# 4

# ANTIMICROBIAL CONSUMPTION IN ANIMALS

# 4. Antimicrobial consumption in animals

**Highlights:** The total use of antimicrobials in animals amounted to approximately 97 tonnes of active ingredients in 2019, 3% less than in 2018. This is the lowest amount since 2002. A consistently decreasing trend has been observed since 2013. In 2019, 30 tonnes (-24%) less was used than in 2010.

The pig sector used approximately 75% of all veterinary-prescribed antimicrobials, equal to 72.6 tonnes active compound. Adjusting for changes in production and export of pigs in 2019, an estimated 2.3% of all pigs received antimicrobial treatment per day (23 DAPD), similar to the level in 2018. In weaner pigs, the annual use in 2019 compared to 2018 was reduced from 91 to 89 DAPD. However, in finishers it increased from 17 to 18 DAPD, while it remained similar to 2018 levels for sows and piglets (19 DAPD).

The use of medical zinc decreased by 7%, from 509 to 475 tonnes from 2018 to 2019, and the industry is still preparing for the EU withdrawal in June 2022.

The types of antimicrobials used in pigs has changed notably. The use of tetracyclines in pigs has decreased significantly since 2009, mainly from 2016 to 2019 as a response to the differentiated Yellow Card initiative. Similarly, colistin use was phased out by 2017. During the same period, discernible, but smaller, increases in the use of macrolides and aminoglycosides occurred, especially in weaners.

The overall use of antimicrobials in cattle has fluctuated between 12 and 13 tonnes over the past five years. In 2019, more than two thirds of the amount was used to treat older cattle (>1 year) and 4% of this amount was for intramammary treatment. The antimicrobial use for older cattle has decreased from 3.9 to 3.2 DAPD over the past decade, while the use for younger cattle (<1 year) has increased from 5.2 to 7.3 DAPD.

Antimicrobial use in poultry was relatively low. Since 2015, the antimicrobial use in poultry decreased every year, however, in 2019 the use increased from 1,326 kg to 1,612 kg. The use of antimicrobials in the aquaculture industry decreased from 3,557 kg in 2018 to 2,522 kg in 2019, which probably reflects the relatively cold summer in 2019.

Increased focus on prudent use combined with low occurrence of disease resulted in an observed 40% reduction in antimicrobial use for fur animals in 2018. In 2019, the use was 3,955 kg, which is 36% lower than in 2017, and is equivalent to a treatment proportion in the mink population of approximately 3% (32 DAPD).

Since 2011, there has been an overall decreasing trend in the use of antimicrobials in dogs and cats, with a marked reduction in the use of cephalosporins. However, companion animals still use critically important antimicrobials, and all fluoroquinolones and more than half of the cephalosporins used in animals are prescribed for dogs and cats.

## 4.1 Introduction

The DANMAP programme began monitoring the national use of antimicrobial agents in humans and animals in 1995. Since the early 1990s, there has been both political and public focus on the consumption of antimicrobial agents in the Danish animal production, which resulted in the discontinued use of antimicrobial agents for growth promotion in the years 1995-1999. The focus on antimicrobial use has continued to increase, more recent initiatives include a voluntary ban on the use of cephalosporins in the pig and cattle production as well as regulatory legislation regarding therapeutic use.

Figure 4.1 shows the total use of antimicrobials in animals and humans since 1990 and 1997, respectively. Changes in the patterns of antimicrobial use in animals can be explained in part by an increase in pig production over the years, but risk management measures to reduce consumption have also contributed to these changes. In addition, the increasing export of pigs at 30-40 kg live weight has also affected the overall use of antimicrobials in animals.

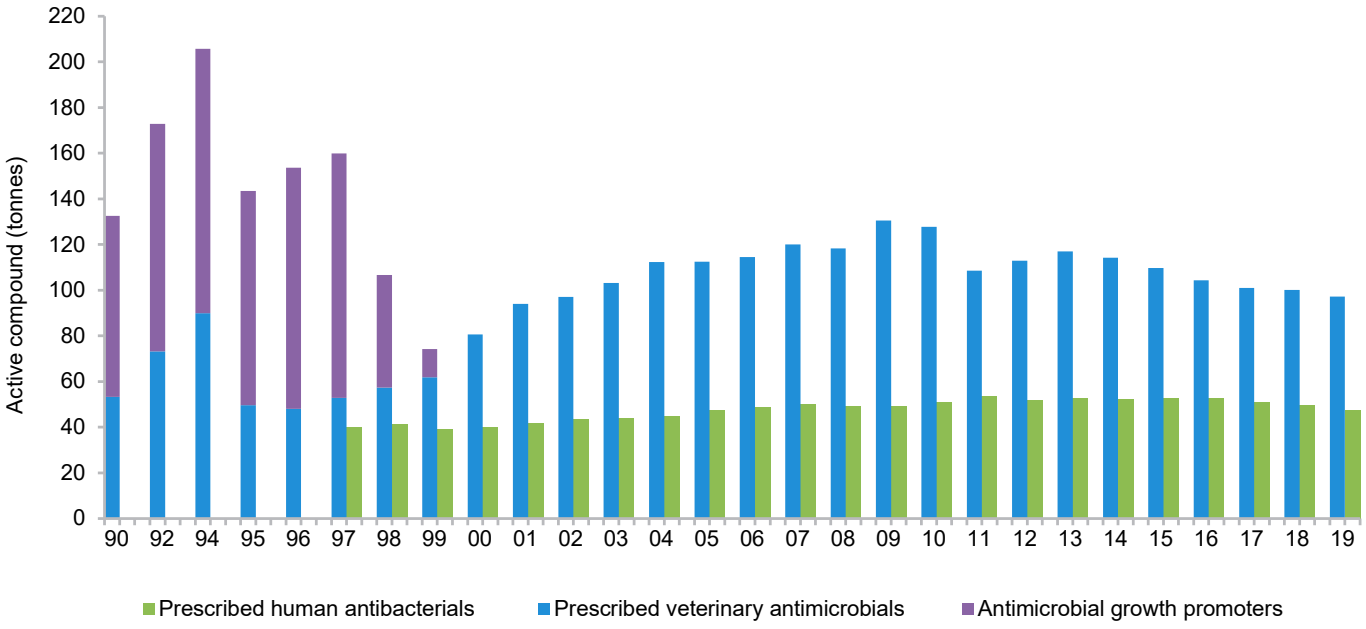
In some periods, the prescription patterns concerning animals were clearly influenced by risk management decisions. For example, the decrease in antimicrobial consumption after 1994 was likely the result of 1) limitation of veterinary practitioners' profit from sales of medicine; 2) implementation of Veterinary Advisory Service contracts (VASCs) with regular visits from the veterinarian in order to promote preventive veterinary strategies and optimize antimicrobial use; and 3) enforcement of the so-called "cascade rule" [Order (DK) 142/1993], limiting the use of (cheaper) extemporaneously produced medicines. To reduce the need for disposal of excess antimicrobials, veterinarians and pharmacies were permitted to split packages of veterinary medicine as from 1 January 2019 [Order (DK) 1655/2018]. This initiative also enhances surveillance by reducing the difference between amounts of antimicrobials prescribed and amounts used.

Other important interventions were the restriction on the use of fluoroquinolones in production animals through legislation implemented in 2002 and 2003, and the voluntary ban on the use of cephalosporins in the pig industry in 2010 followed by a similar initiative in the dairy cattle industry in 2014. From 1 September 2019, the cattle industry implemented a ban on use of 3rd and 4th generation cephalosporins for cattle.

The national action plan against antimicrobial resistance has had several goals throughout time. Initially, a 10% reduction of antimicrobial use in farm animals by 2014 compared to the 2009 level was set as a national target. Furthermore, in 2015 the national action plan to reduce livestock-associated MRSA called for a 15% reduction in antimicrobial use in pigs from 2015 to 2018.

To achieve the action plan goals, the Yellow Card initiative was established in 2010, introducing surveillance at herd level and instating threshold values for antimicrobial use in individual herds to enable legal action on pig farmers with high antimicrobial use per pig [DANMAP 2010]. As a result, a distinct decrease in consumption was observed from 2010 to 2011.

**Figure 4.1 Prescribed antimicrobial agents for humans and all animal species, tonnes of active compound, Denmark** DANMAP 2019




Sources: Human therapeutics: The Danish Medicines Agency. Antimicrobials for animals: Data are based on reports from the pharmaceutical industry of total annual sales (until 2001), from the Federation of Danish pig producers and slaughterhouses (1994-1995), from the Danish Medicines Agency and Danish Plant Directorate (1996–2000), and since 2001 from VetStat. For DANMAP 2019, consumption data were extracted from VetStat on 3 March 2020 and include all antimicrobial agents registered for use in animals

Effects from other parts of the legislation may be less obvious but are also likely to have affected prescription patterns. As an example, the rules for group medication in pig herds were tightened in 2014 [Order (DK) 534 of 27/05/2014], calling for thorough laboratory diagnoses and frequent veterinary visits before and during prescription of antimicrobials for groups of pigs rather than individuals (See Textbox 4.1).

In 2016, the Yellow Card initiative was revised, adding on multiplication factors to adjust the consumption of certain antimicrobials. Fluoroquinolones, cephalosporins and colistin (added in 2017) were given the highest multiplication factor of 10. Tetracyclines were multiplied by 1.2, and the factor was increased to 1.5 in 2017 [DANMAP 2017].

In 2017, the Ministry of Environment and Food in Denmark and the Ministry of Health in Denmark presented a new One Health strategy against antimicrobial resistance, setting the framework for reducing the development and occurrence of antimicrobial resistance (AMR).

At the same time, two national action plans to reduce AMR were introduced, setting specific targets to further reduce the antimicrobial use for both humans and animals in the coming years. As part of the political agreement on the veterinary strategy 2018-2021 (Veterinærforlig III), an Advisory Committee on Veterinary Medicines was established in 2018.

Official treatment guidelines for pigs and cattle have been available since 1996. The guidelines provide specific recommendations for selection of the appropriate antimicrobial treatment of all common problems in the major production animal species. Since 2005, the Danish Veterinary and Food Administration (DVFA) has updated the guidelines in collaboration with stakeholders and university experts. The guidelines were updated in 2010, when new dynamic evidence-based treatment guidelines for pigs were launched [DANMAP 2010, www.fvst.dk], and a revised version was published in April 2018.

In 2012, to promote prudent use of antimicrobials in dogs and cats the Danish Veterinary Association (DVA) published treatment guidelines developed by clinical specialists and experts from the Faculty of Health and Medical Sciences at the University of Copenhagen and the National Food Institute, Technical University of Denmark.

Revised treatment guidelines for dogs and cats were published in 2018. Similarly, DVA published treatment guidelines for use of antimicrobials in horses in 2017.

### 4.1.1 Data sources

In Denmark, antimicrobials are available by prescription only, and data on antimicrobial use have been collected in Denmark since 1990.

Since 2001, data on all medicines prescribed for use in animals, including vaccines, antimicrobial growth promoters (no longer permitted) and coccidiostatic agents (non-prescription) have been recorded in the national database VetStat. Since 2010, the VetStat database is hosted and maintained by DVFA. The 2019 data presented in this report were extracted from VetStat on 3 March 2020 and have been analysed and interpreted for DANMAP by the National Food Institute, Technical University of Denmark.

### 4.1.2 Methods

Metrics of antimicrobial use are numerous, each with its own advantages and limitations. Therefore, the selection of metrics used for monitoring must depend on the monitoring objective and the information available.

The overall amount of antimicrobial agents is measured in kg active compound and is used in section 4.2 for the purpose of an overall crude comparison of antimicrobial use in the veterinary and human sectors (Figure 4.1).

Since 2012, we have further presented "defined animal daily dose" (DADD) and "proportion of population in treatment per day" (DAPD) to monitor trends in antimicrobial consumption. These metrics are defined below, and for additional information on methodology, please refer to chapter 9 and the web annex [www.danmap.org].

**DADD - Defined animal daily dose**

DADD is the average maintenance dose per day for the main indication of a drug in the appropriate animal species. DADD is not defined at product level but for each antimicrobial agent, administration route, and animal species as mg active compound per kg live animal.

DADDs have been defined specifically for use in DANMAP based on current knowledge and may vary from the prescribed daily dose or the recommended dosage in the summaries of product characteristics (SPC) or in the VetStat database.

**DAPD - Proportion of population in treatment per day**

Trends in antimicrobial usage in pigs, cattle, and fur animals are presented in DAPD.

DAPD is equal to DADD per 1,000 animals per day, where "animals" are represented by their live biomass and adjusted for lifespan. The estimated live biomass is expressed as the number of standard animals with an estimated average weight on a given day. This may also be referred to as the "standard animals at risk". This metric allows for comparison of antimicrobial use between species with large differences in body mass and lifespan.

DAPD, is a statistical measure that provides a rough estimate of the proportion of animals treated daily with a particular antimicrobial agent. For example, 10 DAPD means that an estimated 1% of the population, on average, receives a certain treatment on a given day (see section 9.2).

In principle, DAPD as a metric is analogous to DID (defined daily dose per 1,000 inhabitants per day), the metric used to measure antimicrobial consumption in the human sector. Please refer to section 9.8 for a description of DID. In DANMAP 2019, we calculated treatment proportions in pigs, cattle, and fur animals.

**Export**

The large differences in DAPDs between age groups affect the DAPD of the total population, and trends are influenced by changes in population structure. As an example, increased export of live pigs just after weaning could lead to an increase in DAPD in the total pig population since the exported pigs were only in the country when the treatment proportion was highest.

Approximately 45% of the pigs produced in 2019 were exported as live pigs at approximately 30 kg (Table 3.1), in comparison this percentage was approximately 24% in 2010. When estimating DAPD for the total pig production, we account for changes in export of weaners by calculating an adjusted treatment proportion, referred to as DAPDadj, see section 9.2.2.

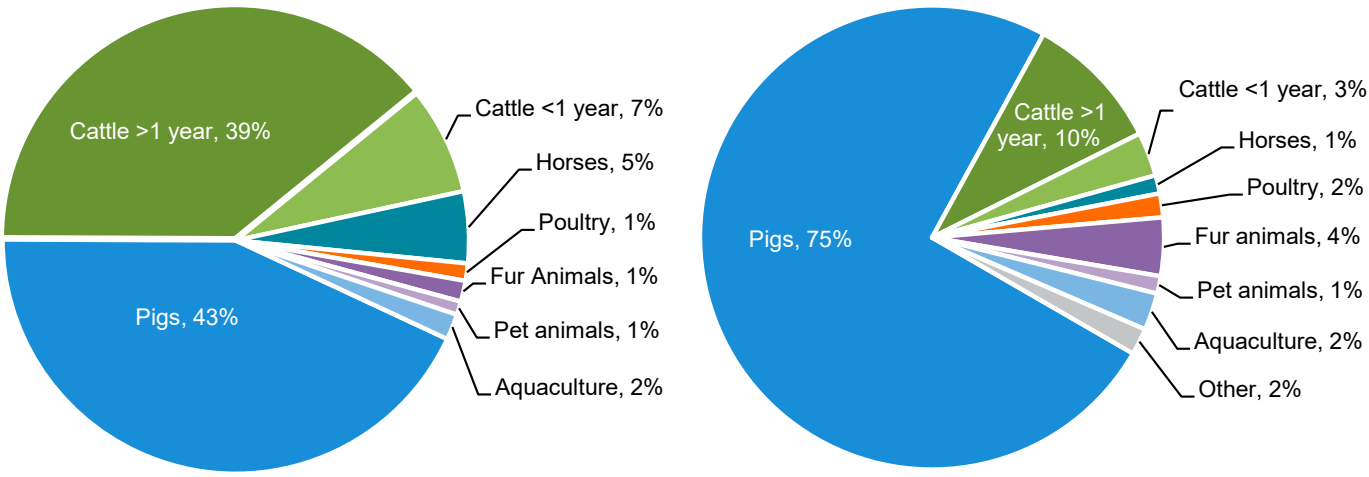
## 4.2 Total antimicrobial consumption in animals

The total use of antimicrobial agents in all animals amounted to 97.3 tonnes active compound, representing a 3% (-2,788 kg) reduction compared to 2018 (Figure 4.1). Similar to 2018, the 2019 antimicrobial use in pigs, cattle, fur animals, and poultry comprised approximately 75%, 13%, 4% and 2%, respectively, of the total antimicrobial consumption in animals (Figure 4.2). The pig industry is the main driver of antimicrobial usage in animals in Denmark, due to the magnitude of the production. Cattle and pigs comprise almost equal proportions of the total live biomass. However, the vast proportion of cattle biomass consists of dairy cows, which have very low consumption of antimicrobial agents compared with growing animals.

Historically, the overall use of kg active compound was 53% lower in 2019 compared to 1994. A major part of this reduction can be explained by the discontinued use of growth promoters from 1994 to 1999.

Between 2000 (start of VetStat) and 2009, the amount of kg active compound used in animals increased by 62% (Figure 4.1). During this period, the number of pigs produced also increased as did the proportion of exported live pigs at approximately 30 kg. Since then, the proportion of exported live pigs has continued to increase, while there has been an overall gradual decrease in the use of antimicrobials in animals. In 2019, the antimicrobial use was approximately 24% lower than in 2010.

**Figure 4.2 Distribution of live biomass and antimicrobial consumption in main animal species, tonnes, Denmark** DANMAP 2019




Note: The live biomass is estimated from census data (pigs, cattle, and pet animals) and production data (poultry, fur animals, and aquaculture). For poultry, the figures comprise only the biomass for the main production types (turkeys and broilers). The live biomass estimates for poultry, aquaculture, horses, and pet animals are based on 2012 data and may be underestimated. The estimation procedures are described in section 9.2

**Table 4.1 Antimicrobial use by animal species and age group, kg active compound, Denmark** DANMAP 2019

| Therapeutic group | Aminoglycosides | Amphenicols | Cephalosporins[a] | Fluoroquinolones | Lincosamides | Macrolides | Other AB | Other quinolones | Penicillins, b-lactamase sensitive | Penicillins, others[b] | Pleuromutilins | Sulfonamides and trim-ethoprim | Tetracyclines | Total 2019 | Total 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pigs* | *8253* | *436* | *<1* | *0* | *1873* | *11874* | *<1* | *0* | *16973* | *8485* | *7203* | *5790* | *11745* | *72632* | *74658* |
| Sows and piglets | 1895 | 283 | 0 | 0 | 434 | 504 | <1 | 0 | 8702 | 3404 | 845 | 4407 | 1087 | 21560 | 22331 |
| Finishers | 161 | 11 | <1 | 0 | 619 | 3322 | 0 | 0 | 6059 | 752 | 3668 | 207 | 2990 | 17790 | 18479 |
| Weaners | 6197 | 142 | <1 | 0 | 820 | 8048 | 0 | 0 | 2211 | 4329 | 2690 | 1177 | 7668 | 33282 | 33848 |
| *Cattle* | *844* | *886* | *88* | *<1* | *15* | *190* | *<1* | *0* | *7097* | *828* | *0* | *808* | *1592* | *12350* | *12865* |
| Intramammaries | 9 | 0 | 81 | 0 | 13 | 0 | <1 | 0 | 163 | 257 | 0 | <1 | 0 | 523 | 534 |
| Cows and bulls | 212 | 12 | 7 | <1 | <1 | 74 | <1 | 0 | 6308 | 447 | 0 | 693 | 854 | 8607 | 9093 |
| Calves <12 months | 590 | 853 | <1 | 0 | 1 | 113 | <1 | 0 | 501 | 116 | 0 | 110 | 699 | 2985 | 2978 |
| Heifers and steers | 32 | 21 | <1 | 0 | <1 | 3 | 0 | 0 | 125 | 9 | 0 | 6 | 39 | 236 | 261 |
| *Poultry* | *55* | *<1* | *0* | *<1* | *28* | *228* | *0* | *0* | *333* | *215* | *<1* | *64* | *689* | *1612* | *1326* |
| All poultry excl. turkeys | 55 | <1 | 0 | <1 | 28 | 228 | 0 | 0 | 333 | 215 | <1 | 64 | 689 | 1612 | 1326 |
| *Other production animals* | *274* | *342* | *<1* | *<1* | *92* | *483* | *<1* | *447* | *14* | *2085* | *<1* | *2308* | *463* | *6510* | *7274* |
| Aquaculture | 0 | 293 | 0 | 0 | 0 | 0 | 0 | 447 | 0 | 39 | 0 | 1721 | 22 | 2522 | 3557 |
| Fur animals | 270 | 50 | 0 | <1 | 91 | 482 | <1 | 0 | 7 | 2039 | 0 | 580 | 436 | 3955 | 3689 |
| Other[c] | 5 | <1 | <1 | <1 | 1 | 1 | <1 | 0 | 7 | 7 | <1 | 7 | 5 | 33 | 28 |
| *Companion animals* | *6* | *<1* | *93* | *14* | *63* | *9* | *38* | *0* | *28* | *662* | *<1* | *1473* | *36* | *2423* | *2418* |
| Pets[d] | 5 | <1 | 93 | 14 | 63 | 9 | 38 | 0 | 20 | 662 | <1 | 246 | 32 | 1183 | 1224 |
| Horses | <1 | <1 | <1 | <1 | 0 | <1 | <1 | 0 | 8 | <1 | 0 | 1227 | 4 | 1240 | 1194 |
| *Unspecified[e]* | *361* | *5* | *3* | *1* | *10* | *36* | *1* | *-6* | *922* | *131* | *4* | *143* | *154* | *1766* | *1541* |
| Total | 9793 | 1671 | 185 | 16 | 2081 | 12820 | 40 | 441 | 25367 | 12406 | 7208 | 10587 | 14679 | 97293 | 100082 |

Note: Data for 2019 were extracted from VetStat on 3 March 2020. Combination products are split into active compounds
a) In 2019, the use of 3rd and 4th generation cephalosporins in cattle, pets, pigs, and horses was 7.5 kg, 1.1 kg, 0.2 kg, and 0.1 kg, respectively
b) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors
c) Mainly sheep and goats
d) Where no animal species are given, antimicrobial agents were allocated to pets based on relevant type of preparation (e.g. tablets, capsules, eye - and eardrops, etc.) or registration (3rd generation cephalosporins and fluoroquinolones only). Approximately 220 kg of the sulfonamides and trimethoprim registered for pets are products (oral paste) typically used for horses. Other AB comprise mainly metronidazole
e) Includes data where the animal species were not registered or where the age group do not apply to the designated animal species

## 4.3 Antimicrobial consumption by animal species

### 4.3.1 Antimicrobial consumption in pigs

The majority of antimicrobials in animals are used in the pig production. The total antimicrobial consumption in pigs was 72.6 tonnes of active compound, which was 2,026 kg less than in 2018, yielding a 3% annual reduction (Table 4.1).

The national MRSA action plan aimed to reduce the antimicrobial use in pigs by 15% in 2018 compared to 2014. In 2018, the overall use in the pig production was reduced by approximately 13% when measured in kg active compound, and in 2019 a 16% reduction was achieved compared to 2014.

**Treatment proportion**

The treatment proportion (DAPD) of the total population reflects the trends in selection pressure within the population. DAPD is much higher in weaners than in finishers and sows. DAPDs in the pig population overall and by age group are presented in Figures 4.3 and 4.4, and DADDs are shown in the web annex (Table A4.1 and in the DADD description). Historically, DAPD increased from 2004 to 2009, followed by a clear decrease in 2010 and 2011 with introduction of the Yellow Card initiative. Since 2013, there has been a gradual decrease in treatment proportion for all age groups (Figure 4.3).

When adjusted for export, the total antimicrobial consumption in pigs was 23 DAPDadj. In 2019, similar to the treatment proportion calculated in 2018 (Figure 4.3). Over a 10 year period, the total antimicrobial use in pigs decreased by 30% (in DAPDadj, Figure 4.3).

While there was a clear reduction in the antimicrobial use in pigs when inspecting crude consumption data (Table 4.1), the changes to the overall treatment proportion are more subtle and vary between age groups and antimicrobial classes. The treatment proportion decreased from 91 to 89 DAPD in weaners, while it remained at almost the same level for sows and piglets and finishers as in 2018 (Figure 4.3, Table A4.1 in the web annex). Thus, on a given day in 2019, approximately 1-2% of sows and piglets and of finisher pigs and approximately 9% of weaner pigs were treated with antimicrobials.

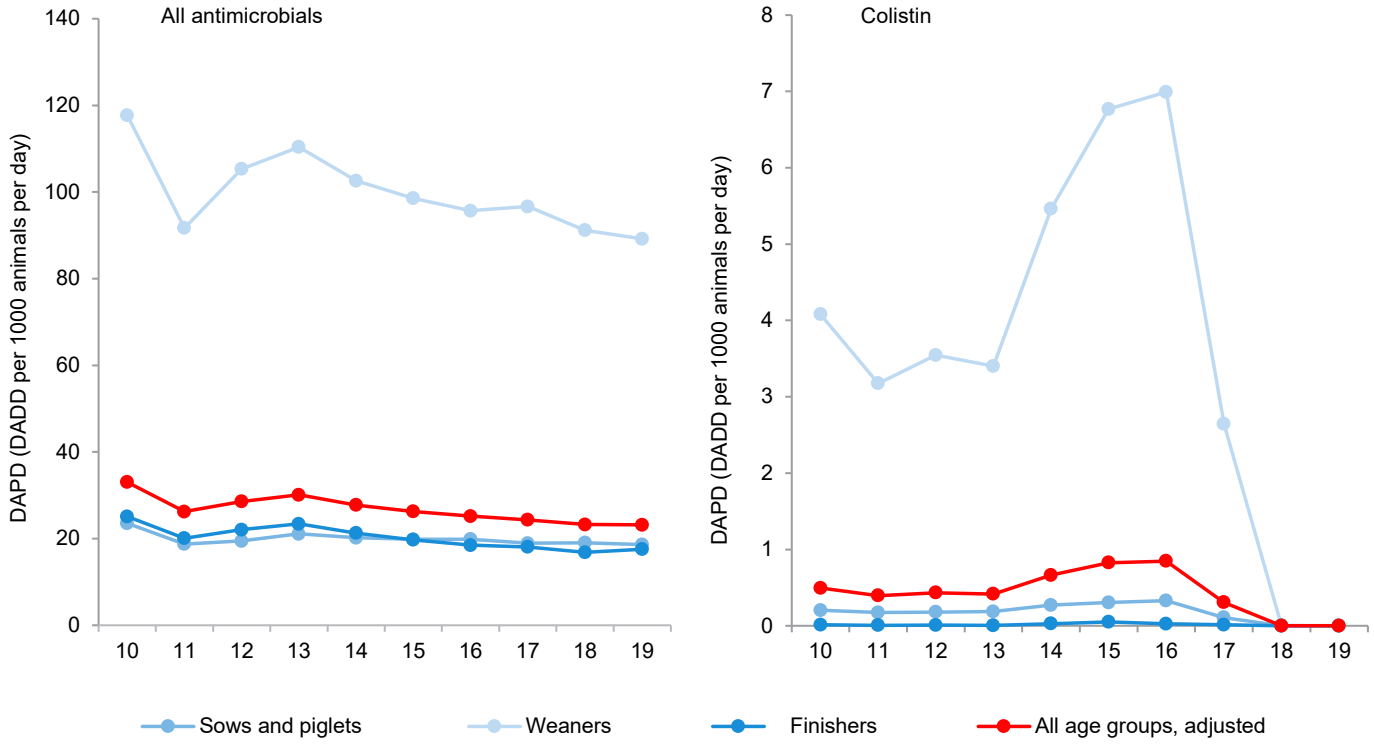
Tetracyclines are some of the most commonly used antimicrobials in the Danish pig production, especially for treatment of gastrointestinal disease in weaners and finishers, and are usually administered orally. The overall use of tetracyclines has decreased since 2013, and in 2019 the treatment proportion was at the lowest level registered in the last 15 years, with the most marked changes following the recent adjustments to the Yellow Card initiative (Figure 4.4). The use of tetracyclines was reduced by 51% from 2015 to 2019 and by 62% since 2010 (in DAPDadj). The proportion of weaners treated with tetracycline on any given day has decreased from approximately 4% (42 DAPD) in 2010 to less than 2% (18 DAPD) in 2019. In contrast, the use of other antimicrobial agents has increased, particularly the use of aminoglycosides (mainly neomycin), macrolides, and beta-lactamase sensitive penicillins (Figures 4.3 and 4.4).

Use of the critically important antimicrobial agents fluoroquinolones and 3rd and 4th generation cephalosporins was close to zero in 2019 (Figure 4.5 and Table 4.1).

**Use of medical zinc in pigs**

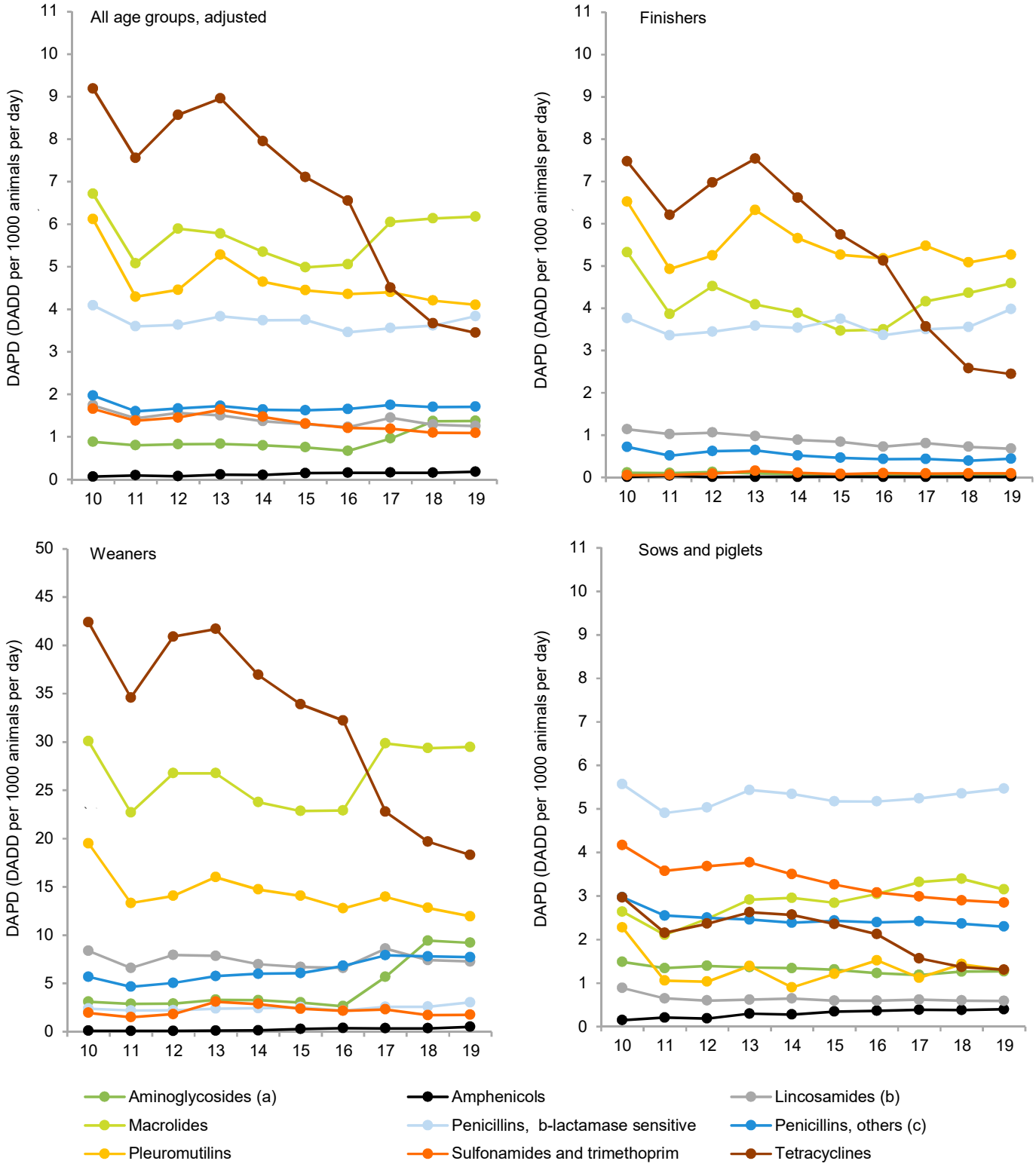
Monitoring the use of medical zink is relevant because its use may select for antimicrobial resistance in some bacteria, including MRSA. Medical zinc in the form of zinc oxide is prescribed to piglets after weaning to prevent or treat diarrhoea. Following a steady increase, the use of zinc oxide for pigs peaked at 548 tonnes in 2015 (Figure 4.6). In 2017, the European Commission announced an EU-wide withdrawal of medical zinc for pigs effective from June 2022. Already in 2016, the Danish pig industry launched an action plan to help the pig producers reduce the use of zinc. This was followed up by an updated action plan in 2018. The use of medical zinc oxide was reduced by 7%, from 509 to 475 tonnes between 2018 and 2019, and has been reduced by 13% since 2015.

**Figure 4.3 Total antimicrobial use and use of colistin in the pig production, DAPD, Denmark** DANMAP 2019




Note: "Sows and piglets" includes treatment in boars. DAPDs are calculated as the number of standard doses for one kg animal divided by the estimated live biomass in the age group of the total population (in tonnes). DAPDs for "all age groups" are adjusted for export of pigs at 30 kg (see text)

**Figure 4.4 Antimicrobial use in the total pig production and in each age group, DAPD, Denmark** DANMAP 2019




Note: Intramammaries, gynaecologicals, and topical drugs are not included (approximately 100 kg in 2019). The age group “sows and piglets” includes treatment in boars, where boars constitute 4-5% of the estimated live biomass for the age group. DAPDs are calculated as the number of standard doses for one kg animal divided by the estimated live biomass in the age group or the total population (in tonnes). DAPDs for "all age groups" are adjusted for export of pigs at 30 kg (see text)
a) Aminoglycosides/benzylpenicillinprocain combinations comprise 60% of this group in 2019
b) Lincosamides/spectinomycin combinations comprise 57% of this group in 2019
c) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly amoxicillin and amoxicillin/clavulanic acid combinations

**Figure 4.5 Use of 3rd and 4th generation cephalosporins in pigs and cattle, kg active compound, Denmark** DANMAP 2019

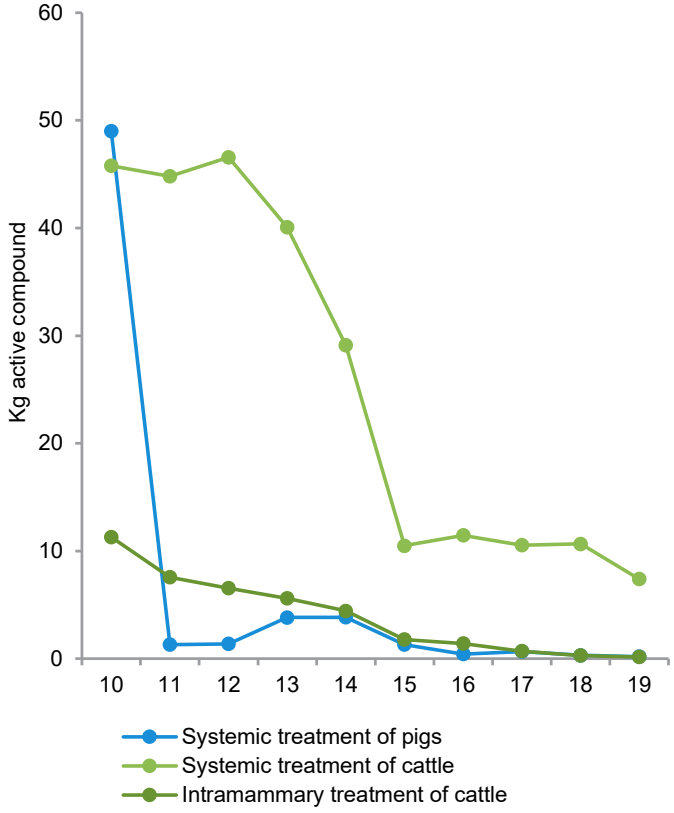
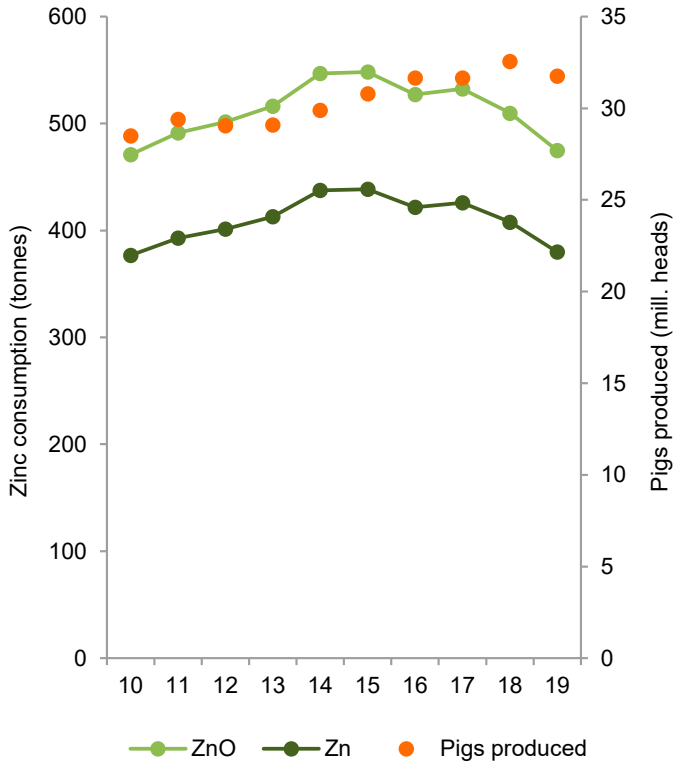



**Figure 4.6 Use of medical zinc oxide (ZnO) and zinc (Zn) in the pig production, tonnes, Denmark** DANMAP 2019




Note: The most commonly used product is zinc oxide (ZnO), which contains 80% zinc and is largely insoluble in water

### 4.3.2 Antimicrobial consumption in cattle

Legislation-supported thresholds for antimicrobial use in cattle have been in place since 2011. The overall consumption of antimicrobials in cattle has fluctuated between 12 and 13 tonnes for the past 5 years. In 2019, approximately 12 tonnes were recorded for use in cattle, approximately 500 kg of which were used for intramammary therapeutic- or dry-cow treatment.

Around 75% of the antimicrobials (kg active compound) used for cattle were used to treat adult cattle (>12 months) (Table 4.1).The production of veal and beef has remained relatively stable over the past 5-10 years, while the production of milk has increased (Table 3.1).

Since 2010, there has been an overall decrease in systemic treatment for adult cattle of 18% measured in DAPD, from 3.9 DAPD in 2010 to 3.2 DAPD in 2019.

The main indication for systemic treatment in adult cattle was mastitis, and beta-lactamase sensitive penicillin accounted for approximately two thirds of the antimicrobials used in this age group followed by tetracycline (17%). The use of macrolides constituted 2% in 2019 (Figures 4.7 and 4.8, Table A4.2 in the web annex).

In contrast, the antimicrobial use in calves and young cattle has increased over the past decade from 5.2 DAPD in 2010 to 7.3 DAPD in 2019, equivalent to an increase of 39%. The main indication for systemic treatment in calves is respiratory disease followed by joint/limb infections and gastrointestinal diseases (Figure A4.2 in the web annex).

In calves and young cattle, treatment (DAPD) with amphenicols (florfenicol) has increased steadily over the past decade, and amphenicols have become the most frequently prescribed antimicrobial class (29%), followed by tetracyclines and macrolides (28% and 18%, respectively).

The use of fluoroquinolones in cattle has been close to zero for the last decade. Fluoroquinolones are only prescribed in food-producing animals as a last-line drug, based on microbiological analysis and susceptibility testing in an accredited laboratory. Use of fluoroquinolones in food-producing animals is also notifiable to the DVFA.

In 2014, the cattle industry began to phase out the use of 3rd and 4th generation cephalosporins used for systemic treatment (orally and parenterally), resulting in a significant drop in 2015, and the annual usage stabilised at approximately 10 kg (Figure 4.5). On 1 September 2019, the cattle industry implemented a ban on use of 3rd and 4th generation cephalosporins in all cattle, and the annual use dropped to approximately 7 kg in 2019, mostly ceftiofur used in cows and bulls.

The board of Danish dairy and beef producers has recently renewed its strategy for good udder health. The goals are a 20% reduction in use of antimicrobials for treatment of mastitis and other cattle diseases as well as a lowering of geometric mean bulk tank cell counts to 150,000 by the year 2020. In addition, the dairy industry will promote use of simple penicillins (beta-lactamase sensitive penicillins) when dry-cow therapy or mastitis treatment is required.

The majority of antimicrobials administered parenterally in cattle are used in dairy cows, primarily to treat mastitis. Further, approximately 500 kg are administered as intramammary treatments, either as therapeutic- or dry-cow treatment. The use of intramammary treatment is shown in Figure 4.8.

The number of treatments per cow has remained stable for the past decade, but the usage pattern has changed. The relative proportion of dry-cow treatment has shifted markedly from 27% in 2012 to 55% in 2019. Dry-cow treatment is only permitted following diagnostic testing, where the presence of bacteria causing mastitis has been confirmed.

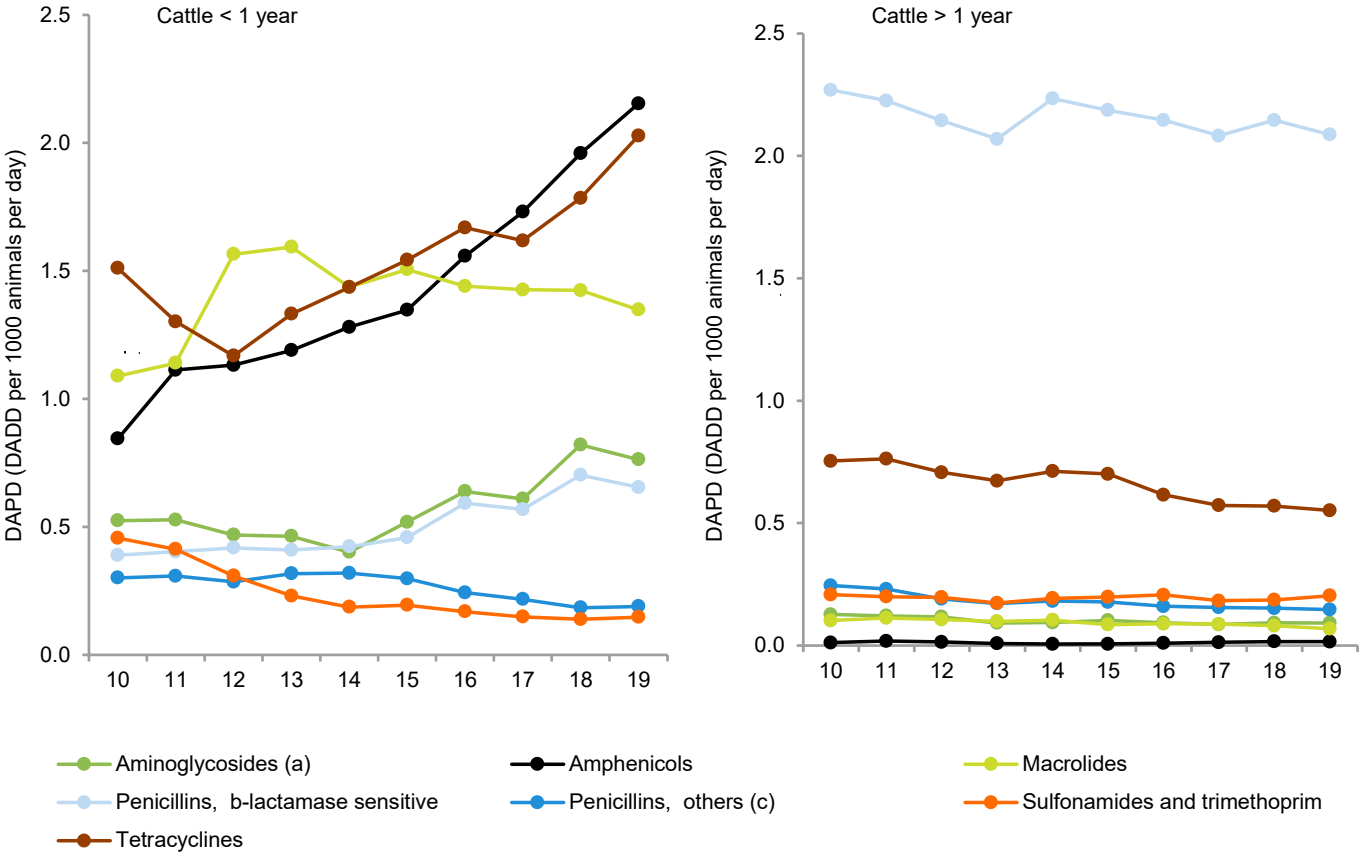
In line with the strategy, the use of beta-lactamase sensitive penicillins increased for dry-cow treatments, whereas use of 1st generation cefalosporins and extended spectrum penicillins decreased from 2012 to 2017.

However, in 2019, there was a remarkable shift in the dry-cow treatments and the use of the beta-lactamase sensitive benzylpenicillin for this purpose almost ceased, while the use of the extended spectrum penicillins, especially cloxacillin, increased. This was due to product shortage, where, the only beta-lactamase sensitive benzylpenicillin product for dry-cow treatment was unavailable for longer periods during 2019, and extended spectrum penicillins, especially product containing cloxacillin, had to be used instead [Personal communication; Michael Farre, Danish Agriculture and Food Council].

Among the therapeutic treatments, beta-lactamase sensitive penicillins (benzylpenicillinprocain) remained the most commonly used antimicrobial.

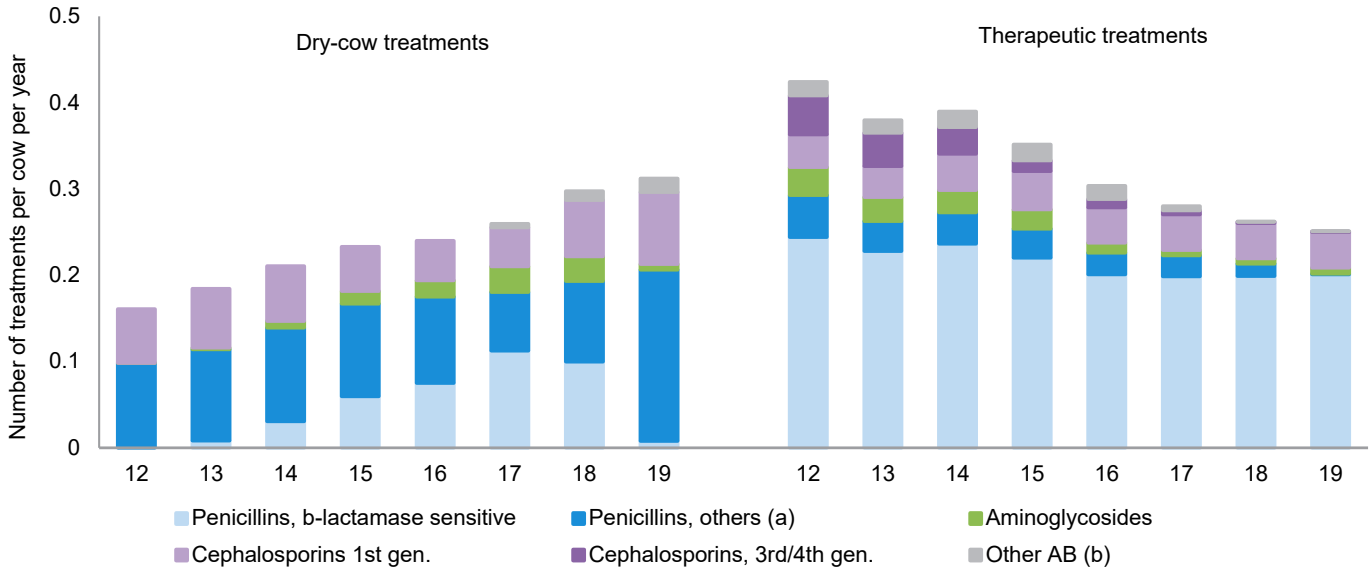
**Figure 4.7 Use of antimicrobial agents in cattle, DAPD, Denmark**

DANMAP 2019




Note: Intramammaries, gynaecologicals and topical drugs not included (approximately 1 tonne in 2019). DAPDs are calculated as the number of standard doses for one kg animal divided by the estimated live biomass in the age group (in tonnes)
a) Aminoglycosides/benzylpenicillinprocain combinations comprise 67% of this group in 2019
b) Lincosamides/spectinomycin combinations comprise 76% of this group in 2019
c) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly amoxicillin and ampicillin

**Figure 4.8 Use of antimicrobial agents for intramammary application in cattle, treatments per cow per year, Denmark** DANMAP 2019




Note: For intramammary treatment, the animal daily doses (ADD) listed in VetStat were used to estimate the number of treatments. For products used for dry-cow treatment, the ADD was primarily 4 tubes (89%), whereas for products used for therapeutic treatments the ADD varied from 1 to 5 tubes, primarily 2 or 3 tubes (86%). Number of cows per year from Statistics Denmark (Table HDYR07)
a) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly cloxacillin
b) Includes lincomycin for dry-cow treatments. For therapeutic treatment, manily sulfonamides/trimethoprim, but also lincomycin and bacitracin

### 4.3.3 Antimicrobial consumption in poultry

The poultry production comprises broiler production, egg layers, and turkey production. In addition, there is a small production of ducks, geese, and game birds. Conventional Danish broiler farms have a very high level of biosecurity, and the antimicrobial consumption in broiler production is generally low compared with other species. Accordingly, disease outbreaks in just a few farms can markedly affect the national statistics on antimicrobial usage in the poultry sector (Table 4.2).

VetStat does not allow easy differentiation of the use of antimicrobials between the different types of poultry production. This year's DANMAP presents the total reported use in all poultry species.

In late 2014 and throughout 2015, several outbreaks increased the total use in broilers. In 2016, use of antimicrobials in poultry decreased again. In 2019, the usage was increased by 22% to 1,612 kg (Table 4.2). Approximately 25% were used in the production of broilers and 50% for turkeys for slaughter [personal communication, Mie Nielsen Blom, Danish Agriculture and Food Council]. Increases were seen mainly for tetracyclines prescribed for respiratory disease and macrolides prescribed for enteritis. For the past decade, cephalosporins have not been used in the poultry industry, and the use of fluoroquinolones has been close to zero. Colistin has not been used since 2016.

**Table 4.2 Use of antimicrobial agents in poultry, kg active compound, Denmark** DANMAP 2019

| Therapeutic group | Aminoglycosides | Amphenicols | Fluoroquinolones | Lincosamides | Macrolides | Other AB | Other quinolones | Penicillins, b-lacta-mase sensitive | Penicillins, others[a] | Pleuromutilins | Sulfonamides and trimethoprim | Tetracyclines | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 258 | 4 | 1 | 129 | 114 | 7 | 0 | 184 | 500 | <1 | 446 | 796 | 2441 |
| 2016 | 60 | 5 | <1 | 24 | 153 | 6 | 0 | 239 | 225 | <1 | 111 | 749 | 1571 |
| 2017 | 65 | 5 | <1 | 32 | 206 | 0 | 1 | 321 | 293 | <1 | 85 | 483 | 1491 |
| 2018 | 51 | 0 | <1 | 26 | 162 | 0 | 0 | 323 | 212 | <1 | 37 | 516 | 1326 |
| 2019 | 55 | <1 | <1 | 28 | 228 | 0 | 0 | 333 | 215 | <1 | 64 | 689 | 1612 |

Note: Data for 2019 were extracted from VetStat on 3 March 2020. VetStat does not differentiate between use in the different sectors of poultry production. Combination drugs are divided into active compounds
a) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly amoxicillin

### 4.3.4 Antimicrobial consumption in aquaculture, fur animals and companion animals

**Aquaculture**

Antimicrobial consumption in aquaculture is mainly driven by the summer temperatures, because bacterial diseases are more likely to occur when temperatures are high. In recent years, the aquaculture industry has developed new and better vaccines and improved vaccination strategies to reduce the risk of diseases that may require antibiotic treatment. The summer of 2019 was not as warm as in 2018, and this was reflected in a 29% decrease in antimicrobial use from 3,557 kg in 2018 to 2,522 kg in 2019 (Table 4.3).

Mainly three compounds are used to treat bacterial infections in aquaculture: sulfonamide/trimethoprim (68%), 1st generation quinolones (18%), and amphenicols (12%) (Table 4.3).

**Fur animals (mink)**

The Danish production of mink has increased over the last decade from 13 million animals in 2004 to 18 million in 2017 (Table 3.1).

During that period the use of antimicrobial agents increased gradually from less than 2 tonnes in 2004 to more than 6 tonnes in 2017. As a response, the industry increased focus on reducing the antimicrobial use and developed an antimicrobial action plan in cooperation with DVFA, DVA, and the veterinary practitioners [Textbox 4.4, DANMAP 2018].

Remarkably, already in 2018 the use was reduced by 40% (from 6,156 kg to 3,689 kg), which was likely a result of the increased focus on reducing antimicrobial usage and a year with fewer disease outbreaks than the previous year.

In 2019, the total use remained at the low end at 3,955 kg, yielding a 7% increase from 2018, but the annual production was reduced from almost 18 million animals to 13 million (Table 3.1). In 2019, the treatment proportion was approximately 3% (32 DAPD) compared to 2% in 2018 (23 DAPD).

The use of tetracyclines, penicillins with extended spectrum, combination penicillins, and macrolides has fluctuated over the past five years (Figure 4.9), and the overall increase in 2019 was equally distributed among these antimicrobial agents. The use of fluoroquinolones and cephalosporins in the fur animal production has been close to zero for more than a decade (Table A4.3 in the web annex).

**Companion animals - horses and pets**

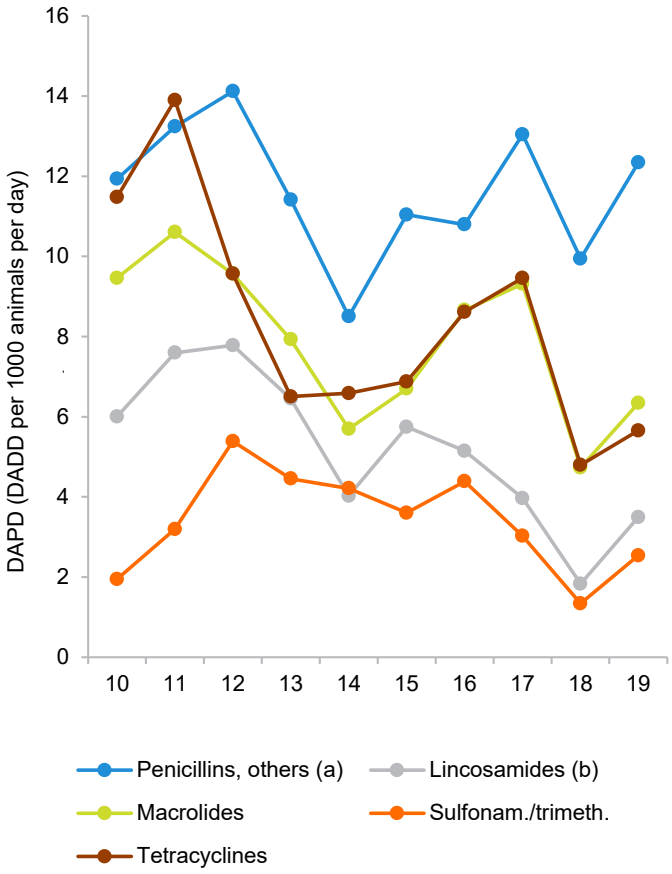
The information available on antimicrobial consumption in companion animals is not as accurate as for production animals, because VetStat allows registration of antimicrobials for companion animals without defining animal species. In DANMAP, the methods used for estimating the consumption for companion animals are described in DANMAP 2016.

**Table 4.3 Use of antimicrobial agents for aquaculture, kg active compound, Denmark** DANMAP 2019

| Therapeutic group | Amphenicols | Other quinolones[a] | Sulfonamides and trimethoprim | Other AB[b] | Total |
|---|---|---|---|---|---|
| 2015 | 311 | 1005 | 1650 | 4 | 2970 |
| 2016 | 315 | 893 | 1086 | 13 | 2307 |
| 2017 | 350 | 637 | 679 | 31 | 1697 |
| 2018 | 323 | 896 | 2293 | 45 | 3557 |
| 2019 | 293 | 447 | 1721 | 61 | 2522 |

Note: Data for 2019 were extracted from VetStat on 3 March 2020
a) Oxolonic acid
b) Other antibiotics include mainly amoxicillin (64%) and tetracyclines (36%)

**Figure 4.9 Use of antimicrobial agents in fur animals, DAPD, Denmark** DANMAP 2019




Note: DAPD is calculated as the number of standard doses for one kg animal divided by the estimated live biomass in the total population (in tonnes)
a) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly amoxicillin/clavulanic acid
b) Lincosamides/spectinomycin combinations comprise 99.9% of this group in 2019

**Table 4.4 Estimated use of antimicrobial agents for horses, kg active compound, Denmark** DANMAP 2019

| Therapeutic group | Sulfonamides and trimethoprim[a] | Penicillins, b-lacta-mase sensitive | Tetracyclines | Aminoglycosides | Other AB | Total |
|---|---|---|---|---|---|---|
| 2015 | 1049 | 10 | 4 | 3 | 1 | 1067 |
| 2016 | 1117 | 8 | 5 | <1 | 1 | 1131 |
| 2017 | 1172 | 9 | 3 | <1 | 0 | 1184 |
| 2018 | 1179 | 10 | 4 | <1 | 1 | 1194 |
| 2019 | 1227 | 8 | 4 | <1 | 1 | 1240 |

Note: Data were extracted from VetStat on 3 March 2020. The estimates include all antimicrobial agents registered by either pharmacies or veterinarians for use in horses. Where no animal species are given, antimicrobial agents were allocated to horses based on relevant type of preparation (e.g. oral paste) or registration. Antimicrobials administered parenterally - with no information on animal species - are not included
a) Sulfonamides and trimethoprim products in the form of oral paste are typically used for horses, however, some of these products have been registered for use in pets over the past years; 220 kg in 2019 and 242 kg in 2018. These data are included in Table 4.5

The total amount of antimicrobials estimated for use in horses was 1,240 kg and 1,183 kg in pets (Tables 4.4 and 4.5). As in previous years, a substantial amount of sulfonamide/trimethoprim registered as used for dogs and cats appears to be products (oral paste) normally administered to horses. Thus, a substantial amount of sulfonamide/trimethoprim included in Table 4.5 is likely to have been used for horses (220 kg in 2019 and 242 kg in 2018).

A large proportion of antimicrobials used for dogs and cats are prescribed for the treatment of chronic or recurrent disease, mainly dermatitis. Due to the close contact between owners and their pets, the repeated use of critically important antimicrobials may pose a risk to the owners, and the use of these antimicrobials is monitored carefully. Since the treatment guidelines by DVA were published in November 2012 (revised in 2018), the use of cephalosporins has been reduced by 66% (from 272 kg in 2012).

The use of fluoroquinolones in pets, mainly dogs and cats, was 14 kg and represented the majority (89%) of fluoroquinolones used in all animals in 2019. Similarly, the pets accounted for half (93 kg, 50%) of all the cephalosporins used in animals (Table 4.5). In 2019, the use of 3rd and 4th generation cephalosporins in pets represented 12% of the total use in animals (1.2 kg of 9.8 kg active compound).

*Birgitte Borck Høg and Helle Korsgaard*
*For further information: Birgitte Borck Høg, bibo@food.dtu.dk*

**Table 4.5 Estimated use of antimicrobial agents for dogs and cats, kg active compound, Denmark** DANMAP 2019

| Therapeutic group | Aminoglycosides | Amphenicols | Cephalosporins[a] | Fluoroquinolones[b] | Lincosamides | Macrolides | Other AB | Other quinolones | Penicillins, b-lacta-mase sensitive | Penicillins, others[c] | Pleuromutilins | Sulfonamides and trimethoprim[d] | Tetracyclines | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 7 | <1 | 157 | 14 | 68 | 5 | 33 | 0 | 25 | 655 | 1 | 235 | 39 | 1240 |
| 2016 | 6 | <1 | 137 | 15 | 69 | 3 | 31 | <1 | 20 | 718 | <1 | 275 | 40 | 1317 |
| 2017 | 6 | 1 | 111 | 14 | 67 | 2 | 31 | 0 | 19 | 718 | <1 | 280 | 38 | 1287 |
| 2018 | 6 | <1 | 97 | 15 | 62 | 2 | 41 | 1 | 20 | 681 | <1 | 261 | 37 | 1224 |
| 2019 | 5 | <1 | 93 | 14 | 63 | 9 | 38 | 0 | 20 | 662 | <1 | 246 | 32 | 1183 |

Note: Data from 2019 were extracted from VetStat on 3 March 2020. Data include all antimicrobial agents registered by either pharmacies or veterinarians for use in pets. Furthermore, where no animal species are given antimicrobial agents were allocated to pets based on relevant type of preparation (e.g. tablets, capsules, eye- and eardrops, etc.) or registration (3rd generation cephalosporins and fluoroquinolones only)
a) Include use of 3rd generation cephalosporin product CONVENIA (1.1 kg in 2019) where no animal species are given
b) Include use of low concentration fluoroquinolones (maximum of 50 mg/g) dispensed parenterally or orally (4.8 kg in 2019) where no animal species are given
c) Penicillins with extended spectrum and combination penicillins, incl. beta-lactamase inhibitors, mainly amoxicillin/clavulanc acid. Include use of tablets (1.1 kg in 2019) where no animal species are given
d) Sulfonamides and trimethoprim products in the form of oral paste are typically used for horses, but some of these products have been registered for use in pets over the past years, 220 kg in 2019 and 242 kg in 2018

## Textbox 4.1

# Campaign to assess compliance regarding group treatment of piglets

**Background:** In 2019, DVFA carried out a "control campaign" to assess compliance with legislative requirements in regard to antimicrobial group treatment of piglets according to the 2014 Danish legislation [Applicable order (DK) 1243 of 26/11/2019]. The definition of group treatment is treatment of two or more pigs with antibiotics in feed or water. The treatment method is widely used, and because of the quantities it is important to safeguard that legislative requirements are met to ensure as prudent use as possible.

The aims of the campaign were to:
- enhance prudent use of group treatment of piglets in Denmark
- evaluate whether the prescribed antibiotics for group treatments were based on diagnostics and susceptibility testing
- reduce the use of antibiotics for group treatment of piglets in Denmark

Compliance with legislation was previously assessed during a campaign in 2015 [DANMAP 2015].

**Methods:** The 2019 campaign especially focused on the written documentation required by farmers and veterinarians. This included whether the veterinarian complied with the rules about sampling and diagnostics, and prepared action plans to reduce group treatment. The farmers compliance to the treatment instructions and the action plan was also evaluated.

The campaign ran from May 1st to December 31st and included visits to 200 herds of piglets and 35 administrative controls of the veterinarians associated to the herds. The herds and veterinarians included in the campaign was distributed among all regions of Denmark.

**Results and conclusion:** The results showed that around one third of the visited herds (36%) and veterinarians (31%) did not comply with the legislative requirements within the focus of the campaign. Farmers were sanctioned mainly due to inadequate records (28%) and for inadequate compliance with the veterinarians' written treatment instructions (13%). Sanctions given to the veterinarians were primarily due to substantive deficiencies in herd diagnosis and/or treatment instructions. Despite the high number of non-compliances, none of them were serious enough to require sanctioning by the police. The campaign also revealed a need to clarify the legal requirements in the rules for the action plans to reduce group treatment. The full report (in Danish) is available at www.FVST.dk.

*Anette Grønkjær Thomsen, DVFA*
*For further information: Anette Grønkjær Thomsen, agxt@fvst.dk*