinary Investigation Diagnosis Analysis database (VIDA)	England and Wales	Producers, private vets, labs	APHA, SRUC	APHA	Passive animal health surveillance for government and industry.
AFBI disease surveillance programme	Northern Ireland	Private vets, AFBI labs	AFBI	AFBI	Passive animal health surveillance for government and industry.
Food Standards Agency	England and Wales	Meat Hygiene Inspectors, Official Vets	Food Standards Agency in England Wales	Food Standards Agency in England and Wales	Active animal and public health surveillance.
Food Standards Scotland	Scotland	Meat Hygiene Inspectors, Official Veterinarians	Food Standards Scotland	Food Standards Scotland	Active animal and public health surveillance.

Data description	Country	Data producer	Data owner	Data user	Purpose of the data
Food Standards Agency Northern Ireland	Northern Ireland	Meat Hygiene Inspectors, Official Veterinarians	Food Standards Agency Northern Ireland	Food Standards Agency Northern Ireland	Active animal and public health surveillance.
Wholesome Pig Scotland abattoir surveillance	Scotland	Veterinary inspectors	QMS	QMS, SRUC , producers	Animal health information for producers and industry.
Pig Health Scheme	England	Veterinary inspectors	AHDB	AHDB, producers	Animal health information for producers.
Voluntary pig health scheme	Northern Ireland	Veterinary inspectors	Pig Regen/AFBI	AFBI, producers, processors	Animal health information for producers and processors.
Wholesome Pig Scotland quarterly veterinary reports	Scotland	Private vets	QMS, Wholesome Pigs Scotland	QMS, SRUC	Animal health information for producers and industry. Quality assurance scheme for consumers.
Red Tractor scheme	England, Wales, Northern Ireland	Private vets	Certification bodies	Red Tractor	Quality assurance scheme for consumers.
Real Welfare Scheme	UK	Private vets	AHDB	AHDB	Welfare information for producers. Welfare assurance scheme for consumers.
APHA cross compliance farm inspections	UK	APHA veterinary staff or animal health officers	APHA	APHA, Rural Payments Agency England (RPA), the Scottish Government Rural Payments & Inspections Directorate (SGRPID), the Welsh	Verify cross compliance on farms claiming subsidies.

Data description	Country	Data producer	Data owner	Data user	Purpose of the data
				Government (WG) and the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland	

B. Denmark

Governance

The legislation on Category A diseases according to the EU Animal Health Law generally follows that law. The specifications follow the annexes of Commission delegated regulation (EU) 2020/687 as listed above. Furthermore, all pig holdings are recorded in the Central Herd Registry (CHR), and all pig movements are recorded in the pig movement database, according to the law on keeping of animals (LBK 9, 2022). This includes also premises with kept wild boar. There are only a few free-ranging wild boar in Denmark, and these are being hunted and shot down by the Danish Environmental Protection Agency with an aim of eradication, due to the risk of spread of ASF-virus to kept pigs.

Surveillance and Data-sharing

All holdings with pigs are recorded in the Danish CHR; furthermore, movement of pigs are recorded in Svineflyttedatabasen (SFD, The Pig Movement database), which is a part of CHR. When pigs are moved between holdings, it is a legal requirement that the movement is recorded in SFD. SFD can be used to record both domestic movements and export of pigs and exports.

SPF herds: A major part of the pig herds are part of the Specific Pathogen Free (SPF) health system, under the Danish Agriculture and Food Council. Approximately 3100 herds are included in the SPF-system, and SPF Health keeps track of the SPF status of the herds. The following pathogens are monitored: *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumoniae* serotypes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 12, PRRS virus (European and American strains), *Brachyspira hyodysenteriae*, toxigenic *Pasteurella multocida*, *Sarcoptes scabiei* var. suis, and *Haematopinus suis*. These farms including these herds have higher requirements for biosecurity than other farms, especially with regards to external biosecurity. The requirements are laid out on the website of the organisation (<https://spfsus.dk/en>).

Passive surveillance data: Passive surveillance is carried out by farmers, veterinarians and personnel at slaughterhouses, who should report suspicions of African Swine Fever to the competent veterinary authority (the Danish Veterinary and Food Administration). A key element of passive surveillance in practice is monitoring for increased rates of on-farm mortality. As ASF is a notifiable disease, any suspected cases of ASF must be reported by the practicing veterinarian to the Danish Veterinary and Food Administration, who will take samples for laboratory testing at Statens Serum Institute.

Active surveillance data: There is no active surveillance for ASF currently in place in Denmark. However, active surveillance is carried out for Classical Swine Fever (CSF) in slaughter pigs, semen stations, and pigs to be exported.

Wild boar data: Wild boar have previously occurred naturally in Denmark, but have not been present in substantial numbers since the 1800s. This status has been deliberately maintained over

recent years so that wild boar are less likely to serve as carriers of ASF virus for transmission to domestic pigs. However, due to a contiguous border with Germany, wild boar can still be found in Denmark in limited numbers. The Danish hunting bag ⁷ can be used to monitor the occurrence of wild boar. However, the hunting bag also contains data on fenced populations, and consequently included a total of 157 recordings of hunted wild boar up to 4th November 2022, of which very few are likely to have existed in a truly wild state. Only a single free-ranging wild boar was reported, which occurred in the south part of Jutland during Autumn 2022, at which time the authorities were attempting to find and kill the animal. A wild-boar fence near the border to Germany was installed in 2019 ⁸. The fence is not 100% effective in preventing wild boar passage, but the intention is to reduce the influx of wild-boar rather than completely stop all incoming wild boar. A previous study confirmed that very few animals were present in the country (Jordt et al., 2016), and the authorities have carried out a hunting campaign after the installation of the fence to reduce the population to a minimum.

C. Sweden

Governance

In complement to regulatory frameworks from EU and on international level, Sweden controls ASF through the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and regulations from SBA on notifiable animal diseases and infectious agents (SJVFS 2012:24 with amendments). The legislation states that epizootic diseases, such as ASF, are notifiable upon clinical suspicion. Official and private veterinarians, veterinary laboratories, animal keepers, and other relevant stakeholders are obliged to notify SBA upon suspicion of ASF. Suspicions are investigated after consultation with disease experts at SVA and following notification to SBA, and sampling and analysis carried out in accordance with diagnostic manuals of the European Commission on ASF (2003/422/EC). If suspected or confirmed, disease control measures will be applied to prevent further spread of ASF (SVA, 2020^b).

The Swedish regulation SJVFS 2021:13 mentioned above, about registration, approval, traceability, movements, imports and exports with regards to animal health, also applies to pigs. Holdings with pigs (or captive wild boar) must be registered to SBA. Pigs should be tagged within 9 months from birth and movements of pigs or captive wild boar need to be reported (not individually) within seven days from the movement, with some exceptions, to SBA. Pig owners are also required to keep records on animals at the facility, movements, dead animals and cause of death, and medical treatments and responsible veterinarian (SBA, 2022^c).

Surveillance and Data-sharing

Premises and movement data: Data on registered pig holdings and pig movements are reported by farmers and registered and administered at SBA in the databases “PLATS” (as for cattle) and the central database of pig, sheep and goat movements.

As for CDB, the central database of pig, sheep and goat movements could be used for tracing, control and administration of cross compliance and in research or other projects. This data is also transferred and stored at SVA and shared with other companies or organisations within the agricultural sector.

Surveillance of pigs and wild boar: There is currently no active surveillance of ASF in Sweden, only for CSF. However, clinical (passive) surveillance is carried out for ASF. As ASF and CSF are notifiable upon clinical suspicion, cases with clinical signs are investigated and notified to SBA. The

⁷ <https://fauna.au.dk/jagt-og-vildtforvaltning/vildtudbytte/udbyttet-online-siden-1941/soejlediagram> --> Vildsvin

⁸ <https://naturstyrelsen.dk/naturbeskyttelse/naturprojekter/vildsvinehegn/>

investigation could include examination of the presence of clinical signs in the herd, sampling of sick or dead animals, and analyses of production results. Collected samples are analysed both for CSF and ASF. In cases where an epizootic disease is not primarily suspected, samples can still be submitted for laboratory investigation if the clinical investigation cannot exclude an epizootic disease. But only after discussions with experts at SVA and in consultation with SBA (SVA, 2020^b).

Since 2013 an enhanced passive surveillance programme for ASF in wild boar has been in place where the Swedish public are encouraged to report all findings of dead wild boar. It is also possible to report suspected sick or hurt wild boar. These reports are stored at a database at SVA. The person finding a dead wild boar could also voluntarily submit the whole carcass or samples from it to SVA for post-mortem examination. All submitted samples are analysed for the presence of ASF virus genome with PCR. If the person who made the report is not willing to send in a sample, SBA could send a veterinarian to gather a sample or the carcass (SVA, 2020^b).

The Swedish Food Agency carries out inspections at abattoirs, both of live animals before slaughter and of carcasses during and after slaughter. The animals should not show signs of disease with significance for human or animal health, and if there is a suspicion of a severe contagious disease measures are taken to prevent spread. The carcasses are inspected and the veterinarian conducting the inspection assesses if there are signs of disease or if the meat is edible (Swedish Food Agency, 2021). If ASF is suspected, it is notifiable.

There is a voluntary biosecurity programme for pigs (“Smittsäkrad besättning gris”), approved by SBA and administered by Farm & Animal Health. The goal of the programme is to increase the biosecurity in Swedish pig farms to prevent outbreaks and disease spread. When joining the programme, a veterinarian will carry out a farm visit and inspect and discuss the biosecurity with the farmer. The programme consists of requirements and rules that the farmers need to fulfil. Measures must be taken when purchasing and selling animals, when handling carcasses, when receiving visitors, in the storage of feed, and more. The connected farms do not only improve the general biosecurity but can also get higher economical compensation in case of a *Salmonella* outbreak (Farm & Animal Health, n.d.^a).

Other data sources: The Animal health database (Vet@data/DAWA) administered by SBA might not be the main data source in the surveillance of ASF but could provide relevant information to understand the health situation on farms.

The database SVALA (containing laboratory data) at SVA is also relevant for ASF surveillance in the case of sampling and testing of suspicious cases.

There is no national database with pig production parameters, such as number of births, fertility, or other reproduction performance parameters. However, there is a software from Farm & Animal Health called WinPig (also used internationally under the name PigVision). Farmers can for a fee get access to this software where they report and store production parameters, and they can then use it for following up their production through provided dashboards and reports. The farmers can share their data with other parts voluntarily (Farm & Animal Health n.d.^b). Data on production parameters is especially useful for syndromic surveillance.

The Swedish Association for Hunting administers a database used for monitoring data on wild animals. Hunters can report different parameters, for example carcass weight, sex and age of the wild boar, observations of wild boar (dead or alive), and number of shot wild boar. This data is public and could be used to get information about number of shot wild boar in different regions and biological parameters of the observed or shot animals (Swedish Association for Hunting, n.d.).

Other data sources could also be relevant regarding ASF, e.g., for disease spread models or simulations. In Sweden there is open data on road networks (with data on fences for wildlife, service areas and more) from the Swedish Transport Administration, meteorological data from the Swedish

Meteorological and Hydrological Institute, data on traffic accidents with wild animals from the National Wildlife Accident Council, and terrain maps and farm locations from the Swedish Mapping, Cadastral and Land Registration Authority.

Table 5 - Existing data sources of relevance for surveillance and modelling of ASF in Sweden.

Data description	Data producer	Data owner	Data user	Purpose of the data
Central register of holdings (PLATS)	Farmers	SBA	SBA, SVA, Växa Sverige,	Fulfil requirements to keep records of holdings
Central database of animal movements (pig, sheep, goat)	Farmers	SBA	Farm & Animal Health, Other companies	Mainly for the ability to do tracing of a contagious disease
Animal health database (Vet@data/DAWA)	Veterinarians	SBA	SBA, SVA, Växa Sverige, Researchers Veterinarians, County administrative boards, Animal owners	Monitor the animal health situation in Sweden and use it as a basis for preventive measures
Laboratory data of analysed samples (SVALA)	Laboratory staff	The submitter of the sample	SVA, Customer	To record and manage laboratory data for all samples analysed at the laboratory
Pig production data (WinPig)	Farmers	Farmers / Farm & Animal Health	Farmers, Veterinarians, Possibly others	For the farmers to follow up their own production
Reports of dead / sick / hurt wild boar	Public, Hunters	SVA	SVA, Public, Others	To sample suspicious reported cases for further analysis
Data on hunted wild boars	Hunters	Swedish Association for Hunting	Hunters, Public, Researchers, Others	For monitoring and management of wildlife
Data on traffic accidents with wild boar	Swedish Transport Administration	National Wildlife Accident Council	Public, Researchers, Others	Understanding and prevention of wildlife accidents, and more.
Road networks (and other data related to roads)	Swedish Transport Administration		Public, Researchers, Others	E.g., infrastructure planning.
Terrain maps	The Swedish Mapping, Cadastral and Land Registration Authority		Public, Researchers, Others	For climate change adaption, a functioning real estate market, sustainable urban development, and more.

Data description	Data producer	Data owner	Data user	Purpose of the data
Meteorological data	The Swedish Meteorological and Hydrological Institute		Public, Researchers, Others	Forecasts, analyses of historical data, and more.

Discussion

In this report, we have identified and compared the major stakeholders, legislative frameworks and data (sources and sinks) in three countries (UK, Denmark and Sweden) across three case studies of health, environment and economic importance: AMR, salmonella and ASF.

The information collected leads to an emphasis in this report primarily on data acquisition, aggregation, and useage, with limited emphasis on coordinated data management, sharing or return value to the data provider or beneficiary. The work in this report highlighted a number of key challenges:

- All 3 countries have transposed European legislation to address the monitoring, surveillance and in some instances, control and eradication of the 3 disease priorities.
- Between countries, there are significant differences with respect to coordination and use of these disease-related data, particularly with respect to notifiable transboundary diseases (top-down (policy) response) versus endemic zoonotic and foodborne diseases (bottom-up (industry) response). This has implications for the FAIRness of data collected for surveillance purposes.
- All 3 countries have relatively large livestock sectors with a major emphasis on rearing pigs and cattle, and each currently have the same status in terms of presence of salmonella and freedom from ASF. However, there are differences in the management of salmonella, as well as the occurrence of wild boar, which can be expected to play a role during a future outbreak of ASF.
- Data collected may not necessarily be for the purposes for which it is used in these systems (e.g., antimicrobial use and sales data) which limits epidemiological interpretations.
- Data quality in all three countries may be variable and dependent on who is inputting the data (and resource/incentives associated with this work), and how the data is transferred or shared.
- Integration of different data types varies between countries. For example, in Denmark, antimicrobial data are integrated with spatial information on farm location, allowing for better understanding of epidemiological linkages in space and time.
- Openness of different data types varies dramatically between countries. For example, herd-level data on *Salmonella* Dublin status, animal movements, and antimicrobial usage is freely available to any individual in Denmark that chooses to download the data from a public website, whereas access to this information in the UK and Sweden is severely restricted.
- Legislative barriers are likely to be a key inhibitor for data sharing, particularly across public and private organisational boundaries.
- The responsibility for data collection for endemic diseases falls mainly to sector specific industry organisations. These data may not necessarily be findable, interoperable or accessible.
 - Most data which are going to be used in the case-studies within this project are not publicly available. Digitalising/automating the processes / data flows require adapted solutions depending on the data access route and the level of confidentiality
 - Nordforsk Digivet partners (such as SVA and UCPH) have access to some of the non-public data sources which offers opportunities to use the data in models and monitoring

tools which may be shareable with stakeholders and the public (when data is aggregated or processed so it's no longer confidential)

- There appears to be limited information on benefits or return value of data to stakeholders. This is an area which will be explored further in subsequent work packages within the Digivet project.

Next Steps

The information in this report has been used to identify stakeholders for a series of participatory workshops to explore:

- Opportunities and challenges in the digital data lifecycle to support the livestock sector and related animal health and welfare services (for endemic, exotic and foodborne disease preparedness and response)
- Attitudes, assumptions and risk perceptions amongst stakeholders, about:
 - Use of digital data in animal health management, for different farm systems.
 - Technical, cultural, social or economic enablers or constraints related to acquisition, aggregation, management, application, use and benefits of digital data for livestock health and welfare.
 - Ethical, legal and regulatory issues which influence public and stakeholder opinion, trust and return value of digital data- including privacy protection and data sharing policies.
 - Critical control points where the data lifecycle can be strengthened to improve surveillance and livestock health and welfare.

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