



Food and Agriculture  
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# TACKLING ANTIMICROBIAL USE AND RESISTANCE IN DAIRY CATTLE LESSONS LEARNED IN SWEDEN





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## FOREWORD


The Food and Agriculture Organization of the United Nations (FAO) is strongly committed to the global fight against the emergence and spread of antimicrobial resistance (AMR). This commitment is described in the FAO action plan on antimicrobial resistance 2016–2020 (FAO, 2016), which supports the global action plan on antimicrobial resistance (WHO, 2015) by underlining the importance of following a “One Health” approach that takes into consideration the connections among human, animal and environmental health. The current FAO action plan will be updated by the end of 2020 with publication of an action plan for 2021–2025, which will introduce overarching strategic objectives for the following years. FAO works closely with the World Health Organization (WHO) and the World Organisation for Animal Health in the Tripartite Alliance, and with other partners such as the United Nations Environment Programme and academic institutions.

The FAO action plan on AMR 2016–2020 focuses on four areas:

1. improving awareness of AMR and related threats;
2. developing capacity for surveillance and monitoring of AMR and antimicrobial use in food and agriculture;
3. strengthening governance related to AMR and antimicrobial use in food and agriculture; and
4. promoting good practices in food and agricultural systems and the prudent use of antimicrobials.

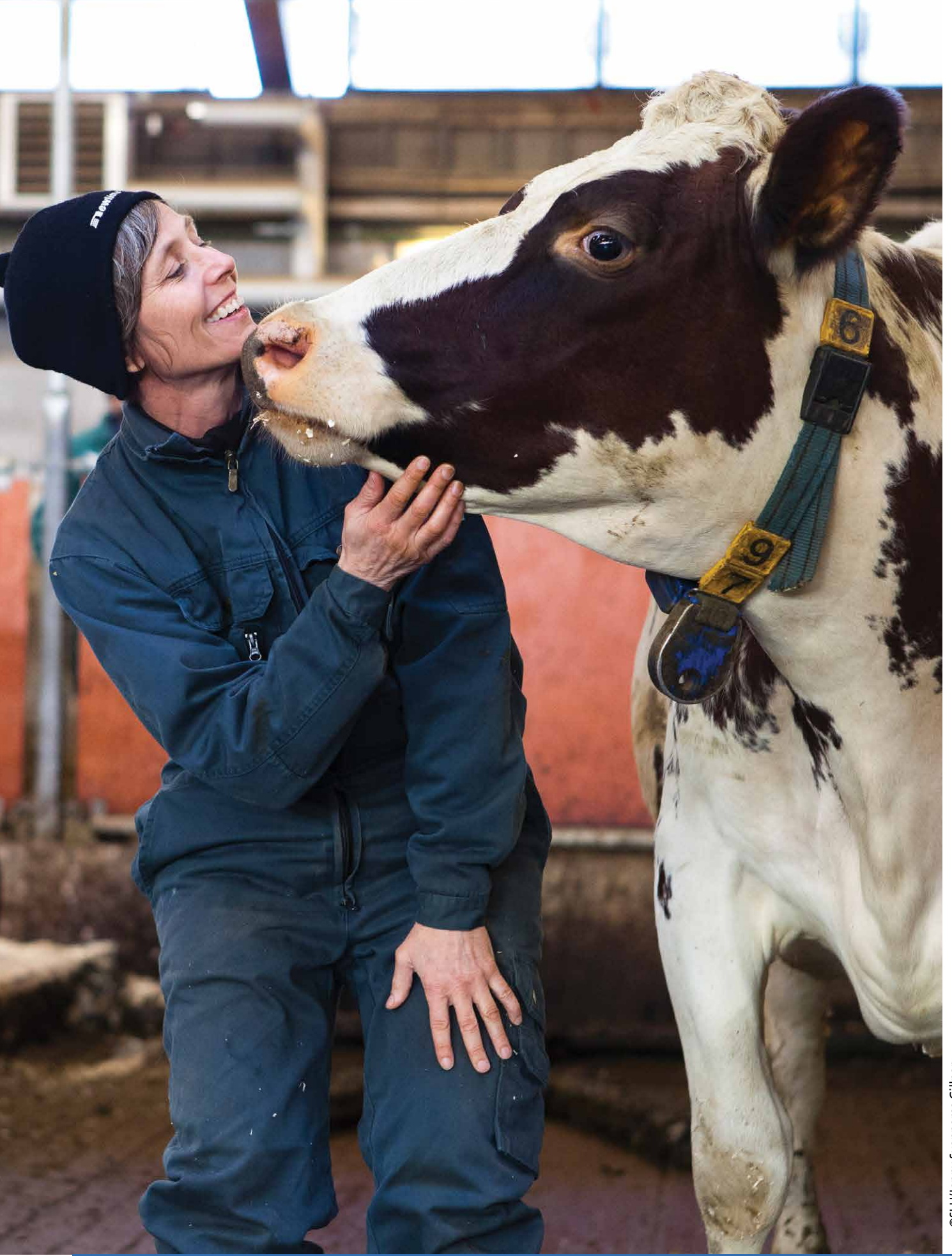
For decades, Sweden has made concerted efforts to ensure the responsible use of antibiotics. This publication provides an overview of how Sweden has worked continuously on preventing diseases and thereby reducing the need for antibiotics in the dairy sector. The report covers best practices and lessons learned in all four focus areas of the FAO action plan.

Meeting the challenges of AMR involves learning from one another. In this spirit, FAO fully supports the present publication as a source of valuable lessons with the potential for adaptation to other contexts and settings. Through the exchange and translation into action of these and similar ideas, FAO hopes that producers, legislators and other key stakeholders may find new and improved ways of reducing the emergence and spread of AMR in order to protect animal, human and environmental health and food production. FAO thanks its partners in Sweden for sharing their valuable knowledge and experience.



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# PREFACE

Antimicrobial resistance (AMR) is a major global threat of increasing concern for human, animal and environmental health. It also has implications for food safety and food security and the economic well-being of millions of farming households. Antimicrobial agents include any substance of natural, semi-synthetic or synthetic origin that, at *in vivo* concentrations, kills or inhibits the growth of microorganisms by interacting with a specific target (Codex Alimentarius Commission, 2011). While all forms of resistance to such agents are important, resistance to antibiotics plays a particularly important role as bacterial infections are common in both animals and humans, especially in low- and middle-income countries with limited sanitary conditions. The main focus of this report is antibiotic use and antibiotic resistance in dairy cattle.

Legislation on the prevention of infectious diseases in animals has a long history in Sweden, reaching back to the eighteenth century, when the focus was initially on combatting rinderpest as a way of contributing to food security. Today other factors such as public health, economic consequences and animal welfare affect decisions regarding the fight against infectious diseases when state funds are involved. In 1986, a general ban on antibiotics for growth-promoting purposes in livestock came into force in Sweden. Although growth promoters have never been used on a large scale in dairy production, the ban led to activities and investments aimed at preventing infections more effectively throughout the livestock sector, including through the use of improved housing facilities, breeding practices and nutrition.

Sweden also has a long history of producing safe food and investing in healthy environments for sustainable production. In 2017, the Swedish Parliament adopted a long-term national food strategy (Government Offices of Sweden, 2016) aimed at supporting Sweden's role as a competitive food-producing nation on a global market and ensuring that food supply chains are fully sustainable. Swedish food production adheres to high standards regarding the environment, climate, overall health, animal welfare, food quality and food safety. Antibiotic use in all food-producing animals is low, at only 13 mg/kg population correction unit (PCU) in 2018, and the incidence of systematic treatment with antibiotics per 100 cow-years declined by 50 percent between 2001 and 2017, while the productivity of Swedish dairy cows is among the highest in Europe.

Sweden, like its neighbouring countries, has a good animal health situation, which is a result of long-term work and cooperation between the state and the livestock industry. A key element in achieving sustainable change in Sweden has been the bottom-up approach that is followed. Mandatory measures or new legislation related to AMR generally result from voluntary commitments and thorough discussions and evaluations among stakeholders, which ensures feasibility, thereby increasing compliance.

Tackling AMR is also a top priority for the Swedish government, which has long been a strong driving force in the international fight against AMR. The first Swedish national action plan was published in 2000 and emphasized the importance of taking a One Health approach. Since then, a long-term government strategy and national action plan (PHAS, 2017) against antibiotic resistance have been developed by the competent agencies and are regularly updated, at four- and two-year intervals respectively. In the latest government strategy of 2020 (Government Offices of Sweden, 2020), greater attention is directed to international efforts, reflecting Sweden's growing ambitions for the rapid development of global mechanisms. Implementation of the action plan is overseen by an intersectoral coordinating mechanism comprising representatives from 25 government agencies and organizations working in human health, animal health, food, the environment, research, development, trade and civil contingency planning (PHAS, 2020a; SBOA, 2020). A joint communication strategy available online in English provides comprehensive and consistent information on implementation of the action plan (PHAS, 2020b).

Another key element of Swedish success in controlling animal diseases and the emergence of AMR is strong collaboration and shared visions among the government, producers and academia, which work towards common goals and are supported by consumers' awareness and commitment. This report shares the success factors and lessons learned in tackling AMR in the Swedish dairy sector, which demonstrate that high productivity is compatible with sustainable production methods and low antibiotic use.

# ABBREVIATIONS

<b>AGP</b>	antibiotic growth promoters
<b>AMR</b>	antimicrobial resistance
<b>EFSA</b>	European Food Safety Authority
<b>EMA</b>	European Medicines Agency
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>ICAR</b>	International Committee for Animal Recording
<b>PCU</b>	population correction unit
<b>PHAS</b>	Public Health Agency of Sweden
<b>SBOA</b>	Swedish Board of Agriculture
<b>SLU</b>	Swedish University of Agricultural Sciences
<b>SVA</b>	National Veterinary Institute
<b>Svarm</b>	Swedish Veterinary Antimicrobial Resistance Monitoring
<b>SVF</b>	Swedish Veterinary Association

# THE KEYS TO SWEDEN'S SUCCESS

**REDUCTION OF THE NEED FOR ANTIBIOTICS** through the use of preventive measures to tackle infectious diseases, with a focus on animal management, welfare and breeding for robust and healthy animals.

**LONG-TERM COOPERATION AND CONSENSUS** among veterinarians, farmers, industry organizations, academia and government authorities, facilitated by appropriate incentives and infrastructure, dedicated government budgets for improving animal health, and trust-building initiatives and sustained management of relationships with stakeholders.

**HIGH AWARENESS OF AND INTEREST IN ANTIMICROBIAL RESISTANCE** among policy-makers, animal health professionals, farmers and consumers through comprehensive, readily available guidelines on antimicrobial use and strategic, targeted communications and advocacy.

**COMPREHENSIVE REGULATORY FRAMEWORKS SUPPORTED BY SOCIAL NORMS** – antimicrobials may only be dispensed by pharmacies on presentation of a veterinary prescription, and veterinarians are not allowed to sell medicinal products.

**AVAILABILITY OF DATABASES ON DISEASE INCIDENCE**, AMR and antimicrobial use for benchmarking, the monitoring of trends and the establishment of goals.





# 1.

## ANTIBIOTIC USE IN THE SWEDISH LIVESTOCK SECTOR: A SUMMARY

Antibiotics can be used at therapeutic doses to cure or alleviate symptoms of disease (therapeutic use) or to prevent disease (preventive use, or prophylaxis). For both purposes, antibiotics can be administered to either individual animals or groups of animals. When antibiotics are given to a group of animals after a clinical diagnosis of disease has been established in parts of that group, the term “metaphylaxis” can be used. The purpose of metaphylaxis is to treat the clinically ill animals in a group while preventing the spread of disease to other animals in that group or in close contact with it. Antibiotics can also be used as growth promoters (antibiotic growth promoters – AGPs) when administered at sub-therapeutic doses. The purpose of such use is to increase growth or yield or to improve feed conversion rates.

Sweden’s experience of livestock management, especially during the twentieth century, has resulted in a holistic approach to animal husbandry practices. Through preventive health strategies – such as eradication of infectious diseases, introduction of hygiene measures and breeding for robustness – and healthy animal environments, including a high level of animal welfare, animals are kept healthy and the need for antibiotics is low.

The use of preventive health strategies is a strong tradition in Swedish veterinary medicine. Systematic efforts to eradicate tuberculosis in cattle began in the 1930s and the eradication of bovine tuberculosis in the 1950s was followed by other efforts to control or eradicate contagious diseases in production animals, including salmonellosis, Aujeszky’s disease in pigs and bovine virus diarrhoea. In the mid-twentieth century, animal production started to undergo a process of intensification and specialization in many high-income countries. In Sweden, although the scaling up of animal production was modest, new management systems were introduced and production diseases soon emerged in these new intensive systems. Preventive strategies became ever-more important and Swedish research into animal production focused on preventing production diseases. In parallel, a preventive animal health care system for the livestock industry was developed and supported by the government. The system involves close collaboration among actors and has been maintained over the years (Carlsson, 2010; SVA, 2011). At the same time, the idea that new technologies should be adapted to the animals concerned,

**SWEDEN’S EXPERIENCE OF LIVESTOCK MANAGEMENT HAS RESULTED IN A HOLISTIC APPROACH TO ANIMAL HUSBANDRY PRACTICES**

rather than the other way round, started to gain attention in Sweden, and since the early 1970s it has been mandatory for all the construction plans for new animal housing to be inspected by the competent authorities to ensure that they comply with animal welfare legislation (Nordéus, 2020).

The discovery of penicillin was highlighted in the journal of the Swedish veterinary association in 1945 (Hülphers, 1945), and penicillin soon became a therapeutic tool for Swedish veterinarians. A few years later, an article in the same journal reported that penicillin had revolutionized the treatment of mastitis, among other diseases (Nilsson, 1948). The author called for efforts to convince Swedish veterinarians to use the new remedy, but also recommended that susceptibility testing be carried out with a view to avoiding unnecessary use of antibiotics. In 1950, a provision of the Royal Veterinary Board made it mandatory for farmers to report the antibiotic treatment of cattle to the dairies processing the animals' milk (Kungliga Veterinärstyrelsen, 1950). The purpose was to limit the occurrence of antibiotic residues in the milk because such residues could adversely affect the milk production process. The provision also instructed veterinarians not to dispense antibiotics without having first carried out a clinical examination, demonstrating that a degree of awareness of and caution regarding resistance were already present. Such awareness is even clearer in the 1979 provisions of the Board of Agriculture, which state that medicinal products for use in animals should be prescribed and dispensed with great restraint and only when needed (Lantbruksstyrelsen, 1979).

At that time, antibiotic medicinal products for veterinary use in Sweden fell within the scope of medicinal products legislation while antibiotic feed additives (for use at low or high doses) were covered by feed legislation. Feed containing low doses of antibiotic feed additives (such as AGPs) could be purchased freely, while feed containing high doses (for therapeutic or preventive use) had to be prescribed by a veterinarian. AGPs were considered to be a technical tool rather than a veterinary one until the late 1970s and early 1980s, when the rules governing AGPs, especially their authorization, were tightened. Some of the government agencies involved expressed concerns about AGPs, but the overall position was that the new rules for their authorization and the removal of some substances from them meant that AGPs could continue to be governed by feed legislation. As a result, AGPs were routinely incorporated into almost all pig and broiler feed and their use increased drastically. In the early 1980s, modern agriculture was heavily criticized in a series of newspaper articles that drew attention to "industrialized" animal keeping with extensive use of "chemicals", or antibiotics, to counteract the negative effects of poor rearing conditions and to make the animals grow faster and more efficiently. The articles specifically mentioned the risk of antibiotic resistance associated with such use. Sweden was not yet a member of the European Common Market and the domestic agricultural market was heavily regulated, with fixed prices for several agricultural products (Nordéus, 2020).





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Cooperative farmer organizations under the umbrella of the Federation of Swedish Farmers (LRF) were the dominant players on the market. In 1981, concerned about losing consumer confidence because of the negative discourse, LRF and its member cooperatives adopted their own policy, which promoted the restricted and controlled use of antibiotics and chemotherapeutics in Swedish animal husbandry. The policy paper stated that only approved substances should be used, in a safe manner and with respect to public health. It called for increased efforts and research in preventive animal health measures from both the livestock industry and the state, and underlined the importance of production environments that ensure good animal health. It should be noted that the primary concern was not the emergence of resistance, but rather that food-producing animals were extensively given antibiotic “chemicals” in their feed. In 1984, the LRF General Assembly voted in favour of requesting the Government of Sweden to ban AGPs, and members of parliament presented parliamentary bills on the issue. At that time, Sweden’s feed legislation was undergoing a lengthy process of revision and the proposed new feed law did not include a ban on AGPs. However, a new feed law that was passed in 1985 stated that antibiotics or chemotherapeutics could be used in animals only to cure, prevent or alleviate the symptoms of disease, which was equivalent to banning AGPs. The legislation entered into force in January 1986, making Sweden the first country in the world to regulate for the withdrawal of AGPs from use in production animals (Cogliani, Goossens and Greko, 2011).



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In the dairy sector, AGPs were used in feed for calves reared for beef production, but at the time of the 1986 legislation, such use was already being questioned owing to its limited effects. The banning of AGPs therefore had little or no effect on the health and production of beef cattle in Sweden (Wierup, 2001). Producers of broiler chickens and weaner pigs were affected more. Broiler producers used low-dosage antibiotics mainly to prevent necrotic enteritis caused by *Clostridium perfringens* and did not initially believe that the ban applied to them. When it became clear that it did affect them, the broiler producers worked with relevant authorities and academia on preparations for the withdrawal of AGPs. In the meantime, it was recommended that veterinarians prescribe the same antibiotics but at higher doses only to flocks at risk of an outbreak of necrotic enteritis. Over the following two years, the routine use of antibiotics ceased and the poultry industry made the necessary changes to poultry housing, feed and management practices with no noticeable effects on animal health or production. The use of ionophore coccidiostats probably played a crucial role in the successful transition through their preventive effect on necrotic enteritis (Nordéus, forthcoming a).

In the pig sector, the adverse effects of the removal of AGPs on piglet health had been significantly underestimated, but other age categories of pigs were not severely affected. The feed without antibiotic additives was unsuitable for piglets because it did not protect against the bacterial overgrowth from *Escherichia coli* that often occurs during a sudden transition from milk to solids.

In addition, many pig sheds were old and unsanitary, increasing further the risk of infectious disease outbreaks. The pig industry was severely hit by animal health problems and failing production, caused mainly by weaning diarrhoea. Improvements in housing, hygiene, feed and management practices slowly reduced the negative trend, especially through measures such as the introduction of all-in, all-out production, the sectioning of pig sheds and the use of zinc oxide to prevent weaning diarrhoea. The pig sector's limited preparedness for the withdrawal of AGPs led initially to an increase in therapeutic use (Figure 4 in Chapter 5) associated with the increased health problems and with the fact that certain AGP substances used for group treatment and recorded as technical products before the ban were now listed as medicinal antibiotics and used at higher doses.

The ban on AGPs and the discussions that followed triggered a process that fundamentally changed Swedish animal husbandry. This process was enhanced by the adoption of a new, far-reaching animal welfare act in 1988 (SFS, 1988). Under the slogan of "healthy animals do not need antibiotics", the focus of Swedish AMR work in the animal sector has since been on improving animal health, rather than reducing the use of antibiotics. Sales of antibiotics for animal use in Sweden have decreased continuously since 1992 and are now the lowest in the European Union (EMA, 2019).

**HEALTHY ANIMALS DO NOT  
NEED ANTIBIOTICS**



# 2.

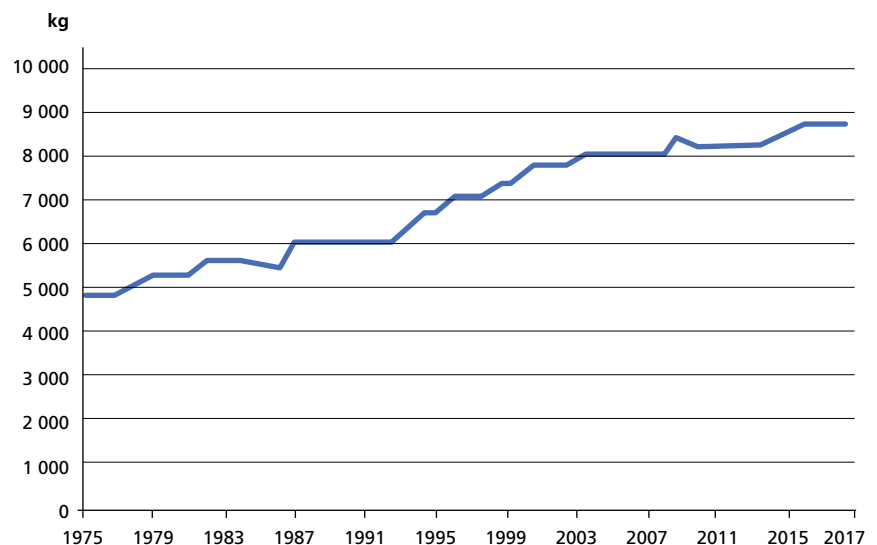
## LARGER HERDS AND INCREASED PRODUCTIVITY

**MILK PRODUCTION PER COW HAS DOUBLED SINCE 1975, PUTTING SWEDEN AMONG THE TOP OF EUROPEAN COUNTRIES FOR DAIRY PRODUCTIVITY**

Major structural changes have taken place in the Swedish dairy sector since the 1970s as family-run dairy farms are gradually replaced by large farms employing external workers. The changes have varied among agro-ecological zones, reflecting increased specialization in farming production. The way in which animals are kept has also changed, from tie-stall housing to loose housing systems, and about a third of farms now use automatic milking systems, which is a very high proportion compared with other countries (Barkema *et al.*, 2015). The main drivers of these changes are economic and social as farmers strive to secure decent incomes and modern working and lifestyle conditions. For example, critical points for many small family farms occur when equipment and facilities are worn out or when the next generation is about to take over the farm and farmers have to decide between making substantial investments to secure profitability or abandoning the farm.

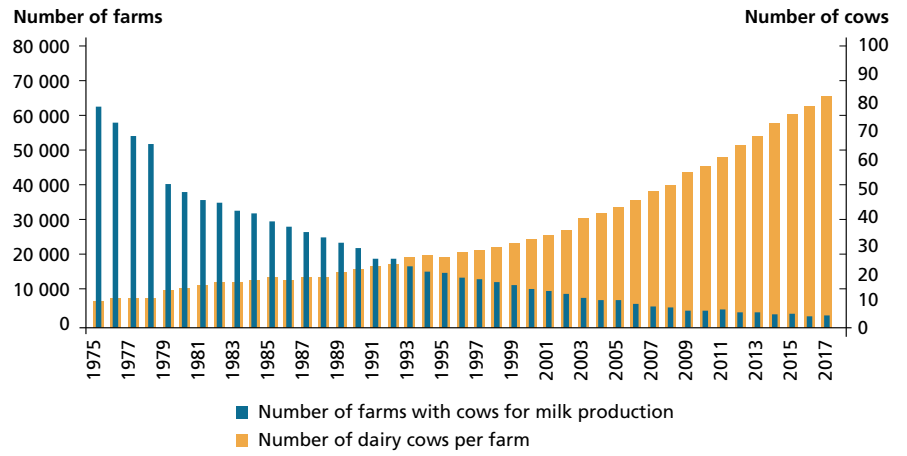
Over the same period, milk production doubled from 4 845 kg per cow in 1975 to 8 900 kg in 2017 (Figure 1), putting Sweden among the top European countries for dairy productivity (European Union, 2019a). The increase is attributable to better feeding regimes, improved health and genetics, and more skilled reproductive and overall farm management.

**FIGURE 1.** Average annual milk production per cow in Sweden, 1975–2017



Source: Swedish Board of Agriculture data.

**FIGURE 2.** Number of dairy farms and average number of cows per farm in Sweden, 1975–2017



Source: Swedish Board of Agriculture data.

The average size of dairy herds has increased tenfold, from nine milking cows in 1975 to 89 in 2017 (Figure 2). In parallel to the increases in herd size and productivity, the number of farms has declined substantially: 95 percent of the farms that existed in 1975 were closed by 2017 (Figure 2).

# 3.

## STRONG COMMITMENT TO GOOD CATTLE HEALTH

**THE ANIMAL HEALTH SITUATION IS FAVOURABLE BECAUSE OF THE LONG-STANDING EFFORTS THROUGH EXTENSIVE LEGISLATIVE WORK AND SIGNIFICANT FINANCIAL COMMITMENTS, COMBINED WITH CLOSE COOPERATION WITH FARMER ORGANIZATIONS**

### LONG-TERM EFFORTS PAY OFF

A key element in reducing the use of antibiotics is to keep animals healthy, thereby diminishing the need for antibiotic treatment. The animal health situation in Sweden is favourable because of the long-standing efforts of the state through extensive legislative work and significant financial commitments, combined with close cooperation with farmer organizations. For example, farmers receive substantial compensation for culled animals and the results of other control measures taken in response to officially listed contagious diseases, which mitigates the risk of farmers failing to notify the authorities of cases of epizootic animal disease. In addition, to protect the health of domestic livestock, very restrictive rules have been imposed on imports of animals and animal products since the 1950s. The results of these efforts are shown in Table 1, which lists the contagious cattle diseases from which Sweden has been declared free.

The development and implementation of animal health control and disease eradication programmes through cooperation between the state and the livestock industry and disease monitoring have been of paramount importance in reaching this favourable situation. Control programmes have been developed further and now comprise active disease surveillance and biosecurity measures such as the requirement that trade be carried out only between herds of the same health status, and the abolition of livestock markets. The maintenance and improvement of animal health continue to be managed through close cooperation between government authorities and the industry.

It is important to note that epizootic diseases are not the only diseases to be subject to control programmes. A control programme for *Salmonella* implemented since the 1950s has led to improved awareness of how to prevent infections throughout the feed and food chain in general.

### A STRUCTURED ANIMAL HEALTH SERVICE FOR THE DAIRY SECTOR

Structured and systematic health and control programmes are crucial for the achievement of good animal health. Through the Swedish Board of Agriculture (SBOA), the Government of Sweden supports several preventive

**TABLE 1.** Current status of infectious cattle diseases in Sweden

DISEASES FROM WHICH SWEDEN IS OFFICIALLY FREE	YEAR IN WHICH FREEDOM WAS DECLARED <sup>a</sup>
Contagious bovine pleuropneumonia	1856
Rabies	1886
Rinderpest	1800's
Brucellosis ( <i>B. abortus</i> )	1957
Foot-and-mouth disease	1966
Bovine genital campylobacteriosis	1976
Bovine tuberculosis	1978
Infectious bovine rhinotracheitis	1995
Bovine spongiform encephalopathy	2006
Bovine leucosis	2007
Bovine viral diarrhoea	2014
Anthrax	2016
<b>Major cattle diseases that have never been recorded in Sweden:</b> Rift valley fever, Vesicular stomatitis, Lumpy skin disease	

<sup>a</sup> Since 1957 declarations of freedom from animal diseases have been issued by the World Organisation for Animal Health.

animal health and welfare, biosecurity and disease eradication programmes, often in cooperation with farmer organizations (Table 2). Several voluntary programmes implemented by the livestock industry cover health issues other than specific infectious agents; for example, there are programmes for addressing diarrhoea and pneumonia in calves and udder health and hoof disorders in cows. A voluntary programme on biosecurity offers risk analyses and advice at three levels: Internet-based education for farmers; self-assessment of on-farm biosecurity; and veterinary assessments of biosecurity routines and hygiene.

Animal health services for livestock in Sweden have changed over recent decades, moving towards more structured preventive extension services, including for the dairy sector, where clinical services for acute diseases have diminished. Veterinarians and other professionals working in extension services are employed by farmer organizations and base their work on ongoing animal health programmes. Veterinarians providing clinical services are either employed by SBOA or operate as private practitioners. Many farms have an assigned herd veterinarian who works in either the extension or the clinical service.

The extension services and farmers collaborate towards the achievement of long-term goals. Herd health status and other aspects are analysed during regular farm visits with the aim of providing herd-specific advice for improved animal health tailored to the production practices and economy of the individual



**TABLE 2.** Major animal health programmes and related activities for dairy cattle farmers in Sweden

PROGRAMME	INSTITUTION/ASSOCIATION CONCERNED	DESCRIPTION	VOLUNTARY OR MANDATORY
Surveillance of Enzootic bovine leucosis	Funded by the government and implemented by the industry	Bulk milk samples from herds are used for surveillance of antibodies to the virus	Mandatory
Surveillance of Infectious Bovine Rhinotracheitis	Funded by the government and implemented by the industry	Bulk milk samples from herds are used for surveillance of antibodies to the virus	Mandatory
Bovine viral diarrhoea eradication programme – for herds not included in the voluntary programme	Funded by the government and from farmers’ fees	Bulk milk samples from herds are used for surveillance of antibodies to the virus	Mandatory
Voluntary disease control program for Bovine Viral Diarrhoea	Funded by the government and from farmers’ fees	Bulk milk samples from herds are used for surveillance of antibodies to the virus	Voluntary
Biosecurity program	Funded by the government and from farmers’ fees	Internet-based education for farmers, self-assessment of on-farm-biosecurity, and herd visits for veterinary assessments of biosecurity routines and hygiene	Voluntary
Disease control programme for paratuberculosis	Funded by the government and from farmers’ fees	Herd testing for paratuberculosis, classification of herds and regulation of the trade of animals	Voluntary
Hoof health	Funded by the government	Subsidies for farmers who comply with a hoof trimming plan	Voluntary
Animal welfare signals	Funded from farmers’ fees	Key indicators of animal welfare from the cow database. Benchmarking against other farms in the cow database for demonstrating developments on individual farms	Voluntary
Health package for dairy cows	Funded by the dairy industry and from farmers’ fees	Veterinary health advisory services based on herd monitoring, biosecurity advice and education for farmers	Voluntary
Safe animal trade program	Funded from farmers’ fees	Regular screening of samples from bulk milk tanks for selected pathogens, with listing of farms whose samples are all negative as being safe to trade with	Voluntary
Beef cattle consultation and calf health services	Funded by the government and from farmers’ fees	Veterinary health advisory services based on herd monitoring, biosecurity advice and education for farmers	Voluntary

farm. Antibiotic use is not regarded as a long-term solution to health problems in herds but is used when needed on a short-term basis. Prior to construction, new buildings for animal housing must be approved by the county administrative board, which ensures the protection of animal welfare and the mitigation of environmental risks, and veterinarians provide advice on biosecurity aspects before construction work commences. Advisory tools for ensuring biosecurity, health and welfare developed as part of animal health programmes include checklists for infection control on farms and are available in many languages (Växa Sverige, 2019a; 2019b).

**MONITORING OF IMPROVEMENTS IN HEALTH AND PRODUCTIVITY IS CRITICAL FOR BENCHMARKING, FOR BOTH INDIVIDUAL FARMERS AND THE OVERALL LIVESTOCK SECTOR**

## **HEALTH AND PRODUCTION RECORDS ARE CRUCIAL**

All veterinary treatments are recorded in an SBOA database to which farmers' extension services have access. These data provide farmers and herd veterinarians with an overview of the incidence of disease and treatment in a herd. National data on health and production inform surveillance, benchmarking, goal setting and follow-up and are summarized in two annual reports on cattle health (Växa Sverige, 2018a) and cattle statistics (Växa Sverige, 2018b). Post-mortem disease registrations following slaughter are another source of data, which are reported from the abattoir to the farmer and can be used in strategic health work on the farm to inform breeding and other decision-making, such as the categorization of animals by udder health, and the design of culling strategies. These data-sharing initiatives provide transparency and help build trust, thereby facilitating stakeholder collaboration.

Other important sources of information on animal health and production are the official milk recording scheme and lineage recording of dairy cows, which are managed by the dairy industry with supervision from SBOA and quality certification from the [International Committee for Animal Recording](#) (ICAR, no date). The database for the milk recording scheme and lineage recording contains records of milk production, calving, culling, insemination, hoof trimming and incidence of disease and covers all the animals on approximately 70 percent of the dairy farms in Sweden, accounting for 70 percent of the country's dairy cows. It is used to inform the development of management tools for farmers, extension workers and veterinarians, and research in feeding, animal health and genetics.

## **BREEDING FOR HEALTHY COWS**

The breeding of healthy animals is a long-standing objective in Swedish dairy production. Swedish animal welfare legislation bans breeding from animals that have inherent deleterious alleles for defects or features that may lead to suffering in the offspring. Breeding organizations have set a higher goal than this by demonstrating that it is possible to manage breeding in ways that ensure healthy and productive cows (Nordic Cattle Genetic Evaluation, 2020); long-term work drawing from data on animal diseases and production has allowed the breeding of cattle with resistance to mastitis, for example. Recently, breeding for improved foot and leg health has also had a positive impact. As healthy animals do not need antibiotics, this breeding strategy has been important in minimizing antibiotic treatment and maintaining a high level of animal welfare, which has in turn reinforced stakeholders' trust in recommended best practices.

**TABLE 3.** Annual culling/mortality rates for calves and heifers, per 100 animals per year, 2009/10 and 2017/18

AGE GROUP	MILK RECORDING YEAR 2009/10	MILK RECORDING YEAR 2017/18
0–24 hours	7.0	5.9
1–60 days	4.4	3.9
2–6 months	2.2	1.7
6–15 months	1.6	1.4

### CONTINUOUSLY IMPROVING COW AND CALF HEALTH

As a result of strong commitments to improving disease prevention and breeding cows that are genetically more robust, the total number of reported cases of veterinary treatment of disease among cows has steadily decreased over the past 15 years. The most common disease complexes are mastitis and diseases of the hoof and leg, for which the incidences of antibiotic treatment per 100 cows per year in 2017/18 were 8.8 for clinical mastitis and 1.5 for hoof and leg-related diseases. These are significant reductions compared with 2012, when the corresponding figures were 13.4 and 1.8.

The health status of calves and young cattle can be reflected in mortality indicators. The proportion of calves and young cattle to be lost to culling or mortality has declined slightly over recent years (Table 3), and the disease syndromes in calves for which antibiotics are most frequently used are pneumonia and diarrhoea.

The Swedish model for improved cow and calf health is based on good animal health and welfare through optimal management, top-quality breeding, strict biosecurity and eradication of infectious diseases. Historically, other preventive measures have been more important than vaccination in controlling diseases. The absence of many infectious diseases reduces the need for vaccines against both the eradicated disease itself and other endemic diseases, which occur less frequently when general animal health improves as a result of the elimination of, for example, bovine viral diarrhoea virus. Today however, the use of many calf vaccines (such as those against respiratory infections and diarrhoea) is becoming more common in Sweden.



# 4.

## REGULATIONS AND VOLUNTARY GUIDELINES ON THE USE OF ANTIBIOTICS

Reductions in the use of antibiotics in Swedish animals are the result of legislation but also stem from long-standing voluntary policy work among veterinarians and farmers whose aim is to preserve the efficiency of antibiotics in treating disease. National legislation restricting the use of antibiotics in animals has been in place for more than 40 years and the related standards and norms provide a strong foundation for the prudent use of antibiotics in general.

When Sweden became a member of the European Union in 1995, it was granted several exemptions from European Union Directive 70/524/EEC concerning the use of additives in feedstuffs, including from the rules on antibiotic feed additives. This allowed Sweden to maintain its ban of AGPs for four years, during which it had to present scientific evidence for the ban or comply with the European Union legislation. In this four-year period intense efforts were made to compile scientific evidence of, and spread knowledge about, the connection between the use of AGPs and the development of resistance to antibiotics used in human and veterinary therapy. These efforts included a two-year enquiry (Government Offices of Sweden, 1997), conferences, bilateral meetings with other European Union Member States and extensive lobbying in relevant sectors. Collaboration among the state, farmers, veterinarians, advisers and academia, and a holistic perception of the connections among preventive health strategies, sound animal environments and low use of antibiotics were central to this process (Nordéus, forthcoming b).

Sweden was not the only Member State advocating a more restrictive approach to AGPs, and many other factors contributed to the eventual success of the process. However, the gradual banning of AGPs throughout the European Union, which started in the late 1990s and ended in a complete ban in 2006, is seen as a great Swedish success within the European Union regulatory framework, not least because Sweden provided the rest of the European Union with a living example of modern and efficient animal production without AGPs. Since then, the country has continued to advocate a more restrictive approach to the use of antibiotics in animals throughout the European Union.

## REGULATIONS ON THE USE OF ANTIMICROBIALS IN SWEDEN

The European Union now has harmonized rules on the marketing and administration of medicines for animals, and Sweden implements European Union rules through national legislation issued by the competent authorities. New European Union regulations on veterinary medicinal products and medicated feed were adopted in 2018 (European Union, 2019b; 2019c) and restrict the use of antibiotics in animals from 2022. For example, the preventive use of antibiotics for groups of animals and via medicated feed will both be banned. Sweden was a driving force in development of the new European Union legislation and championed the banning of routine preventive treatment of groups of animals as an effective way of quickly reducing the quantities of antibiotics used in animal production. In the European Union today, an average of 90 percent of all antibiotics are used to treat groups of animals therapeutically or preventively, and about 10 percent are for individual treatment. In Sweden, these percentages are reversed.

A key element in preventing the unnecessary use of antibiotics in the livestock sector is the requirement that they be dispensed only after a professional examination of the animal and on presentation of a veterinary prescription. Another critical element is the absence of economic incentives for veterinarians to use antimicrobials. In Sweden, since the 1960s, veterinary medicinal products, including antibiotics, can be dispensed only by pharmacies and only on presentation of a veterinary prescription, as regulated by the Medical Product Agency. For acute treatment, however, veterinarians are allowed to provide farmers with antibiotics in specific situations, such as when local pharmacies are closed.

International organizations have recommended that certain antibiotics of critical importance to human medicine are not used in veterinary medicine in order to protect their efficiency (WHO, 2019). An annex to the Swedish national regulation on the use of veterinary medicinal products (SBOA, 2019b) provides a list of antibiotics that are approved for human use but prohibited for use in animals, even when no alternative for the treatment of a current health condition exists. The list was drawn up in 2013, based on risk assessments conducted in cooperation with the public health authorities (Table 4).

The same regulation restricts the use of fluoroquinolones and third- or fourth-generation cephalosporins. Veterinarians may prescribe treatment with drugs containing any of these substances only when microbiological and susceptibility testing show that there is no effective alternative. To reinforce adherence to the regulation, the choice of such substances must be justified in the medical record.

**NATIONAL LEGISLATION STATES THAT VETERINARIANS MUST EXAMINE THE ANIMAL OR GROUP OF ANIMALS BEFORE PRESCRIBING MEDICINES AND MUST CONSIDER THE RISK OF THE EMERGENCE OF RESISTANCE**

**TABLE 4:** Antibiotics that are approved for human use only and prohibited for the treatment of animals

Aztreonam	Etambutol	Mupirocin
Ceftarolin	Imipenem	Rifabutin
Daptomycin	Isoniacid	Rifampicin*
Doripenem	Linezolid	Teicoplanin
Ertapenem	Meropenem	Tigecycline
Vancomycin		

\* The restriction does not apply to the treatment of horses with infection caused by *Rhodococcus equi*.

## OBLIGATION TO REPORT CERTAIN RESISTANT BACTERIA PROMOTES PUBLIC HEALTH

To help monitor the development of certain severe forms of AMR in the livestock sector, several resistant bacteria have been made notifiable. Since 2013, methicillin-resistant *Staphylococcus aureus*, methicillin-resistant *S. pseudintermedius*, other methicillin-resistant coagulase-positive staphylococci and carbapenemase-producing *Enterobacteriaceae* are notifiable infectious agents in animals (SBOA, 2012). A laboratory that suspects the presence of any of these agents must notify the veterinarian who took the sample, SBOA and the local county administrative board. After confirmation a final notification will be issued to SBOA.

The presence of these bacteria in animals may have negative impacts on public health through transmission of the pathogens or their resistance genes to people or human pathogens via food or direct contact. Reporting allows the establishment of direct control measures for preventing such transmission, and legal instruments facilitate such measures.

## RESTRICTED USE OF MEDICINES ALLOWS MORE FOCUS ON PREVENTIVE MEASURES

Under certain conditions, according to an SBOA regulation (SBOA, 2019b), an assigned herd veterinarian is allowed to prescribe medicines for a maximum of eight weeks. This arrangement is an option for the veterinarian, but not a right for the farmer, and requires that the animal health status at the farm is above a certain level and that the farmer is trained to handle the pharmaceuticals concerned. The aim is to simplify the work of dairy farms. The arrangement also enables thorough and regular collaboration between the farmer and the herd veterinarian, who monitors implementation of the arrangement through regular visits to the farm and encourages increased work on disease prevention, which helps to reduce the need for medicines.

Under the arrangement, the farmer can keep the medicines at home and treat certain conditions without having the veterinarian on site. The veterinarian must: i) visit the farmer every eight weeks and make an evaluation of herd management and the health of all animals on the farm; ii) write protocols specifying the conditions that the farmer can treat and the medicines, doses, etc. that can be used; and iii) monitor and document the use of medicines. The veterinarian must also report the conditional use of medicines to SBOA and the country administrative board, and provide annual reports of animal welfare at the farm to the county administrative board.

In dairy production conditional antibiotic use is permitted in only a few, specific cases and following a thorough diagnosis. In adult cows, conditional antibiotic use is permitted when there are symptoms indicating bacterial interdigital dermatitis or acute bacterial mastitis, and for dry cow treatment. In calves, use is permitted when there are symptoms indicating a wider range of conditions: bacterial pneumonia, bacterial enteritis, bacterial navel infection, bacterial infection in a single joint or the oral form of necrobacillosis. The antibiotics permitted for conditional use in dairy farming are limited to narrow-spectrum antibiotics that are less prone to drive the general development of resistance: benzylpenicillin and intramammary preparations with benzylpenicillin or benzylpenicillin plus aminoglycosides.

## **VOLUNTARY GUIDELINES**

The Swedish Veterinary Association (SVF) published its first policy on antibiotic use in 1998 and its members are obliged to follow this policy. Since then, the policy has been updated and specific guidelines for the main domestic animal species (dogs, cats, horses, cattle, pigs, sheep and goats) have been issued. The guidelines are written by veterinary experts who are members of SVF, and are revised regularly. The policy states that infectious diseases are best tackled by preventive measures. When treatment of a sick animal is necessary for the sake of animal welfare, it should be carried out as effectively as possible while minimizing the risk of negative side-effects, including environmental impacts drug residues and the development of resistance. Veterinary use of antibiotics should be carried out carefully and justified; the policy provides a list of the factors that must be taken into account, which include the need for bacteriological diagnosis and a susceptibility test, and consideration of pharmacokinetics and pharmacodynamics, environmental aspects, food safety and economic aspects. The policy regarding food-producing animals, including dairy cows, is available in English on the SVF web-site (SVF, 2017).

The Swedish Dairy Association issued its first policy on drug use in dairy farms in 1995. The policy includes guidelines on antibiotic use, bacteriological examination of mastitis, documentation and restrictions regarding the use of broad-spectrum antibiotics (third-generation cephalosporins and quinolones)



and selective dry cow therapy. Comprehensive guidelines on mastitis treatment have been followed by veterinarians since 1995 and are now well established. The guidelines on the most commonly treated infectious disease in dairy cows, mastitis, have resulted in a substantial reduction in the use of antibiotics through implementation of the following recommendations:

- For mastitis caused by Gram-negative bacteria (*Escherichia coli* and *Klebsiella* being the most common) supportive treatments without antibiotics are usually applied.
- Cows with chronic mastitis are culled.
- Selective dry cow therapy is applied only after careful deliberation by the veterinarian.



# 5.

## MONITORING AND SURVEILLANCE FOR LOW ANTIMICROBIAL RESISTANCE AND ANTIBIOTIC USE IN DAIRY PRODUCTION

**A ONE HEALTH APPROACH IS ESSENTIAL FOR PROTECTING HUMANS FROM RESISTANT ZONOTIC AGENTS AND RESISTANCE GENES AND MAINTAINING EFFICIENT TREATMENT OPTIONS FOR CATTLE**

In Sweden, monitoring and surveillance of AMR and antibiotic use in dairy cattle have been carried out systematically for approximately 20 years. These activities are essential elements of a One Health approach to AMR based on best practices. In turn, a One Health approach is essential for protecting humans from resistant zoonotic agents and resistance genes and maintaining efficient treatment options for cattle. Knowledge of AMR is also important for the formulation of recommendations on the use of antibiotics, while monitoring of antibiotic use is important for benchmarking, the identification of trends in use, and the implementation of suitable control measures.

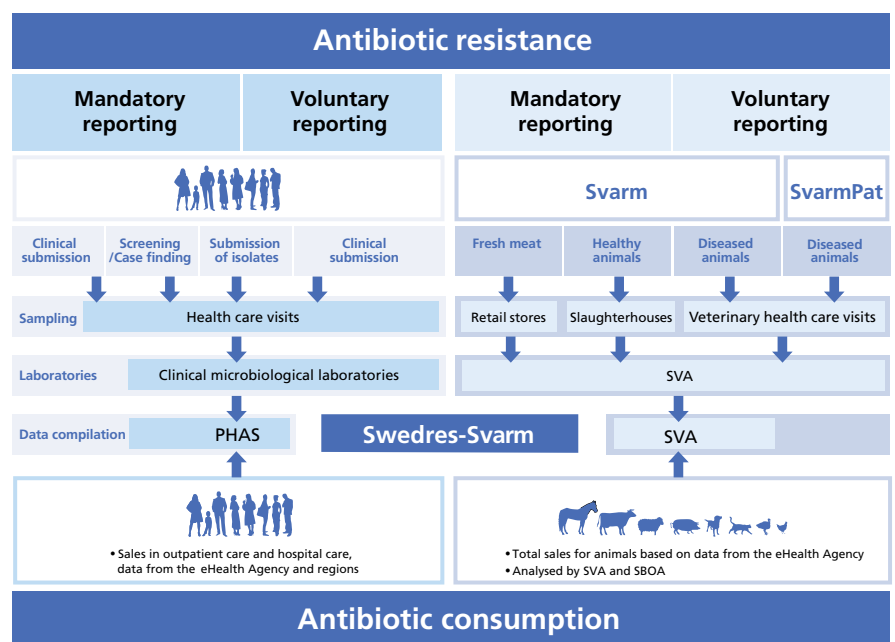
### TWENTY YEARS OF MONITORING AND SURVEILLANCE OF ANTIMICROBIAL RESISTANCE IN LIVESTOCK

The Swedish Veterinary Antimicrobial Resistance Monitoring (Svarm) report on antimicrobial susceptibility in the bacteria of healthy animals and in zoonotic bacteria and animal pathogens was first issued in 2001 (SVA, 2001) and has been published annually since then. Since 2012, animal and human data on AMR have been combined in an integrated report on Swedish Antibiotic Sales and Resistance in Human Medicine (Swedres) and Svarm, providing surveillance reporting in full alignment with the One Health approach. Swedish surveillance therefore preceded the European Union's harmonized surveillance of AMR in zoonotic and commensal bacteria, which was initiated during the 2000s following the Scandinavian model. In the European Union, mandatory surveillance of AMR in cattle, poultry, pigs and their meat applies to *Salmonella* spp., *Campylobacter jejuni*, the indicator bacterium *Escherichia coli*, extended-spectrum beta-lactamases, AmpC or carbapenemase-producing *Salmonella* spp. and *E. coli* (European Food Safety Authority, 2019), but not

non-zoonotic animal pathogenic bacteria. Sweden’s monitoring and surveillance of animal pathogens is therefore performed as part of the diagnostic activities of the National Veterinary Institute (SVA) and through the [SvarmPat](#) programme (SVA, 2005) supported by the government and other partners. Coverage is set each year, depending on the information needed. The combined Swedres-Svarm and SvarmPat programmes are illustrated in Figure 3.

Mandatory surveillance of commensal and zoonotic bacteria protects public health by monitoring the emergence or spread of new resistant strains with the potential for transference to humans through the food chain, such as extended-spectrum beta-lactamases and vancomycin-resistant enterococci, while surveillance of non-zoonotic animal pathogens allows the detection of new resistant strains that threaten animal health, welfare and productivity. In the SvarmPat programme and research projects in cattle, the emphasis is on monitoring and surveillance of respiratory and mastitis pathogens in dairy cows, and resistance is rare in such pathogens. Other focus areas of the SvarmPat programme are the occurrence of resistance in *Escherichia coli* in calves with diarrhoea, navel infections in young calves, or resistance in anaerobic bacteria. Data on causal organisms recovered from bovine mastitis and on the organisms’ resistance are continuously collected and reported in the Swedres-Svarm report and scientific publications. Together, these studies provide a reliable picture of resistance levels in the most important bacteria

**FIGURE 3.** Antibiotic consumption and resistance monitoring and surveillance in Sweden, 2018



Lefthand block applies to resistance in bacteria from humans and antibiotic consumption for humans and righthand block applies to resistance in bacteria from animals and food and antibiotic consumption for animals.

Source: based on Swedres/Svarm, 2018.

in cattle and form the basis for recommendations aimed at the continuous improvement of treatment. For example, Sweden's guidelines on the use of antibiotics in farm animals recommend that benzylpenicillin be used as the first choice of antibiotic in cases of mastitis in ruminants and pneumonia in calves.

A challenge to the continuous surveillance of AMR is the need for regular access to bacterial isolates from laboratory examinations, which may be hampered by the costs of diagnostic and laboratory examination. Diagnostic analyses are costly and for some diseases the number of samples of bacterial isolates presented for laboratory examination has decreased in recent years. Optimized utilization of samples for as many purposes as possible is therefore recommended. One lesson learned is that a dedicated budget together with strong and close collaboration among the dairy industry, academia and veterinary, food and public health authorities are of utmost importance in maintaining a surveillance programme.

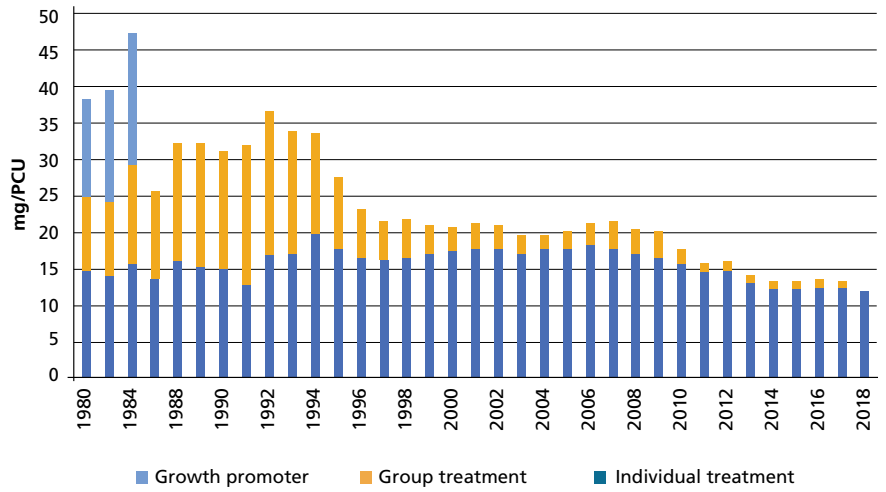
### THIRTY-FIVE YEARS OF MONITORING ANTIMICROBIAL USE

Use of antimicrobials is regarded as the most important driver for AMR, so monitoring of antimicrobial use is therefore important. In Sweden, the use of antimicrobials in animals has been monitored since the 1980s through compilations of data on total amounts of antimicrobials and amounts of specific antimicrobials sold. The government has tasked SBOA with the collection and reporting of annual statistics on drug sales, including antibiotics used for animals (SBOA, 2019c); sales are also reported to the European Surveillance of Veterinary Antimicrobial Consumption project. Sales of antibiotics expressed as milligrams per population correction unit have decreased continuously over time, and most sales are now for individual treatments (Figure 4). In 1986, Sweden became the first country in the world to ban the use of antimicrobial agents for growth promotion, and since 2010 (EMA, 2012) it has had the lowest reported sales of antibiotics for use in food-producing animals in the European Union (Figure 5).

Information on sales of antimicrobials including antibiotics is collected from pharmacies by the national eHealth<sup>1</sup> Agency and analysed by SBOA in cooperation with SVA. In addition to the annual Swedres-Svarm report, Växa, Sverige (Sweden's largest animal health and advisory service) reports on antimicrobial use in dairy cows based on registrations of veterinary treatments reported to SBOA, in combination with recording for the official milk recording scheme. As can be seen in Figure 6, the total incidence of antibiotic treatments of dairy cows (not including for dry cow therapy) was 12.9 per hundred cow years in 2018, representing a decrease of almost 50 percent since 2001. A large proportion (87 percent) of those treatments involved the use of narrow-spectrum benzylpenicillin. Newer generations of cephalosporins were

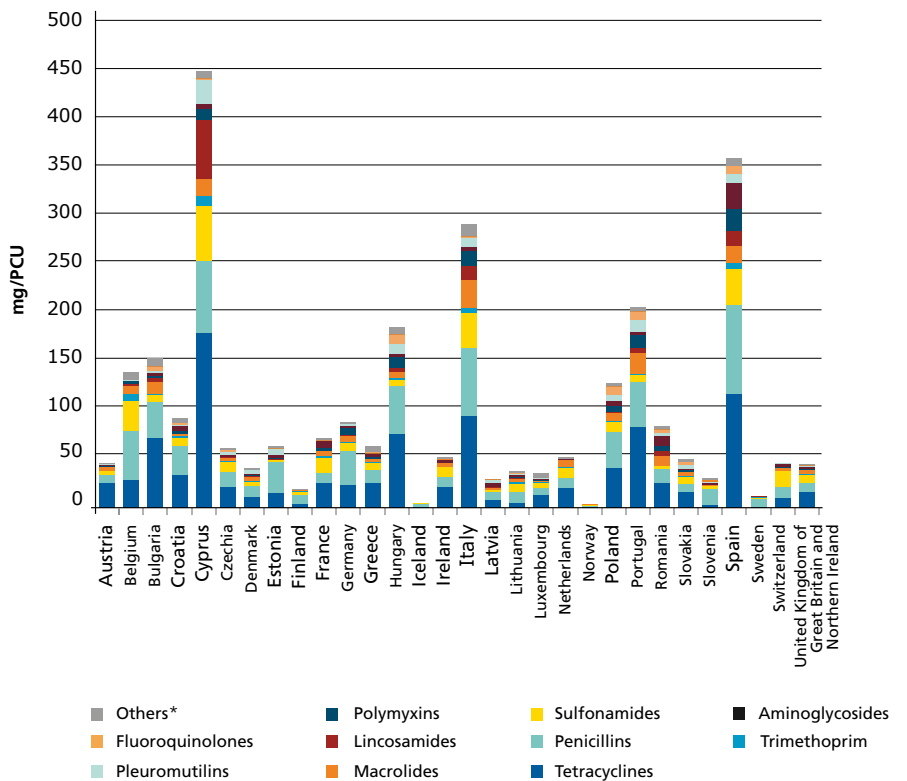
<sup>1</sup> The term "eHealth" refers to the use of digital tools and the exchange of information digitally in order to achieve and maintain health.

**FIGURE 4.** Sales of antibiotics for animals in Sweden



All products, including tablets, are included in the counts.  
Source: Swedres/Svarm, 2018.

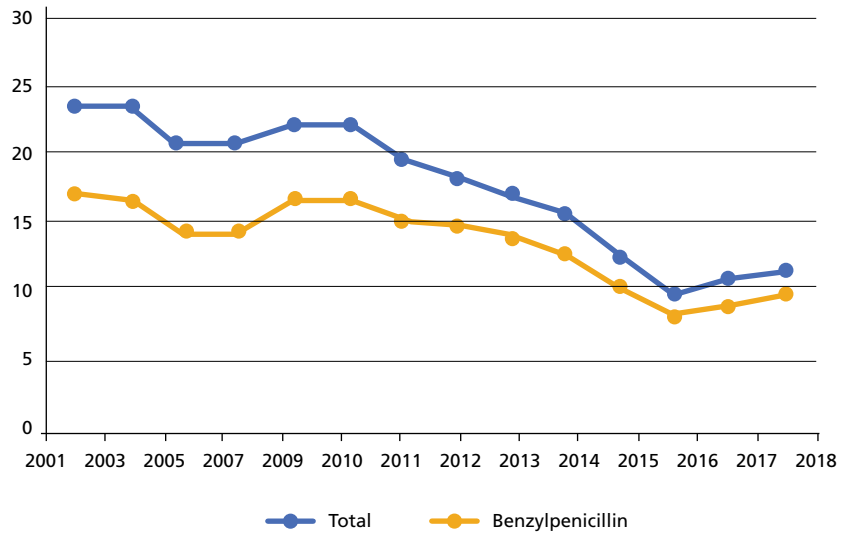
**FIGURE 5.** Sales of veterinary antimicrobial agents for food-producing animal species in selected European countries, in 2017



\* "Others" refers to amphenicols, cephalosporins, other quinolones and other antibacterials (as classified in the ATCvet system).

Source: EMA, 2019.

**FIGURE 6.** Total incidence of antibiotic treatments and treatments using benzylpenicillin in dairy cows in Sweden



Treatments for dry cow therapy are not included.  
 Source: Nyman, 2019.

not used at all, and only 1.1 percent of the treatments involved the use of fluoroquinolones. Most (60 percent) of the antibiotic treatments were for cases of mastitis, of which 91 percent involved benzylpenicillin. Close collaboration and transparency among the dairy industry, academia, and veterinary, food and public health authorities have been of utmost importance in maintaining these monitoring programmes.





# 6.

## COOPERATION: THE KEY TO SWEDISH SUCCESS

The key players in shaping healthy dairy production with low use of antibiotics are dairy farmers and their organizations, veterinary professionals working in practice or research, and the government with its agencies. The cornerstone of this work is close cooperation among and between farmers, veterinarians and the government.

Swedish farmers organized themselves at the national level about 90 years ago, but local dairy cooperatives were already established in several regions during the nineteenth century. This demonstrates how deeply cooperation is embedded in Swedish dairy culture, facilitating the sustained application of best practices. Farmer organizations have traditionally had a large membership among Swedish livestock farmers, making them efficient providers of services and disseminators of new procedures for better animal health and productivity. These benefits have helped maintain the organizations' position as a valued reference point for farmers. For example, farmer organizations have established member-owned enterprises that provide advanced breeding services such as artificial insemination, production and fertility recording, udder health programmes and extension services for better animal nutrition. In these enterprises, practitioners from several professions, such as animal scientists, veterinarians and economists, work together to provide support for dairy farmers.

The dairy sector is a source of several kinds of employment for veterinarians, particularly in government agencies, the farmer-owned enterprises mentioned in the previous paragraph, and – in recent decades – the private service sector. Veterinarians are also employed in academia, institutes and farmers' enterprises, where they are engaged in research and development for optimal animal health, welfare and productivity. Most veterinarians are members of the Swedish Veterinary Association (SVF) and many have used their expertise in various areas to contribute to the development of the national guidelines produced by SVF on topics such as the use of antibiotics in dairy production.

Given that until the late 1980s, for national security reasons, Sweden aimed to be self-sufficient in food and that agriculture has played an important role in the Swedish economy, the government's engagement in livestock health has been substantial. Today, this engagement is related not only to livestock productivity and welfare, but also – and even more closely – to public health, including food safety. As a result, several government agencies specialized

in legislation and policies for the control of animal health, the use of veterinary medicines and food safety also operate animal disease surveillance programmes, monitor and survey antibiotic use and resistance in the livestock sector, and control food safety, including through surveillance of antibiotic residues. Most of these tasks are harmonized with European Union legislation.

Well-organized farmers, a veterinary profession with collegially agreed standards and active academic and government bodies have developed several forms of cooperation for better livestock health and welfare with high productivity and low use of antibiotics. Examples of this cooperation in the dairy sector include shared research and development positions between farmers' enterprises and universities and institutes and the engagement of veterinarians, regardless of the nature of their employment, in establishing treatment guidelines that create a common view of how to use antibiotics in the veterinary profession. Such guidelines are also used in veterinary education, and responsible use of antibiotics has been a central element of the curriculum of veterinary students for the past 50 years, thereby facilitating the development of a common view. National disease control programmes have been established in close consultation among farmer organizations, the scientific community, veterinary practitioners and government bodies, and this participatory approach has fostered joint ownership of guidelines and decisions. The fact that SBOA delegates the implementation of certain programmes to farmers' enterprises demonstrates the strong cooperation between the dairy industry and the government.

There is overall consensus among farmers, veterinarians and policy-makers that emphasis should be put on disease prevention for animal welfare and productivity purposes and for reducing the need for antibiotics.

# 7.

## LESSONS LEARNED AND FUTURE PERSPECTIVES

**THE SWEDISH EXPERIENCE DEMONSTRATES THAT PROBLEMS CAN BE TACKLED WHEN ALL OF SOCIETY WORKS TOGETHER TOWARDS COMMON GOALS**

The challenges posed by AMR cannot be solved by individual countries alone. They require global cooperation, coherent measures and an enabling environment. Progress in tackling AMR is typically greater in high-income than in low-income countries. This is likely attributable to greater awareness and consumer demand in high-income countries and the need to prioritize other needs when resources are scarce in low-income ones. However, there is scope for improvement in all countries. Sweden is actively engaged in global efforts and committed to sharing best practices and lessons learned for advancing this work. The Swedish experience demonstrates that problems can be tackled when all of society works together towards common goals. Change takes time and requires continuous cooperation among producers, distributors, legislators and academia if it is to become lasting. Rules and regulations on antimicrobial use in farm practices need to be supported by investments, incentives, norms and guidance on cost-effective measures that support producers and ensure sustained production. The Swedish model for dealing with AMR in animal farming has been developed through a bottom-up approach that takes into consideration farmers' views and conditions before introducing interventions for limiting the emergence and spread of AMR. Rules and regulations have not been adopted until the measures implemented have been evaluated and considered. Close and mutually beneficial cooperation among farmers, researchers and government authorities is a cornerstone of the Swedish model.

The current situation in Sweden is relatively favourable, with low spread of AMR among livestock and low use of antibiotics. However, as in all countries around the world, globalization may bring new resistant bacteria to Sweden, or climate change may lead to the emergence of new diseases and bacteria that require enhanced treatment. To meet these future challenges, farmers, veterinarians and government authorities must be vigilant and continue to monitor trends and keep up with the development of new production systems that may alter the challenges to animal health. At present, one of the challenges for Swedish animal health organizations is communication with farmers. Extension workers and veterinarians have strong technical expertise, but their communication skills could be improved. For example, farmers with highly specialized large herds and those living in hard-to-reach areas require tailored communications based on scientific and behavioural evidence that

motivates and engages them. A lesson learned is that farmers must know not only “how” but also “why” a recommended practice should be adopted.

Consumer power has recently become increasingly important in influencing production methods and livestock keeping, and encouraging reduced use of antibiotics is a strong and important force in improving livestock production management. However, the efficacy of and access to antimicrobials, including antibiotics to cure diseased animals, must be safeguarded as they are crucial in ensuring animal health and welfare and food safety, food security and economic development.

Health and sustainable food production face serious threats. Global cooperation and support are critical for reducing the emergence of AMR around the world. Sweden is committed to sharing with stakeholders around the world its practical knowledge and experience of how to use antimicrobials responsibly and efficiently. The Government of Sweden is highly committed to supporting international initiatives and the Swedish University of Agricultural Sciences is developing and running several capacity development activities for livestock keepers and other professionals in the livestock sector worldwide (SLU, 2020), including on-line courses, practical manuals and training workshops (SLU, 2019). Meeting the challenge of AMR involves learning from one another.

By sharing the success factors and challenges experienced by Sweden, the authors of this report aim to provide other stakeholders with guidance and inspiration in their search for ways of reducing the emergence and spread of AMR, which threatens animal and human health and the safe production of food.

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This publication describes the long-term efforts of the Swedish dairy sector to keep animals healthy and thereby reduce the need for antibiotics. The Swedish success story rests on strong partnerships among farmer organizations, veterinary services, academia and government agencies and ministries. This document is a tribute to the pioneers and current stakeholders for their sustained work in continuously improving animal health, welfare and productivity, including through the development and implementation of specific health programmes, the recording of production and disease data, the formulation of treatment guidelines and the surveillance and monitoring of antibiotic resistance and use. Key has been a bottom-up approach, allowing farmers' views and conditions to be considered before introducing interventions for limiting the emergence and spread of antibiotic resistance.



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