Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2015

Trends, benchmarking of livestock farms and veterinarians, and a revision of the benchmarking method

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Preface

This is a copy of the report *Usage of Antibiotics in Agricultural Livestock in the Netherlands in* 2015 drawn up by the Netherlands Veterinary Medicines Authority (SDa). With this report, the SDa expert panel provides insight into the usage of antibiotics at Dutch livestock farms for the fifth consecutive year.

Over the past few years, the Dutch livestock sector as a whole has managed to achieve a significant decline in the amounts of antibiotics used. However, reductions are leveling off and the various livestock sectors are becoming more differentiated in terms of their usage levels. For this report, the SDa expert panel decided to take a closer look at how usage levels of the various livestock sectors have changed since 2011. This showed that over the years, in addition to significant reductions in the amounts of antibiotics used, the livestock sectors have also managed to substantially reduce the amount of variation in usage levels between individual livestock farms.

The expert panel does feel further reductions in the amounts of antibiotics used are possible. For this to be achieved, livestock farms currently included in the action zone (red) or signaling zone (orange) are to realize lower usage levels. This does, however, require insight into the factors contributing to the high usage levels of the livestock farms concerned. After all, awareness of critical success factors should make it easier to distinguish between avoidable and unavoidable antibiotic use at these livestock farms. Once this information has been collected and usage variation patterns have been analyzed, the benchmarking method can be reviewed and updated accordingly. This SDa report describes the developments that are taking shape in this respect.

I would like to thank each and every one who contributed to this report.

Utrecht, June 2016

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The SDa promotes transparency regarding the usage of antibiotics in agricultural livestock in the Netherlands. To this end it monitors usage data of the main livestock sectors, assesses sales figures, and benchmarks usage levels of livestock farms as well as prescription patterns of veterinarians.

Developments in usage levels of monitored livestock sectors and developments in sales figures

In 2015, the broiler, pig and cattle farming sectors managed to reduce their usage of antibiotics by 7.4%, 5.0% and 2.2%, respectively, in terms of defined daily doses animal ($DDDA_{NAT}$). Antibiotic use did, however, increase in the turkey farming sector (by 16.9%) and the veal farming sector (by 4.3%). The turkey farming sector failed to make the changes necessary to reduce the amounts of antibiotics used.

The levelling off of the downward trend in recorded antibiotic use continued in 2015, although many livestock farms managed to consolidate their low usage levels. Increases in antibiotic use were observed primarily in livestock sectors with relatively high usage levels and relatively substantial between-farm variation in the amounts of antibiotics used.

The following long-term trends in antibiotic use have been identified for the veal, pig, broiler and dairy cattle farming sectors:

- The veal farming sector achieved a 35% reduction in its usage of antibiotics (in $DDDA_{NAT}$) between 2009 and 2015. When comparing its current usage with the usage data recorded in 2007 – the year that as a result of implemented policies marked the beginning of this sector's downward trend – the veal farming sector managed to achieve a 43.9% reduction in terms of $DDDA_{NAT}$.
- The pig farming sector achieved a 56% reduction in terms of $DDDA_{NAT}$ throughout the 2009-2015 period.
- The broiler farming sector achieved a 60% reduction in terms of $DDDA_{NAT}$ during the 2009-2015 period.
- The dairy cattle farming sector achieved a 46% reduction in terms of $DDDA_{NAT}$ throughout the 2009-2015 period. This is the first SDa report with data on long-term trends in the dairy cattle farming sector.

Between 2014 and 2015, the total number of kilograms of antibiotics sold decreased by 0.65%. According to the number of kilograms of active substances sold, overall usage of antibiotics decreased by 58.4% between 2009 (the government-specified reference year) and 2015.

Developments in usage of the main second- and third-choice antibiotics

Comparison of sector-specific usage data and sales figures shows that third- and fourth-generation cephalosporins were mainly used in sectors not subjected to monitoring. The number of kilograms included in delivery records pertaining to monitored livestock sectors account for just a minor

fraction (5.2%) of the total number of kilograms of third- and fourth-generation cephalosporins sold according to sales figures.
Use of these agents in monitored livestock sectors therefore appears to have been very limited. They were only used in the cattle farming sector, and only in a relatively small number of cases at that: 671 treatments in dairy cattle (intramammary: 584; injected: 87), 1 treatment in beef bulls, and 14 treatments in suckler cows (intramammary: 8; injected: 6). Even though only very small amounts were involved, use of these agents still requires attention.
In 2015, usage of third- and fourth-generation cephalosporins in unmonitored sectors decreased from 14 kg to 11 kg. The companion animal sector was responsible for 11.3% of the overall reduction, and managed to cut its sales of third- and fourth-generation cephalosporins by half in 2015. The other unmonitored sectors were responsible for 83.5% of the total amount of third- and fourth-generation cephalosporins used.

Overall sales of fluoroquinolones decreased between 2014 and 2015. Of the total amount of fluoroquinolones sold, 33.2% concerned the monitored livestock sectors, 2.3% concerned products indicated for use in companion animals, and 64.5% concerned other unmonitored sectors.
Usage of fluoroquinolones in monitored livestock sectors decreased by approximately 26%, from 168 kg to 125 kg.

Most of the livestock sectors managed to further reduce their use of aminoglycosides. An exception was the turkey farming sector, which showed a 78% increase in its usage level. Overall sales of aminoglycosides increased by 44%. Of the total amount of aminoglycosides sold, 45% could be traced back to the monitored livestock sectors, and 1.5% concerned products solely indicated for use in companion animals. This means the remaining 53.5% concerned either the companion animal sector or other unmonitored sectors. Aminoglycoside use in either the companion animals or other unmonitored sectors showed a striking increase, from 242 kg to 666 kg.

Use of polymyxins, including colistin, went up in most livestock sectors. The extent of these increases varied, from 11% in the pig farming sector to over 700% in the turkey farming sector. Only the cattle farming sector recorded a decline in polymyxin use, of 9%. Sales of colistin monotherapy products increased by 145 kg, with monitored livestock sectors accounting for 98% of colistin monotherapies used. Sales of colistin combination products decreased in 2015. This resulted in a slight drop in overall sales of colistin (both monotherapy and combination products) between 2014 and 2015, to 1,604 kg. Over the 2011-2015 period, sales of colistin decreased by 68% (from 4,986 kg to 1,604 kg). The recently identified (plasmid-mediated) type of colistin resistance that can be transferred between bacteria is cause for concern in this respect. In light of these findings, the expert panel feels colistin use has to be reduced.

The amounts of quinolones used decreased significantly in the cattle and pig farming sectors, but did increase in the veal and poultry farming sectors. The sectors not subjected to monitoring also increased their use of quinolones in 2015. As a result, overall sales of quinolones rose by 13% (from 3,379 kg to 3,818 kg). First- and second-generation cephalosporins were used primarily in companion animals. There are no changes to report in this respect. Use of second-choice penicillins (amoxicillin and ampicillin) decreased by 7.8%, from 32,854 kg in 2014 to 30,296 kg in 2015.Usage in monitored livestock sectors accounted for 90%, 3% concerned products solely indicated for use in companion animals, and usage in unmonitored sectors accounted for the remaining 7%.

These findings indicate that it is not entirely clear which unmonitored sectors use antibiotics that are of critical importance for public health. The expert panel still feels that each kilogram sold should be fully accounted for, and that usage of these antibiotics should be reduced even further wherever possible.

Benchmarking of livestock farms and veterinarians

The SDa has defined specific benchmark thresholds for the livestock sectors that are subjected to monitoring. These benchmark thresholds are used to assess whether based on the amounts of antibiotics used, a livestock farm falls within the target zone, the signaling zone, or the action zone. The minor decline in mean antibiotic use that was seen in 2015, was associated with only a small number of livestock farms moving from the action zone to a lower usage level zone. Apparently, the sector-specific improvement measures to be implemented by livestock farms in the action zone no longer result in a further reduction of the amounts of antibiotics used. Movement of livestock farms from the signaling zone to the target zone also seems to be coming to a halt in several livestock sectors, particularly in the poultry and veal farming sectors. In both livestock sectors, the number of livestock farms in the action zone and/or signaling zone have remained virtually unchanged. Additional efforts are required to facilitate further reductions in the amounts of antibiotics used in these livestock sectors. Reduction efforts should be focused on livestock farms with action or signaling zone usage levels. After all, development of antibiotic resistance is particularly at risk at these farms, followed by spread of resistant bacteria.

The SDa expert panel has also calculated the 2015 Veterinary Benchmark Indicators (VBI) for individual veterinarians. Over 70% of veterinarians fell within the target zone based on their prescription patterns. The proportion of veterinarians with a VBI over 0,3 and therefore being included in the action zone, was 1.8%. The expert panel feels it is necessary to find out why these veterinarians had such a high VBI. Approximately 27% of veterinarians were included in the signaling zone based on their prescription patterns. The proportion of veterinarians in the signaling zone varied: 51% for the veal farming sector (142 veterinarians in total); 28% for the pig farming sector (280 veterinarians in total), 27% for the broiler farming sector (85 veterinarians in total), 13% for the turkey farming sector (8 veterinarians in total), and 22% for the cattle farming sector (783 veterinarians in total). Wherever necessary, measures should be taken to quickly bring the prescription patterns of veterinarians included in the action or signaling zone in line with the prescription patterns of veterinarians in the target zone.

Revision of the benchmarking method

In this report, the SDa expert panel proposes changes to the methods used for benchmarking livestock farms and veterinarians. It will further substantiate these changes in the months to come. The expert panel will discuss its revision of the benchmark thresholds with each of the monitored livestock sectors. It expects that for several livestock sectors, this will soon result in new benchmark thresholds. In late 2017/early 2018 at the latest, updated benchmark thresholds should have been defined for each of the monitored livestock sectors. Factors contributing to the amounts of antibiotics used will have to be taken into account in some cases, which means the expert panel will have to identify the critical success factors for the livestock sector concerned before it can redefine the benchmark thresholds. Critical success factor-informed assessment of signaling and action zone farms will help determine which proportion of the antibiotics used represents avoidable antibiotic use. A similar course of action will be taken with regard to veterinarians.

The expert panel still feels that with the current benchmark thresholds for veterinarians, a veterinarian's prescription pattern will not easily be classified as too high. In the course of 2016, it will redefine the cut-off values separating the signaling and action zones in order to bring the benchmarking method for veterinarians more in line with the method used for benchmarking livestock farms.

All sectors except for the dairy cattle farming sector will have to increase their efforts in order to realize target zone usage levels at each individual livestock farm. The expert panel feels the critical success factor-informed approach is the way to go to achieve this objective. It hopes to further substantiate this approach over the course of 2016.

Terms and definitions

Animal years	The cumulative number of days of animals' presence in a particular year, divided by 365. This parameter is used because most agricultural livestock have a life expectancy of less than one year. When referring to usage data for individual animals, sometimes usage levels are expressed in DDDA/animal place over a particular period of time rather than in DDDA/animal year.
$DDDA_{NAT}$	The 'Defined Daily Dose Animal' based on national antibiotic usage data. The $DDDA_{NAT}$ is determined by first calculating the total number of treatable kilograms within a particular livestock sector for a specific year, and then dividing this number by the average number of kilograms of animal present within the livestock sector concerned. This measure is used to determine the amount of antibiotics used within a particular livestock sector, irrespective of the various types of livestock farms within the livestock sector concerned and any differences between these livestock farms. The $DDDA_{NAT}$ is used in other countries as well. It is similar to the parameter DDD per 1,000 patient days used in human medicine when multiplied by 1,000/365. The $DDDA_{NAT}$ is expressed in DDDA/animal year.
$DDDA_F$	The 'Defined Daily Dose Animal' based on the antibiotic usage data of a particular livestock farm. The $DDDA_F$ is determined by first calculating the total number of treatable kilograms at a particular livestock farm for a specific year, and then dividing this number by the average number of kilograms of animal present at the livestock farm concerned. It reflects the amount of antibiotics used at a particular livestock farm, and is used for benchmarking individual livestock farms. This is the measure used by the SDa since 2011 (see the Standard Operating Procedure *Berekening van de DDD/J voor antimicrobiële middelen door de SDa* [SDa method for calculating the DDDA/Y for antimicrobial agents]). The $DDDA_F$ data of all individual livestock farms within a particular livestock sector are used to determine the mean and the median (*unweighted*, i.e. with all livestock farms contributing equally). The *weighted* mean of the $DDDA_F$ (with weighting based on the value of the denominator, i.e. the number of kilograms of animal) is equal to the mean $DDDA_{NAT}$ based on all livestock farms within the livestock sector concerned. The $DDDA_F$ is expressed in DDDA/animal year. In previous publications, this parameter was expressed in ADDD/Y.

EMA	European Medicines Agency
ESVAC	European Surveillance of Veterinary Antimicrobial Consumption
EUROSTAT	EUROSTAT is the statistical office of the European Union. It is situated in Luxembourg. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.
Mass balance	An equation for comparing the reported amount (in kilograms, kg) of an active substance sold with the amount (in kg) of the active substance used according to delivery data reported by veterinarians (delivery records).
RPR	Relative Prescription Ratio. The amount of antibiotics used at a particular livestock farm ($DDDA_F$) divided by the action threshold applicable to the livestock farm concerned.
Treatable kilograms	The number of kilograms of a particular type of livestock that, according to the package leaflet information, can be treated with a single mass unit of the antibiotic concerned.
VBI	Veterinary Benchmark Indicator. A veterinarian's VBI expresses the probability that livestock farms for which the veterinarian concerned is responsible will fall within the action zone for livestock farms based on their usage of antibiotics. A veterinarian's VBI is based on the distribution of his or her RPRs.

Introduction

The SDa has been monitoring usage of antibiotics at Dutch livestock farms since 2011, by assessing the livestock farms based on benchmark thresholds. Specific benchmark thresholds have been defined for the various livestock sectors and types of livestock farms. In the spring of 2014, the SDa also introduced and published a benchmarking method to be used for veterinarians. Data provided by the various livestock sectors enables the SDa to:

- Report on developments in usage of antibiotics in the Dutch livestock sector;
- Define benchmark thresholds and benchmark livestock farms and veterinarians accordingly;
- Compare data on the amounts of antibiotics used with data on the amounts sold.

Once analyzed, the data will also show whether an individual livestock farm's usage level or a veterinarian's prescription pattern has been persistently high or low for several years.

This is the fifth year for which the SDa publishes usage data. The layout of the current report is largely in line with that of the 2013 and 2014 reports. However, certain sections of the current report contain additional information or are structured slightly differently, because certain findings gave rise to new questions that needed answering and new challenges emerged in 2015. This year's report addresses revision of the benchmark thresholds and the appendices now include usage level distributions for each of the livestock sectors. The distributions are discussed in this report.

Furthermore, the classification of antibiotics as either first-, second- or third-choice antibiotics is now used more frequently than in previous reports. This classification is based on the guideline by the WVAB[1], the veterinary working group for antimicrobial policy of the Royal Dutch Society for Veterinary Medicine (KNMvD). The WVAB guideline, in turn, is based on the advisory report *Antibiotics in food animal production and resistant bacteria in humans*, published by the Health Council of the Netherlands in 2011[2]. Both the WVAB and the Health Council[3] reviewed the antimicrobial policy in 2015 and felt the current approach should be continued for the next few years. The following sections provide additional information on the classification of antibiotics, since categories are defined differently depending on the organization concerned, and such differences could lead to confusion among livestock farmers and veterinarians.

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[1] WVAB guideline (in Dutch): *Richtlijn classificatie van veterinaire antimicrobiële middelen*, January 15, 2015 http://wvab.knmvd.nl/media/default.aspx/emma/org/10859751/150210+wvab-richtlijn+3.0+definitief.pdf
[2] https://www.gezondheidsraad.nl/sites/default/files/201116E_Antibiotica_in_food_animal.pdf
[3] https://www.gezondheidsraad.nl/en/publications/preventie/antibiotic-use-in-animals-should-be-reduced-further

Principles of the Dutch policy on veterinary use of antibiotics

Since 2012, the main focus of the Dutch policy on veterinary use of antibiotics is extended-spectrum beta-lactamase-producing (ESBL-producing) enterobacteriaceae, as they are regarded to be the most problematic micro-organisms resistant to first-choice antibiotics or several classes of antibiotics. As a result, the following categories of antibiotics have been defined:

- First-choice antibiotics: ESBL-indifferent antimicrobial agents (i.e. antimicrobial agents not selecting for or specifically targeting ESBL-producing micro-organisms);
- Third-choice antibiotics: antimicrobial agents that are regarded to be of critical importance for human medicine, i.e. fluoroquinolones and third- and fourth-generation cephalosporins;
- Second-choice antibiotics: all antimicrobial agents not meeting the criteria set out above. Administration of these agents may result in selection for resistant pathogens, even in non-pathogenic micro-organisms, which will increase the prevalence of antimicrobial resistance.

WHO and OIE classification of antibiotics

The World Health Organization (WHO) and the World Organisation for Animal Health (OIE) categorize antibiotics as either important, highly important or critically important for human medicine (WHO) or veterinary medicine (OIE). The WHO classification (2011)[4] is based on the following two criteria: 1) the antimicrobial agent is the sole available therapy or one of limited available therapies to treat a serious human disease, and 2) the antimicrobial agent is used to treat diseases caused by either organisms that may be transmitted to humans from non-human sources, or organisms that may acquire resistance genes from non-human sources. An antimicrobial agent meeting both criteria is categorized as critically important. An antimicrobial agent meeting just one criterion is categorized as highly important. All other antimicrobial agents are categorized as important. Additionally, the antimicrobial agents meeting both criteria are prioritized based on the absolute number of people affected by a serious human disease as referred to in criterion 1), and on their frequency of use for any indication in human medicine. Antimicrobial agents meeting criterion 2) are prioritized based on the degree of confidence that there are non-human sources that result in transmission to humans.

[4] World Health Organization 2012. *Critically important antimicrobials for human medicine* – 3rd rev

Consequences of the WHO and OIE classification for the Dutch policy on veterinary use of antibiotics

Based on the criteria set out above, the WHO and OIE classify quinolones and fluoroquinolones, third- and fourth-generation cephalosporins and macrolides as highest priority critically important antimicrobials. This was taken into account when categorizing the antibiotics used in veterinary medicine in the Netherlands. Authorized veterinary prescription drugs containing highest priority critically important antimicrobials other than macrolides and quinolones have been categorized as third-choice antibiotics. Cascade use in veterinary medicine of prescription drugs authorized for use in human medicine is prohibited by law for prescription drugs containing particular critically important antimicrobial agents. With the exception of benzylpenicillin and lincosamides, all critically important antimicrobial agents not classified as being of highest priority, i.e. broad-spectrum penicillins and benzylpenicillins, lincosamides, flumequine, polymyxins (colistin) and aminoglycosides, have been categorized as second-choice antibiotics for veterinary use in the Netherlands, in addition to macrolides and quinolones. The highly important antimicrobial agents first- and second-generation cephalosporins have been categorized as second-choice antibiotics as well. The other highly important antimicrobials, i.e. amphenicols, narrow-spectrum penicillins, sulfonamides, tetracyclines, pleuromutilins and fusidic acid have been categorized as first-choice antibiotics for veterinary use in the Netherlands, together with the important antimicrobials metronidazole, bacitracin and spectinomycin.

As indicated by the Health Council's advisory report, in 2011 the Netherlands decided to focus its policy regarding veterinary use of antibiotics on preventing antibiotic use that results in an advantage, and subsequent selection, for ESBL-producing bacteria, which are responsible for the most problematic type of resistance. In this regard, the Dutch policy deviates from OIE List of Antimicrobial Agents of Veterinary Importance[5] (2014), which classifies amphenicols, aminoglycosides, third- and fourth-generation cephalosporins, macrolides, all penicillins, fluoroquinolones, sulfonamides and tetracyclines as Veterinary Critically Important Antimicrobial Agents. First- and second-generation cephalosporins, lincosamides, pleuromutilins, polymyxins (colistin) and quinolones are referred to as Veterinary Highly Important Antimicrobial Agents. Fusidic acid is referred to as a Veterinary Important Antimicrobial Agent. Despite being listed as critically important, amphenicols, narrow-spectrum penicillins, most macrolides, sulfonamides and tetracyclines have all been assigned to the category of first-choice antibiotics in the Dutch classification, since they do not select for ESBL-producing Gram-negative enterobacteriaceae.

[5] OIE LIST OF ANTIMICROBIAL AGENTS OF VETERINARY IMPORTANCE. The refined list was submitted to the 75th International Committee during the General Session in May 2007 and adopted unanimously by Resolution No. XXVIII. This list was further updated and adopted in May 2013 and May 2015 by the World Assembly of OIE Delegates

Trends in usage and sales of antibiotics

Developments in usage and sales of antibiotics are analyzed based on the following two reporting methods: 1) delivery records for each livestock sector, and 2) national sales figures.

1. Usage of antimicrobial agents is assessed based on all delivery records for antimicrobial agents from livestock farms. The delivery records are transferred to the SDa through the databases of the various livestock sectors, and provide insight in the amounts of antibiotics used in each sector.
2. Sales figures are provided by FIDIN, the federation of the Dutch veterinary pharmaceutical industry. Differentiation of sales figures according to livestock sector is only possible for a very small number of products.

For each of the livestock sectors, the annual overall number of defined daily doses animal for the entire livestock sector ($DDDA_{NAT}$) has been determined, based on all of the delivery records and the average number of kilograms of animal present within the sector concerned. The $DDDA_{NAT}$ has been selected as the general trend indicator for antibiotic consumption within the various Dutch livestock sectors over several years. This parameter is similar to the ones suggested by the European Medicines Agency as part of the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project, and is in line with the MARAN data previously reported by the Agricultural Economic Institute (LEI) of Wageningen University & Research centre (Wageningen UR). From 2012 onwards, the livestock sectors (except for the broiler and turkey farming sectors) have reported all delivery record data to the SDa. This means that $DDDA_{NAT}$ trends for these livestock sectors could be analyzed from 2012 onwards. Only part of the 2012 delivery record data for the broiler farming sector were provided to the SDa. The SDa therefore decided to estimate the broiler farming sector's 2012 usage levels based on the available 2012 data. Data on usage of antibiotics in the turkey farming sector have been reported since 2013. Determination of the $DDDA_{NAT}$ requires data on the number of animals present in the Netherlands. Data from Statistics Netherlands (CBS) and EUROSTAT were used to this end.

Number of kilograms of animal present in the Netherlands

Table 1. Live weight (x 1,000 kg) of agricultural livestock in the Netherlands from 2012 to 2015*

Livestock sector	2012	2013	2014	2015
Veal farming sector (EUROSTAT)	162,056	176,882	161,884	164,642
Veal farming sector (CBS)	156,602	159,547	158,828	156,751
Pig farming sector	710,688	710,802	704,937	706,025
Turkey farming sector	4,962	5,046	4,763	5,178
Broiler farming sector	43,846	44,242	47,020	49,107
Cattle farming sector, not including calves	1,522,500	1,532,000	1,615,000	1,680,000

** The 2012 and 2013 figures were provided by LEI Wageningen UR. 2014 and 2015 figures were based on EUROSTAT data, with the exception of poultry farming sector figures, which were provided by CBS. Sources of veal farming sector figures are specified in the table.*

The CBS data were compared with information on the numbers of animals provided by the livestock sectors. This information was then used to calculate the average live weight present (in kilograms). In the event of substantial differences between European and national figures, the national figures were used. This is in line with the approach used by the EMA in its ESVAC project. Such differences between European and Dutch figures were observed for the veal farming sector. For the veal farming sector, analyses with CBS data on the live weight of agricultural livestock in the Netherlands as well as analyses with EUROSTAT data were performed. The SDa expert panel has not been able to identify the exact reasons for the discrepancies between CBS and EUROSTAT data. It is still consulting with the EMA (ESVAC) on this matter and hopes the discrepancies can be cleared up later this year.

Developments in usage of antibiotics based on delivery record data

Delivery record data were used to determine the number of treatable kilograms of animal for each of the livestock sectors. Using the figures set out in Table 1, the results were then linked to the average number of kilograms of animal present in 2015 (for the veal and poultry farming sectors CBS data were used, and EUROSTAT data were used for the other livestock sectors). This was done for each type of livestock within the various livestock sectors in the Netherlands. This resulted in livestock sector-specific $DDDA_{NAT}$ figures. The $DDDA_{NAT}$ figures for the 2012-2015 period are included in Table 2.

Just like last year, CBS data on the number of animals were used to calculate $DDDA_{NAT}$ figures for the **veal farming sector**. Overall use of antibiotics in this livestock sector increased by 4.3% over the 2014-2015 period. Striking is the dominance of first-choice antibiotics, which accounted for 86% of the veal farming sector's overall antibiotic use in 2015. In the 2014-2015 period, usage of polymyxins increased by 20%. Usage of aminoglycosides decreased by 46% in this period.

In terms of $DDDA_{NAT}$, the **pig farming sector** achieved a 5% reduction in usage of antibiotics. Compared with 2014, usage of colistin increased by 11%, while usage of aminoglycosides decreased by 15%. Although 2015 saw a decline in the use of second-choice penicillins, usage of second-choice long-acting macrolides (only parenteral agents, i.e. agents used for individual treatment) showed a markedly steep increase of almost 50% (from 0.17 $DDDA_{NAT}$ to 0.25 $DDDA_{NAT}$). Usage of third-choice antibiotics is practically nonexistent in the pig farming sector. First- and second-choice products have been used in a stable 3:1 ratio for years now.

The 2012 and 2013 $DDDA_{NAT}$ figures for the **broiler farming sector** were recalculated using the latest version of the so-called "Diergeneesmiddelenstandaard" (also referred to as the "DG-standaard"), the SDa's online veterinary prescription drugs database. Recalculations were required because the turkey farming sector is now being subjected to monitoring as well. As a result, rather than including a single dosage for poultry in general, the current DG-standaard includes separate dosages for broilers and turkeys. The broiler farming sector managed to reduce its $DDDA_{NAT}$ by 7.4% over the 2014-2015 period. In 2015, third-choice antibiotics accounted for only 0.48% of the sector's overall antibiotic use, while this category of antibiotics still accounted for 4.53% in 2012. Although usage of polymyxins in the broiler farming sector is still low, it did increase by 20% between 2014 and 2015 period. Usage of aminoglycosides, on the other hand, decreased by 22% during this period even though it was low to begin with. Over the 2012-2015 period, the broiler farming sector recorded a shift from usage of first-choice penicillins (phenoxymethylpenicillin) and third-choice fluoroquinolones towards the second-choice antibiotic classes of penicillins (amoxicillin) and quinolones (flumequine). While first-choice antibiotics still accounted for 42% of the broiler farming sector's overall antibiotic use in 2012, in 2015 they accounted for just 29%. This development is remarkable, and undesirable in the opinion of the SDa expert panel.

Usage of antibiotics in the **turkey farming sector** increased by 16.9% (in terms of $DDDA_{NAT}$). In absolute terms, it qualified as high-level usage. Usage of fluoroquinolones showed a 6.8% reduction. The sector increased its use of polymyxins by a striking 700% between 2014 and 2015. The expert panel will discuss this development with the turkey farming sector in order to find out the underlying reasons. Usage of aminoglycosides increased by 78% over the 2014-2015 period. The extent to which first-choice antibiotics accounted for the turkey farming sector's overall antibiotic use, decreased from 77% in 2013 to 59% in 2015.

Usage of antibiotics in the **cattle farming sector** decreased slightly in comparison with the 2014 level, by 2.2%. Over the 2014-2015 period, usage of polymyxins and aminoglycosides decreased by 9% and 2%, respectively. First-choice antibiotics accounted for 75% of overall use in both 2014 and 2015, while in 2012 it accounted for just 51% of overall use.

If weighted by the number of kilograms of animal present within the various livestock sectors, the figures indicate a modest 2.5% reduction in terms of $DDDA_{NAT}$ for the Dutch livestock sector as a whole.

In light of the recently discovered emergence of colistin resistance, the SDa now also reports on **developments in colistin use**. Colistin (polymyxin) use increased in all livestock sectors except for the cattle farming sector. The extent of these increases varied from 11% in the pig farming sector to over 700% in the turkey farming sector, with 25% of turkey farms (10 out of 40) having used colistin in 2015. This increase in the turkey farming sector's usage level was associated with several blackhead disease outbreaks. In addition, colistin was used at 13 (1.6% of) broiler farms, 497 (1.6% of) cattle farms, 176 (8.9% of) veal farms, and 833 (14.3% of) pig farms.

Table 2. $DDDA_{NAT}$ data for the 2012-2015 period, by livestock sector (pig, veal, cattle, broiler and turkey farming sectors) and pharmacotherapeutic group

	Livestock sector																		
	Pig farming sector				Veal farming sector				Cattle farming sector				Broiler farming sector				Turkey farming sector		
	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015	2013	2014	2015
No. of farms with delivery records	6,425	6,588	6,072	5,824	2,175	2,125	2,061	1,978	32,254	31,650	31,223	30,708	732	770	798	816	48	41	40
Pharmacotherapeutic group																			
1st-choice antibiotics	**10.39**	**7.42**	**7.45**	**6.98**	**20.21**	**18.15**	**18.23**	**18.99**	**1.53**	**1.97**	**1.81**	**1.79**	**7.80**	**6.91**	**5.51**	**4.24**	**22.47**	**19.87**	**21.17**
As a proportion of overall AB use	**73%**	**74%**	**78%**	**77%**	**78%**	**84%**	**86%**	**86%**	**51%**	**65%**	**74%**	**75%**	**42%**	**51%**	**35%**	**29%**	**77%**	**65%**	**59%**
Amphenicols	0.06	0.09	0.17	0.18	1.23	1.23	1.52	1.63	0.05	0.07	0.08	0.08	*	*	*	*	0.02	*	*
Macrolides/lincosamides	0.93	0.71	0.92	0.79	3.42	3.49	3.53	3.70	0.06	0.10	0.12	0.12	1.11	0.44	0.35	0.48	3.07	2.12	1.98
Penicillins	0.33	0.52	0.61	0.58	0.19	0.41	0.43	0.42	0.75	1.11	1.01	0.99	2.10	2.05	2.12	1.20	5.86	5.80	4.49
Pleuromutilins	0.35	0.12	0.09	0.08	*	*	*	*	*	*	*	*	0.00	0.00	*	*	*	*	0.12
Tetracyclines	6.79	4.58	4.34	4.15	12.61	10.87	10.66	11.01	0.48	0.48	0.42	0.41	2.52	2.71	1.70	1.49	11.19	9.58	12.57
Trimethoprim/sulfonamides	1.92	1.40	1.33	1.20	2.76	2.14	2.08	2.22	0.18	0.20	0.19	0.20	2.07	1.71	1.34	1.07	2.33	2.37	2.01
2nd-choice antibiotics	**3.93**	**2.54**	**2.07**	**2.07**	**5.33**	**3.33**	**2.90**	**3.04**	**1.43**	**1.07**	**0.62**	**0.59**	**9.84**	**6.50**	**10.07**	**10.28**	**5.13**	**9.59**	**13.57**
As a proportion of overall AB use	**27%**	**26%**	**22%**	**23%**	**21%**	**15%**	**14%**	**14%**	**48%**	**35%**	**25%**	**25%**	**53%**	**48%**	**64%**	**70%**	**17%**	**31%**	**38%**
Aminoglycosides	0.00	0.00	0.01	0.01	0.81	0.53	0.34	0.19	0.01	0.01	0.01	0.01	0.61	0.04	0.03	0.02	1.24	0.40	0.71
1st- and 2nd-gen. cephalosporins	*	*	*	*	*	*	*	*	0.02	0.02	0.01	0.01	*	*	*	*	*	*	*
Quinolones	0.03	0.03	0.05	0.03	0.27	0.30	0.49	0.58	0.00	0.00	0.01	0.01	2.07	1.67	2.13	2.86	0.23	0.02	0.10
Fixed dose combinations	0.27	0.10	0.05	0.04	0.42	0.09	0.01	0.00	0.85	0.66	0.30	0.28	0.55	0.36	0.06	0.11	*	*	*
Macrolides/lincosamides	0.46	0.31	0.17	0.25	0.49	0.35	0.19	0.18	0.03	0.02	0.02	0.01	*	*	*	*	*	*	*
Penicillins	2.58	1.66	1.45	1.36	2.61	1.69	1.71	1.91	0.47	0.34	0.26	0.26	5.73	4.35	7.80	7.23	3.48	9.09	12.13
Polymyxins	0.58	0.44	0.34	0.38	0.73	0.36	0.15	0.19	0.05	0.02	0.01	0.01	0.88	0.08	0.05	0.06	0.18	0.08	0.63
3rd-choice antibiotics	**0.00**	**0.00**	**0.00**	**0.00**	**0.31**	**0.03**	**0.02**	**0.02**	**0.04**	**0.00**	**0.00**	**0.00**	**0.84**	**0.25**	**0.18**	**0.07**	**1.76**	**1.29**	**1.20**
As a proportion of overall AB use	**0.01%**	**0.00%**	**0.02%**	**0.00%**	**1.20%**	**0.12%**	**0.09%**	**0.11%**	**1.41%**	**0.16%**	**0.12%**	**0.14%**	**4.53%**	**1.83%**	**1.13%**	**0.48%**	**6.01%**	**4.19%**	**3.34%**
3rd- and 4th-gen. cephalosporins	0.00	*	*	*	0.00	0.00	0.00	*	0.03	0.00	0.00	0.00	*	*	*	*	*	*	*
Fluoroquinolones	0.00	*	0.00	0.00	0.31	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.84	0.25	0.18	0.07	1.76	1.29	1.20
Overall	**14.32**	**9.96**	**9.52**	**9.05**	**25.85**	**21.50**	**21.15**	**22.05**	**3.00**	**3.04**	**2.44**	**2.38**	**18.48**	**13.66**	**15.76**	**14.59**	**29.36**	**30.74**	**35.94**

0.00 means usage was below 0.005 $DDDA_{NAT}$; * means no usage was reported.

The expert panel has analyzed long-term developments in usage levels. By integrating LEI Wageningen UR and SDa data, it could calculate the reductions achieved over the 2009-2015 period by the veal, broiler, pig and dairy cattle farming sectors.

The LEI Wageningen UR data for the veal and dairy cattle farming sectors were adjusted for average dose-based calculations. This enabled the expert panel to identify sector-specific trends over a longer period of time as accurately as possible with the currently available data. The results are shown in Figure 1.

Figure 1. Long-term developments in usage of antibiotics according to LEI Wageningen UR data (in DD/AY, as published in MARAN reports) and SDa data (in $DDDA_{NAT}$), based on a spline (curve) with 95% CI point estimates for each year. See the appendices for the computational basis. Blue: veal farming sector; orange: broiler farming sector; light green: pig farming sector; dark green: dairy cattle farming sector

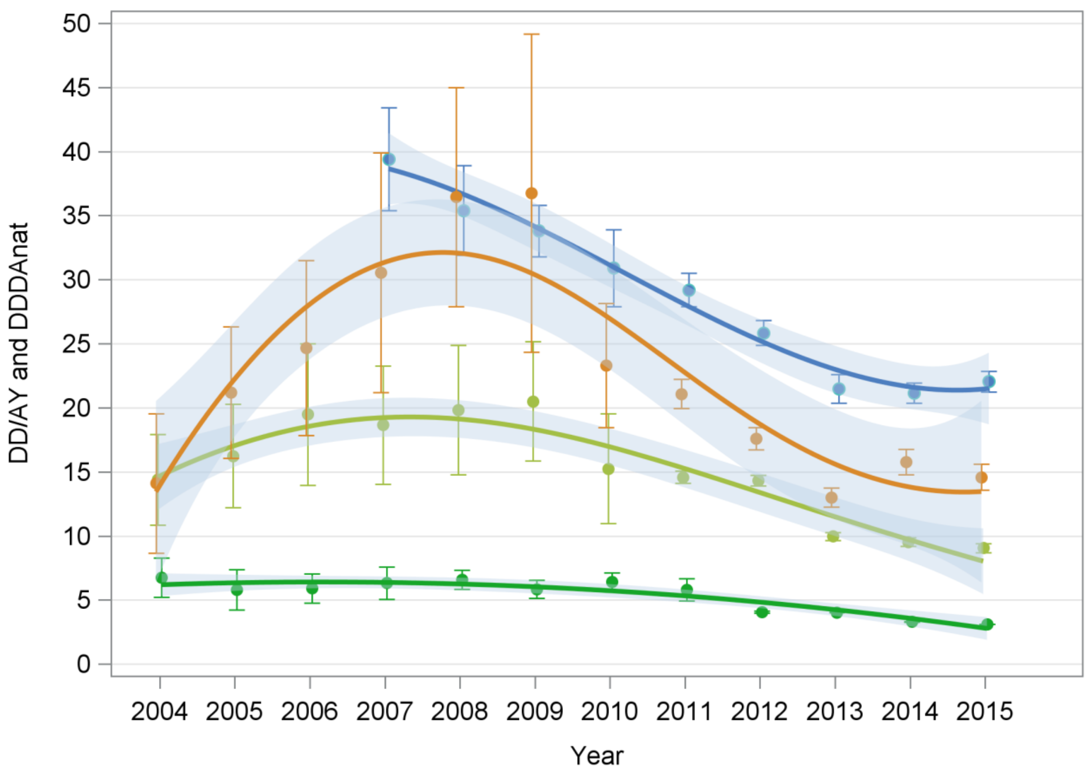


Table 3. Reductions in usage of antibiotics in agricultural livestock from 2009 to 2015

	$DDDA_{NAT}$	**Reduction from the 2009 level, in %**					
Livestock sector	2009	2010	2011	2012	2013	2014	2015
Veal farming sector	33.80	9	14	24	36	37	35
Pig farming sector	20.51	26	29	30	43	54	56
Broiler farming sector	36.76	37	43	52	65	57	60
Dairy cattle farming sector	5.78	-10	1	30	30	43	46

For the entire observation period, veal and dairy cattle farming sector data have been adjusted to take account of the dosage-related changes introduced in the 2014 DG-standaard.

The veal farming sector achieved a 35% reduction in its usage of antibiotics in terms of $DDDA_{NAT}$ between 2009 and 2015. Compared with the 2007 level, usage decreased by 43.9%.
Between 2009 and 2015, the pig and broiler farming sectors achieved reductions of 56% and 60%, respectively, in terms of $DDDA_{NAT}$. The dairy cattle farming sector's reduction in terms of $DDDA_{NAT}$ had never been determined before, and amounted to 46%.

Distribution of the usage of antibiotics over the various livestock sectors, overall usage, and sales figures

Usage data were provided by the various livestock sectors. Using all delivery data recorded by the livestock sectors, the total number of *kilograms of active substances* used within each livestock sector was calculated. This was necessary to enable completion of the mass balance (an equation for comparing the FIDIN-provided number of kilograms of an active substance sold with the reported number of kilograms of the active substance used in the monitored livestock sectors). Total usage according to delivery records amounted to 182,525 kg, while total sales amounted to 205,665 kg. Over the 2014-2015 period, the monitored livestock sectors collectively managed to achieve a 4.0% reduction in their usage of antibiotics, in terms of the number of kilograms of active substances used according to the delivery records.

Just like the $DDDA_{NAT}$ figures, the number of kilograms of veterinary prescription drugs used in each livestock sector is reported for each category of antibiotics (i.e. first-, second- or third-choice agents), and further specified by pharmacotherapeutic group.

According to the sector-specific databases, the total number of times an antibiotic was prescribed in 2015 amounted to 836,328. These antibiotics were prescribed for 39,366 livestock farms in total. The data were based on delivery records from 5,824 pig farms, 1,978 veal farms, 816 broiler farms, 40 turkey farms, and 30,708 cattle farms.

For livestock farms with high delivery record results, the data were rechecked. In a number of cases, high delivery record results reflected errors in the data file. In those cases, the data were resubmitted.

Table 4. Distribution of use of antibiotics in kg over the various livestock sectors, overall usage, and sales figures in 2015, by pharmacotherapeutic group

	According to delivery records						According to sales figures		
Pharmacotherapeutic group	Pig farming sector	Cattle farming sector	Veal farming sector	Broiler farming sector	Turkey farming sector	All livestock sectors	Companion animal sector	All sectors	Remarks
1st-choice antibiotics **As a proportion of overall AB use**	**64,606** **83%**	**20,462** **87%**	**54,044** **85%**	**5,741** **41%**	**2,715** **72%**	**147,568** **81%**	**2,652** **64%**	**164,915** **80%**	
Amphenicols	974	1,263	2,557	0	0	4,794	22	4,564	kg used > kg sold
Fixed dose combinations	0	0	0	0	0	0	389	389	
Macrolides/lincosamides	6,486	2,964	14,241	1,090	686	25,467	95	22,215	kg used > kg sold
Other	0	0	0	0	0	0	383	475	Companion animals and rabbits
Penicillins	5,127	3,376	463	988	388	10,341	49	12,671	
Pleuromutilins	604	0	0	0	11	615	0	775	
Tetracyclines	33,842	6,858	2,7963	1,416	1,330	71,410	649	81,896	
Trimethoprim/sulfonamides	17,572	6,001	8,822	2,247	300	34,941	1,064	41,930	
2nd-choice antibiotics	**13,057**	**3,105**	**9,558**	**8,112**	**1,000**	**34,832**	**1,471**	**40,351**	
As a proportion of overall AB use	**17%**	**13%**	**15%**	**58%**	**26%**	**19%**	**36%**	**20%**	
Aminoglycosides	39	193	214	73	26	544	27	1,210	
1st- and 2nd-gen. cephalosporins	0	18	0	0	0	18	487	508	
Quinolones	270	180	1,644	1,404	5	3,502	0	3,818	
Fixed dose combinations	755	938	17	269	0	1,979	1	2,534	
Macrolides/lincosamides	56	8	15	0	0	79	0	50	kg used > kg sold
Penicillins	10,741	1,728	7,533	6,356	957	27,316	955	30,296	
Polymyxins	1,197	39	136	10	12	1,395	1	1,935	
3rd-choice antibiotics	**0**	**15**	**14**	**33**	**62**	**125**	**20**	**399**	
As a proportion of overall AB use	**0.00%**	**0.06%**	**0.02%**	**0.24%**	**1.65%**	**0.07%**	**0.47%**	**0.19%**	
3rd- and 4th-gen. cephalosporins	0	1	0	0	0	1	1	11	
Fluoroquinolones	0	15	14	33	62	125	18	388	
Overall	**77,664**	**23,582**	**63,616**	**13,886**	**3,778**	**182,525**	**4,143**	**205,665**	

Trend analysis based on national sales figures

Sales figures were provided by FIDIN. The figures represent the number of kilograms of active substances sold. They are reported by category of antibiotics (i.e. first-, second- or third-choice antibiotics) with further classification based on the main pharmacotherapeutic groups. Between 2014 and 2015, the total number of kilograms of antibiotics for veterinary use sold decreased by 0.65% (see Figure 2). According to the number of kilograms of active substances sold, overall usage of antibiotics decreased by 58.4% between 2009 (the government-specified reference year) and 2015.

Discrepancies between the number of kilograms of antimicrobial veterinary prescription drugs sold and usage recorded for the monitored livestock sectors were in part due to usage in unmonitored sectors and year-to-year differences in the number of kilograms in stock. 2015 saw a marked increase in the absolute difference between the amounts sold and the amounts used. This may have been the result of two new pharmaceutical wholesalers offering a full range of veterinary prescription drugs entering the market in 2015. Other factors that may have contributed to this discrepancy include new parties preparing for market entry in 2016, and increased export to other EU countries. The factors responsible for the big difference recorded for 2015 are currently being investigated.

Developments in usage of antibiotics

With regard to usage of third- and fourth-generation cephalosporins in SDa-monitored livestock sectors, the number of kilograms used according to delivery records represented just a minor fraction (5.2%) of the number of kilograms sold. Although to a lesser extent, a similar discrepancy was seen for fluoroquinolones and aminoglycosides, with the delivery records accounting for just 33.2% and 45% of the amounts sold, respectively. For colistin-containing products, however, the number of kilograms used according to delivery records represented 98% of the number of kilograms sold.
These findings show usage of third- and fourth-generation cephalosporins primarily occurred outside of the five livestock sectors subjected to SDa monitoring. Apparently, fluoroquinolones and aminoglycosides were used in monitored as well as unmonitored sectors, while use of colistin mainly took place in the five monitored livestock sectors.

Third-choice antibiotics

Although usage of third- and fourth-generation cephalosporins in monitored livestock sectors was very limited, it did increase by 97 grams in 2015, to 564 grams, which represented 5.2% of overall usage of third-choice antibiotics. The cattle farming sector was the only monitored livestock sector in which third- and fourth-generation cephalosporins were used. Of the total number of kilograms used, 35% was administered intramammarily and 65% was injected. These antibiotics were used for a total of 671 treatments (intramammary use: 584; injected: 87) in dairy cattle (total no. of dairy cattle farms: 17,737), 1 treatment in beef bulls (total no. of beef farms: 3,196), and 14 treatments (intramammary use: 8; injected: 6) in suckler cows (total no. of suckler cow farms: 9,305). Even though only very small amounts were involved, use of these agents still requires attention. In 2015, usage of third- and fourth-generation cephalosporins in unmonitored sectors decreased from 14 kg to 11 kg, with usage in companion animals accounting for 11.3%. The companion animal sector managed to cut sales of these agents in half in 2015. The other unmonitored sectors were responsible for 83.5% of the total amount of third- and fourth-generation cephalosporins used.

Usage of fluoroquinolones in monitored livestock sectors decreased by approximately 26%, from 168 kg to 125 kg. Overall sales of fluoroquinolones also decreased in 2015, in contrast to the year before. Of the total amount of fluoroquinolones sold, 33.2% concerned the monitored livestock sectors, 2.3% concerned products indicated for use in companion animals, and 64.5% concerned other unmonitored sectors.

Second-choice antibiotics

Most of the livestock sectors managed to further reduce their use of aminoglycosides. The turkey farming sector was an exception, with a 78% increase in usage of these agents. Overall sales of aminoglycosides increased by 44%. Of the total amount of aminoglycosides sold, 45% could be traced back to the monitored livestock sectors, and 1.5% concerned products solely indicated for use in companion animals. This means the remaining 53.5% concerned either the companion animal sector or other unmonitored sectors. Aminoglycoside use in either the companion animal or other unmonitored sectors showed a striking increase, from 242 kg to 666 kg. This increase seemed to coincide with the launch of a new veterinary prescription drug, and therefore may have been caused by wholesalers and veterinarians building up stock.

According to delivery records, usage of polymyxins (including colistin) went up in most livestock sectors. The extent of these increases varied, from 11% in the pig farming sector to over 700% in the turkey farming sector. In 2015, several turkey farms experienced outbreaks of histomoniasis (blackhead disease). As the proven effective (and in some cases prophylactic) treatment strategies for this primarily gastrointestinal parasitic infection are no longer available, the turkey farming sector has been searching for alternative strategies. This may have resulted in the strong increase in colistin use at turkey farms. Only the cattle farming sector recorded a decline in the use of polymyxins, of 9%.

This was also reflected in the sales figures. Sales of colistin monotherapy products increased by 145 kg, with monitored livestock sectors accounting for 98% of colistin monotherapies used. Sales of colistin combination products went down in 2015. This resulted in a slight decline in overall sales of colistin (both monotherapy and combination products) between 2014 and 2015, to 1,604 kg. Between 2011 and 2015, sales of veterinary prescription drugs containing colistin (including combination products) dropped by 68%, to just 32% of the 2011 level of 4,986 kg. The recently identified (plasmid-mediated) type of colistin resistance that can be transferred between bacteria is cause for concern in this respect, even though sample analysis performed by the Central Veterinary Institute (CVI) has suggested the risks are still limited. The expert panel feels colistin use has to be reduced further, and formularies should shift their focus to products not containing colistin. The Health Council of the Netherlands has already advised the Dutch livestock sector to find alternatives to colistin-based therapies in order to phase out veterinary use of colistin over time. The Health Council's 2015 report contains the same advice, and urges the WVAB, the veterinary working group for antimicrobial policy of the Royal Dutch Society for Veterinary Medicine (KNMvD), to adapt the formularies in order to minimize usage of colistin.

Topical treatment of mastitis in dairy cattle was the only application of first- and second-generation cephalosporins recorded in the monitored livestock sectors. Sales of these antibiotics continued to go down in 2015. Oral therapies for dogs and cats accounted for all other applications of first- and second-generation cephalosporins, and represented 96% of the total number of kilograms used.

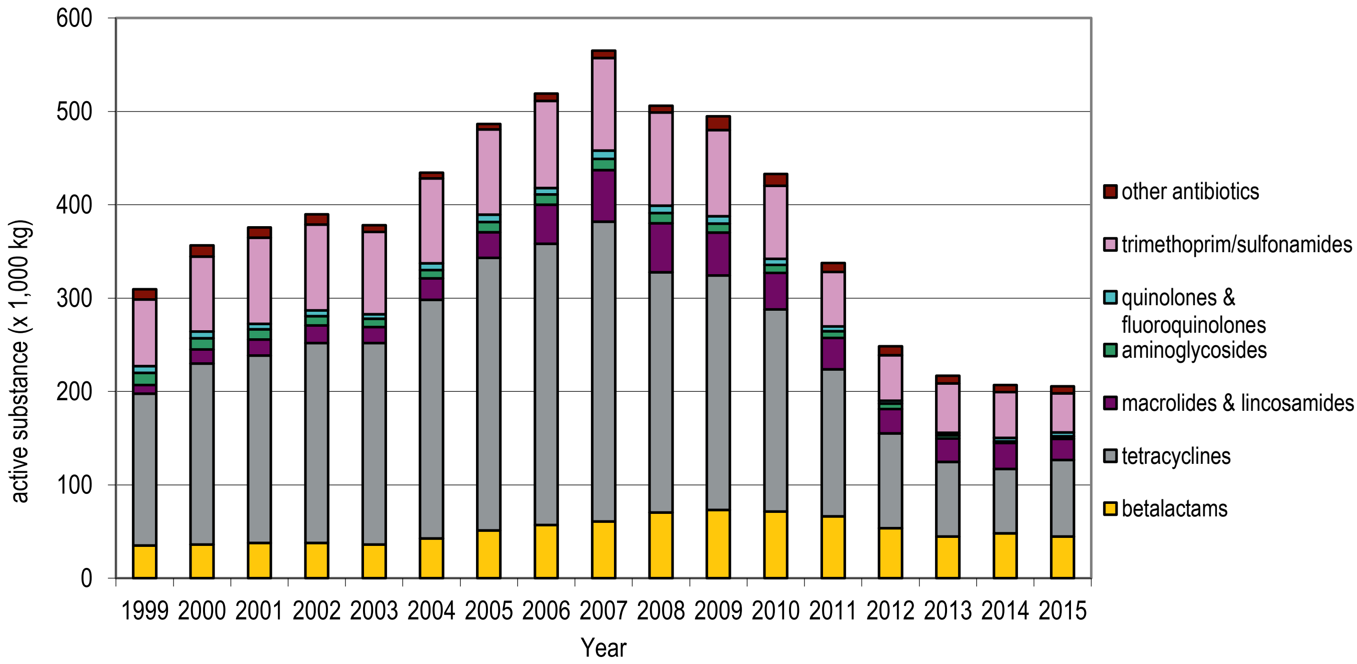
Usage of second-choice penicillins (amoxicillin and ampicillin) decreased by 7.8%, from 32,854 kg in 2014 to 30,296 kg in 2015. Usage in monitored livestock sectors accounted for 90%, 3% concerned products solely indicated for use in companion animals, and usage in unmonitored sectors accounted for the remaining 7%. 2014 had seen a sharp increase in the number of kilograms of amoxicillin and ampicillin used, due to the launch of several authorized veterinary prescription drugs specifically indicated for use in broilers and turkeys. Sales of first-choice beta-lactam antibiotics dropped by 6.5%.

The preceding paragraphs show that unmonitored sectors contribute substantially to the usage of the above-mentioned antibiotics that are of critical importance. To shed light on the usage of these agents in companion animals and horses, one-off surveys of veterinary practices for companion animals and horses are currently being conducted. The results will help decide whether the companion animal and horse sectors should be subjected to monitoring as well. As of 2016, antibiotic use in meat rabbits will be monitored. Existing LEI Wageningen UR data on meat rabbits do not provide sufficient information on usage of antibiotics (LEI Wageningen UR 2014). The amounts used in mink, sheep and goats are known to a certain extent. Not known is the extent to which antibiotics are used in production animals kept by hobby farmers, homing pigeons, small rodents, birds etc. It would also be helpful to gain more insight into antibiotic use earlier in the poultry supply chain. The expert panel therefore proposes to conduct one-off surveys in these sectors. Furthermore, the expert panel still feels that each kilogram of antibiotics sold should be fully accounted for, and that antibiotic use should be reduced even further wherever possible.

Of the overall amount of antibiotics sold in 2015, 88.7% could be traced back to usage in SDa-monitored livestock sectors. This shows that the proportion of overall sales accounted for by the other sectors has increased slightly over the past few years. This may have been due to the five monitored livestock sectors having achieved a steeper decline in their usage levels than the unmonitored sectors. Sales of antimicrobial agents for companion animals have also declined over the past few years. Macrolides and amphenicols were the only agents for which usage exceeded sales in 2015. Contrary to the two years before, the number of kilograms of tetracyclines sold in 2015 exceeded the number of kilograms used. The relatively small deviations between the number of kilograms used and sold may in part be explained by changes in the amounts held in stock, in particular by wholesalers and retailers. With regard to macrolides, the number of kilograms used exceeded the number of kilograms sold. Amphenicol usage in 2015 once again exceeded amphenicol sales (by 5%). Considering cascade use of a product containing florfenicol was included in the so-called “Branchecodetabel” database, this could indicate usage of foreign veterinary prescription drugs imported under the cascade (which is permitted, since the products concerned were included in the “Branchecodetabel” as a cascade product). After all, in such cases sales of foreign products are not reported, while their usage is in fact included in the delivery records. In contrast, parallel imports of veterinary prescription drugs are recorded in the Netherlands, as are the amounts of these products sold. Usage of macrolides exceeded sales by 15% in 2015. Considering the actual number of kilograms involved, this was only a minor deviation, which means it could have been the result of stockpiling.

The expert panel is of the opinion that the recording of sales figures and the recording of delivery data both have benefits as well as shortcomings as a method for monitoring usage of antibiotics at national and livestock sector level. For the five SDa-monitored livestock sectors, the two recording methods can be deemed to be largely consistent with regard to the 2015 figures, despite their shortcomings and associated uncertainties.

Figure 2. Developments in sales of antimicrobial agents between 1999 and 2015, in number of kilograms of active substances sold (x1,000) (source: FIDIN), by main pharmacotherapeutic group



Benchmarking of livestock farms

The expert panel uses the parameter $DDDA_F$ for expressing the defined daily dose animal at farm level. Usage level distributions with accompanying statistics can be found for each of the livestock sectors in the appendices.

Increased usage of antibiotics in the **veal farming sector** was primarily due to white veal farms and rosé veal starter farms. Rosé veal fattening farms and rosé veal combination farms recorded slightly lower usage levels than they did in 2014. Usage patterns for white veal farms and rosé veal starter farms showed a considerable amount of variation. The distributions for these types of livestock farms are relatively wide and show big $DDDA_F$-differences between high and low users. No or hardly any white veal farms or rosé veal starter farms recorded a usage level of zero, while very high $DDDA_F$ values were a regular occurrence. The distribution for rosé veal fattening farms is narrow, shows a substantial group of zero-level users, and has a long tail. Although the distribution for rosé veal combination farms is narrower than the one for starter farms, it is still relatively wide.

Table 5. Annual defined daily doses animal ($DDDA_F$) for the veal, pig, poultry and cattle farming sectors and the various types of farms in 2015. Provided parameters are the mean, 50th percentile (median), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	Type of farm/type of animal	N	Mean	Median	P75	P90
Veal farming sector	White veal farms	855	25.1	24.3	31.7	38.3
	Rosé veal starter farms	247	82.7	83.0	101.5	115.1
	Rosé veal fattening farms	638	2.7	1.0	4.0	7.3
	Rosé veal combination farms	238	11.8	11.2	16.2	21.4
Pig farming sector	Sows/suckling piglets	2,109	5.3	3.1	6.8	12.7
	Weaner pigs	2,276	19.6	7.6	24.4	52.2
	Fattening pigs	5,072	4.1	1.6	5.4	10.2
Poultry farming sector	Broiler farms	816	12.2	7.2	17.9	30.5
	Turkey farms	40	25.9	18.9	33.3	59.5
Cattle farming sector	Dairy cattle farms	17,737	2.2	2.1	2.9	3.7
	Rearing farms	470	0.8	0.0	0.2	1.7
	Suckler cow farms	9,305	0.6	0.1	0.7	2.0
	Beef farms	3,196	1.5	0.0	0.4	2.9

2015 is the first year for which usage data for the **pig farming sector** are provided per type of animal rather than type of farm. The following three types of pigs are distinguished: sows including suckling piglets, weaner pigs, and fattening pigs. The distributions for sows/suckling piglets and fattening pigs are relatively narrow, with long tails towards higher $DDDA_F$ values. In both types of pigs, zero-level usage of antibiotics was quite common. Usage in sows/suckling piglets and fattening pigs was similar for specialized pig farms (with sows/suckling piglets or fattening pigs accounting for >90% of pigs present) and farms with two or more different types of pigs. The distribution for weaner pigs is much wider and has a longer tail. Specialized weaner pig farms (with weaner pigs accounting for >90% of pigs present) recorded higher usage levels than farms with several types of pigs. This difference was unexpected. It might be possible that in veterinarians' delivery records for farms with several types of pigs, antibiotics used in weaner pigs are sometimes not accurately attributed to this type of pig. After all, there have been some concerns regarding the quality of delivery records for weaner pigs in particular. According to the expert panel, the pig farming sector should once again stress how important it is for veterinarians to check that the target species is recorded correctly in the delivery records.

The **broiler farming sector** managed to reduce its mean and median antibiotic use in terms of defined daily doses animal. The sector also recorded lower P75 and P90 values than the year before, which means its distribution as a whole has shifted towards lower usage levels. Following the increase in usage levels recorded for 2014, this is a positive development. However, there is still a relatively large amount of variation between individual broiler farms. The distribution for the broiler farming sector is relatively wide, with quite a substantial plateau, a long tail, and several peaks. These findings show additional attention is required over the next few years, since the expert panel's goal is a narrower, unimodal distribution that has no plateau. Breed-related differences between individual broiler farms may have contributed to the level of heterogeneity seen in the broiler farming sector's 2015 distribution. Such differences will come to light next year, when growth curves will be incorporated in the calculation method. The expert panel already noticed at an earlier date that the broiler farming sector's decline in the usage of antibiotics has not resulted in a proportional decline in the occurrence of specific types of resistance. The expert panel therefore deems it necessary to consider the entire broiler supply chain (including the links preceding broiler farms) when analyzing usage of antibiotics at broiler farms.

Usage of antibiotics in the **turkey farming sector** increased markedly in the 2014-2015 period. This is a highly undesirable development. Mean usage levels were high, and there was substantial variation between individual turkey farms. The tail of the distribution, which represents turkey farms with high usage levels, is long, and exceptionally high $DDDA_F$ values were a regular occurrence. In 2014, the expert panel already noted that additional measures were required for the turkey farming sector, given this livestock sector's high usage levels and minor improvements throughout the years before. The expert panel expects the turkey farming sector to take serious action soon in order to systematically reduce the amounts of antibiotics used at the farms concerned.

In the **dairy cattle farming sector**, mean and median antibiotic use continued to decline in 2015. The expert panel once again wants to commend this livestock sector for its efforts. It is a remarkable achievement for a livestock sector characterized by low usage levels and only minor between-farm variation in usage levels to reduce its usage of antibiotics even further. The other cattle farming sectors also managed to reduce the amounts of antibiotics used.

Table 6. Signaling and action thresholds for the various livestock sectors and types of farms for 2015, based on the DDDA$_F$

Livestock sector	Type of farm/type of animal	Signaling threshold	Action threshold
Veal farming sector	White veal farms	23	39
	Rosé veal starter farms	67	110
	Rosé veal fattening farms	1	6
	Rosé veal combination farms	12	22
Pig farming sector	Sows/suckling piglets	10	20
	Weaner pigs	22	60
	Fattening pigs	10	12
Poultry farming sector	Broiler farms	15	30
	Turkey farms*	19	31
Cattle farming sector	Dairy cattle farms	4**	6
	Rearing farms	1	2
	Suckler cow farms	1	2
	Beef farms	1	2

* See the 2013 SDa report.
** The signaling threshold for dairy cattle farms was based on the P80 value. The signaling threshold for all other types of farms/types of animal, except fattening pigs, refers to the P50 value minus 20%.

Table 7. Distribution of livestock farms over the various benchmark zones in 2015

Livestock sector	Type of farm/ type of animal	Target zone n (%)	Signaling zone n (%)	Action zone n (%)
Veal farming sector	White veal farms	390 (46%)	392 (46%)	73 (9%)
	Rosé veal starter farms	52 (21%)	156 (63%)	39 (16%)
	Rosé veal fattening farms	319 (50%)	232 (36%)	87 (14%)
	Rosé veal combination farms	129 (54%)	88 (37%)	21 (9%)
Pig farming sector	Sows/suckling piglets	1,807 (85%)	225 (11%)	77 (4%)
	Weaner pigs	1,650 (73%)	445 (20%)	181 (8%)
	Fattening pigs	4,551 (90%)	154 (3%)	367 (7%)
Poultry farming sector	Broiler farms	570 (70%)	162 (20%)	84 (10%)
	Turkey farms	20 (50%)	8 (20%)	12 (30%)
Cattle farming sector	Dairy cattle farms	16,495 (93%)	1,140 (6%)	102 (1%)
	Rearing farms	399 (85%)	30 (6%)	41 (9%)
	Suckler cow farms	7,441 (80%)	963 (10%)	901 (10%)
	Beef farms	2,631 (82%)	174 (5%)	391 (12%)

Table 8. Shifts in the proportion of livestock farms in the various benchmark zones in the 2012-2015 period

Livestock sector	Type of farm/ type of animal	Target zone %				Signaling zone %				Action zone %			
	Year 20..	12	13	14	15	12	13	14	15	12	13	14	15
Veal farming sector	White veal farms	33	49	48	46	50	41	44	46	17	10	8	9
	Rosé veal starter farms	36	39	33	21	48	48	56	63	16	13	11	16
	Rosé veal fattening farms	38	46	48	50	33	33	34	36	29	21	19	14
	Rosé veal combination farms	-	60	50	54	-	30	40	37	-	10	10	9
Pig farming sector	Sows/suckling piglets	56	66	72	85	24	24	19	11	20	11	8	4
	Weaner pigs	-	-	-	73	-	-	-	20	-	-	-	8
	Fattening pigs	77	83	86	90	16	6	6	3	7	11	8	7
Poultry farming sector	Broiler farms	52	68	66	70	31	25	21	20	17	6	13	10
	Turkey farms	-	50	51	50	-	25	22	20	-	25	27	30
Cattle farming sector	Dairy cattle farms	56	55	91	93	40	42	8	6	4	3	1	1
	Rearing farms	81	83	84	85	3	6	6	6	16	11	9	9
	Suckler cow farms	82	80	84	80	8	6	6	10	10	14	9	10
	Beef farms	-	79	79	82	-	10	10	5	-	11	10	12

The distribution of livestock farms over the various benchmark zones (Table 7 and Table 8) is in line with the general trends indicated in the previous tables and figures, and generally similar to the situation in 2014. No major shifts were observed.

Table 9. Number of livestock farms with structurally high usage levels (i.e. farms that have been in the action zone for three consecutive years based on their overall usage level or the usage level recorded for one particular type of animal present (for pig farms))

Livestock sector	Number of livestock farms with available data for the 2013-2015 period	Number of livestock farms in the action zone during the 2013-2015 period
Veal farming sector	1,863	31 (2%)
Pig farming sector (1)	5,465	91 (2%)
Pig farming sector (categorization based on type of pigs) (1, 2)	5,862	82 (1%)
Broiler farming sector	731	15 (2%)
Turkey farming sector	36	4 (11%)
Cattle farming sector	28,970	539 (2%)

1: Changes regarding the categorization of different types of pigs and the prescription of antibiotics have affected the accuracy of year-to-year comparisons.
2: 5,392 pig farms accounting for 5862 groups of particular types of pigs.

In most livestock sectors, only 1-2% of livestock farms had structurally high usage levels (action zone usage levels for three years in a row). The expert panel feels this is quite a positive result. The two calculation methods used for the pig farming sector resulted in different proportions. With structurally high usage levels found for 11% of farms, the turkey farming sector was an exception. It should be noted, however, that this figure represents just four turkey farms. Actually, considering the number of farms included in the action zone, a 1-2% proportion of all farms having recorded structurally high usage levels is relatively high. In some cases it means that up to 20% of livestock farms in the action zone had structurally high usage levels. In the 2013-2015 period, 3 to 39% of livestock farms recorded usage levels consistent with the signaling or action zone for three consecutive years. This underlines the importance of focusing both on long-term high users and other livestock farms in the signaling and action zones in order to achieve further reductions in the amounts of antibiotics used. One of the reasons for focusing reduction efforts on livestock farms with action or signaling zone usage levels is the fact that they are particularly at risk for development of antibiotic resistance and associated spread of resistant bacteria. In its report on associations between antibiotic use and antibiotic resistance, the SDa already warned that higher usage levels are associated with higher numbers of resistant micro-organisms being detected (SDa 2016).

In 2014, the expert panel expressed its concern about the various veal farming sectors not managing to further reduce the number of farms in the signaling zone. Although the number of rosé veal combination farms in the action zone decreased in 2015, the distribution of the other types of veal farms over the various benchmark zones remained largely the same. The relatively high proportion of veal farms in the signaling zone remains cause for concern and requires additional measures to be taken. Another concern is the high proportion of turkey farms in the action zone. Efforts should be intensified to realize the necessary improvements.

Benchmarking of veterinarians

The benchmarking method for veterinarians was introduced in March of 2014 and was based on prescription data recorded in 2012. The 2014 benchmarking results were published last year, but the veterinarians were yet not provided with their personal scores. This was due to the fact that the quality management systems were not yet equipped to report results for individual veterinarians. Veterinarians could, however, calculate their personal Veterinary Benchmark Indicator (VBI) by using a simple online calculator in order to obtain information on the amounts of antibiotics used at the livestock farms with which they had a registered one-to-one relationship. Currently, veterinarians can find out their VBI's through the Integrated Chain Management (IKB) quality management system or the quality assurance body for veterinarians (Stichting Geborgde Dierenarts, SGD).

In 2015, the number of veterinarians with whom livestock farms had a registered one-to-one relationship remained virtually the same (1,298 in 2015 vs. 1,291 in 2014). Most veterinarians (71.4%) had prescription patterns that met the target zone criteria. The proportion of veterinarians with a VBI over 0.3 continued to decline, from 3.4% to 1.8%. Those veterinarians are expected to take action immediately in order to improve their prescription patterns.

The proportion of veterinarians with a VBI>0.30 (action zone) varied slightly between the various livestock sectors, with proportions of 0.4%, 1.1%, 2.8%, 5.2% and 50% being recorded for the pig, dairy, broiler, veal and turkey farming sectors, respectively. Although the proportion of veterinarians with a VBI in the signaling zone went down from 37% to 27%, it still represented a substantial percentage of all veterinarians. The proportion of veterinarians in the signaling zone also varied between the various livestock sectors, ranging from 13%, 22%, 27% and 28% to 51% for the turkey, cattle, broiler, pig and veal farming sectors, respectively.

Table 10. Number of veterinarians per benchmark zone, by livestock sector; specified for veterinarians responsible for several farms per livestock sector and veterinarians responsible for a single farm per livestock sector

	Number of veterinarians with several farms per livestock sector who fall within the target, signaling or action zone based on their Veterinary Benchmark Indicator (VBI), by livestock sector			Number of veterinarians with a single farm per livestock sector who fall within the target, signaling or action zone based on the usage level of the farm concerned, by livestock sector		
Livestock sector	**Target**	**Signaling**	**Action**	**Target**	**Signaling**	**Action**
	≤0.10	**(0.10<VBI≤0.30)**	**(VBI>0.3)**	-	-	-
Veal farming sector	44	66	6	19	6	1
Pig farming sector	196	78	1	5	0	0
Broiler farming sector	46	23	2	14	0	0
Turkey farming sector	2	1	3	2	0	0
Cattle farming sector	567	174	8	32	0	2

Remarkably, compared with the number of livestock farms in the signaling zone, the number of veterinarians included in this zone is quite low. Especially considering a veterinarian's VBI relates to the amounts of antibiotics used at livestock farms for which he or she has provided veterinary care. According to the expert panel, this discrepancy results from the cut-off values selected for the VBI-based signaling and action zones. Therefore, the cut-off points will be reviewed and redefined in 2016.

Usage of antibiotics in livestock sectors not subjected to SDa monitoring

The expert panel found out that in 2014, certain second- and third-choice antibiotics were being used outside of the five SDa-monitored livestock sectors. This was discovered when the expert panel was comparing sales figures with delivery record data recorded by veterinarians. Detailed information on usage in unmonitored sectors is not available. The expert panel has therefore decided that monitoring should no longer be limited to the five livestock sectors that are currently being monitored. It does acknowledge, however, that there are several ways in which it could extend its monitoring activities, and that the type of monitoring should reflect the extent of antibiotic use within the sector concerned. The expert panel therefore proposes two different scenarios:

- In sectors with documented low-level usage (such as the layer farming sector, according to prior assessment by the expert panel), the amounts of antibiotics used could be assessed every three years based on a random sample of farms, in order to keep track of any developments. The expert panel expects this to be an appropriate approach for farms with laying hens, ducks or sheep.
- In sectors for which insufficient or no information is currently available, spot checks should be performed at a random sample of farms. The findings could then be used to decide whether continuous monitoring is required or whether sample-based monitoring once every few years would be sufficient. A survey of veterinary practices for companion animals and horses was started in 2015 and will be finalized in the course of 2016. Once the data have been analyzed, the expert panel will advise on the desirability of further monitoring.

As of 2016, usage of antibiotics in meat rabbits will be monitored continuously. Previously, meat rabbit farms were monitored on a voluntary basis.

Exploratory assessments should be performed to find out the extent to which antibiotics are used in the remaining sectors. In light of concerns regarding the amounts of antibiotics used in the goat/dairy goat and mink farming sectors, the expert panel feels assessment preparations for these sectors should start soon.

Revision of the $DDDA_F$ calculation method

The benchmarking method for livestock farms was developed in 2012. Since its introduction, considerable experience has been gained in the benchmarking of livestock farms. Over the years, the expert panel as well as the livestock sectors have identified several bottlenecks and limitations. The SDa is continuously looking for ways to improve its benchmarking method. Several livestock sectors have suggested changes to improve how the method takes accounts of the various product cycles at certain farms and in order to reduce the occurrence of distorted DDDA figures caused by variations in how a population of agricultural livestock is made up. The changes to be implemented for the various livestock sectors can be summarized as follows:

- **Veal farming sector:** The number of times veal farms start with a new herd of young calves (either once or twice a year) may vary from year to year. Such year-to-year variations result in fluctuating usage levels. As a result, the SDa and the veal farming sector have agreed that as of 2016, veal farms' usage levels will be calculated for 1.5-year periods. In addition, the SDa will investigate whether growth curves for veal calves could be incorporated in the calculation method applied to individual veal farms.
- **Pig farming sector:** In 2015, a new method was applied for calculating usage levels in the pig farming sector. This method calculates usage levels based on the type of pigs concerned. In addition to the new calculation method, corresponding benchmark thresholds were introduced. Generally speaking, the implementation of the new method went well. There were indications, however, of some inaccuracies regarding target animal specification in delivery records. The expert panel feels the quality management systems should underscore the importance of the relevant target animal being specified each time a veterinarian records delivery data.
- **Poultry farming sector:** The SDa and the poultry farming sector have agreed to start recording antibiotic use in terms of defined daily doses animal rather than treatment days from January 2017 onwards. The SDa support the incorporation of a limited number of growth curves. In light of this new calculation method, the poultry farming sector has drawn up an Standard Operating Procedure (SOP) detailing how the $DDDA_F$ will be calculated. The SOP should soon be ready for SDa approval, after which the poultry farming subsectors can implement it in their databases.
- **Cattle farming sector:** The SDa and the cattle farming sector will discuss whether young stock up to 56 days of age should be included as a separate category when calculating a cattle farm's usage level.

For each of the livestock sectors, a revision of the calculation method also requires revision of the benchmark thresholds.
The poultry farming sector is the first livestock sector that has drawn up its own calculation method SOP (for the broiler farming sector), albeit within an SDa-defined framework. The expert panel aims for the SOPs for all livestock sectors to be revised and agreed upon by the end of 2016.

The SDa expert panel has noticed discrepancies in how the various livestock sectors present usage data to livestock farmers and veterinarians. It does acknowledge, however, that the livestock sectors may have valid reasons for presenting their data in a particular way. If necessary, the expert panel will work towards some level of harmonization in the way results are presented in the years to come. In principle, this should not affect the sector-specific nature of such notifications.

Towards prudent usage of antibiotics in the Dutch livestock sector: the importance of new benchmark thresholds

Over the past few years, the Dutch livestock sector has managed to decrease the amounts of antibiotics used. The implementation of benchmarking methods for livestock farms and veterinarians contributed significantly to this success. The SDa expert panel defined its first benchmark thresholds for livestock farms in 2011. The current benchmarking methods are based on a pragmatic approach aimed at identifying relative differences in usage levels and prescription patterns between livestock farms and veterinarians, respectively. The findings are used to reduce the amounts of antibiotics administered or prescribed by high-level users or prescribers in particular.

After having applied the benchmarking method for several years, the expert panel now feels it is time to revise certain aspects:

- Up to now, the usage levels reported and benchmark thresholds used were different for white veal farms and rosé veal farms. The expert panel wants to harmonize the benchmark thresholds for both types of veal farms, while still taking relevant subsector-specific differences into account. It has therefore requested the veal farming sector to identify such differences. The expert panel hopes to finalize this process later this year.
- In 2015, a new calculation method was introduced for the pig farming sector. As a result, usage levels are now reported based on the type of pigs concerned, with three types of pigs (animal categories) being distinguished and three corresponding benchmark thresholds being applied. At the moment, there are some concerns as to whether delivery records are always being attributed to the correct animal category. This is why the expert panel has decided that for weaner pigs, adjusted benchmark thresholds be used temporarily. As of January 1, 2017, the signaling and action thresholds applied for weaner pigs are 20 $DDDA_F$ and 40 $DDDA_F$, respectively. Final benchmark thresholds will be communicated once there is certainty regarding the accuracy of recorded delivery data.

Benchmark thresholds will remain an important factor in efforts aimed at prudent usage of antibiotics. The expert panel has noticed distinct changes in several livestock sectors' usage patterns over the past few years, and feels this should be reflected in the benchmarking method used for the sectors concerned. The following pages will describe how this can be achieved.

The future of benchmarking

As long as people keep and produce livestock, they will continue to use antibiotics. This should, however, not necessarily be a problem, as antibiotics can be used prudently in veterinary medicine. Prudent use in veterinary medicine does require an accurate diagnosis, usage being limited to specific indications, and adequate and timely treatment of affected animals without resorting to herd or flock treatment if individual treatment is possible. Hygiene, biosecurity measures and good farm management practices are cornerstones of disease prevention in agricultural livestock. These aspects are closely associated with prudent usage of antibiotics. Although there is a clear correlation between usage of antibiotics and the prevalence of antibiotic resistance, detailed analyses have not resulted in a benchmarking method that allows for determination of resistance-informed benchmark thresholds (SDa 2016).

The SDa aims to quantify prudent veterinary usage of antibiotics for each of the livestock sectors. This requires identification and specification of factors contributing to high- and low-level usage of antibiotics.

Critical success factors

Analysis of critical success factors is necessary in order for livestock farmers to responsibly (i.e. without compromising animal welfare) continue reducing the amounts of antibiotics used. Assessments and targeted interventions are needed to reduce the amounts of antibiotics used at livestock farms with high usage levels, and to limit variation in usage levels within the livestock sectors concerned. A critical success factor-informed approach lends itself very well to reduce the amounts of antibiotics used at livestock farms with action or signaling zone usage levels. Factors contributing to high usage levels can be identified by comparing livestock farms with low usage levels ('green' livestock farms) with livestock farms with higher usage levels ('orange' and 'red' livestock farms). Once the contributing factors are identified, appropriate interventions can be specified. These interventions should help individual livestock farms to responsibly limit the amounts of antibiotics used. The interventions can be incorporated in sector-specific improvement measures to be taken by orange and red livestock farms in order to bring their usage levels in line with those of other livestock farms in the livestock sector concerned. The expert panel has noticed that only a small number of livestock sectors have already developed a clearly defined critical success factor-informed approach. It does expect this approach to be further substantiated over the coming period.

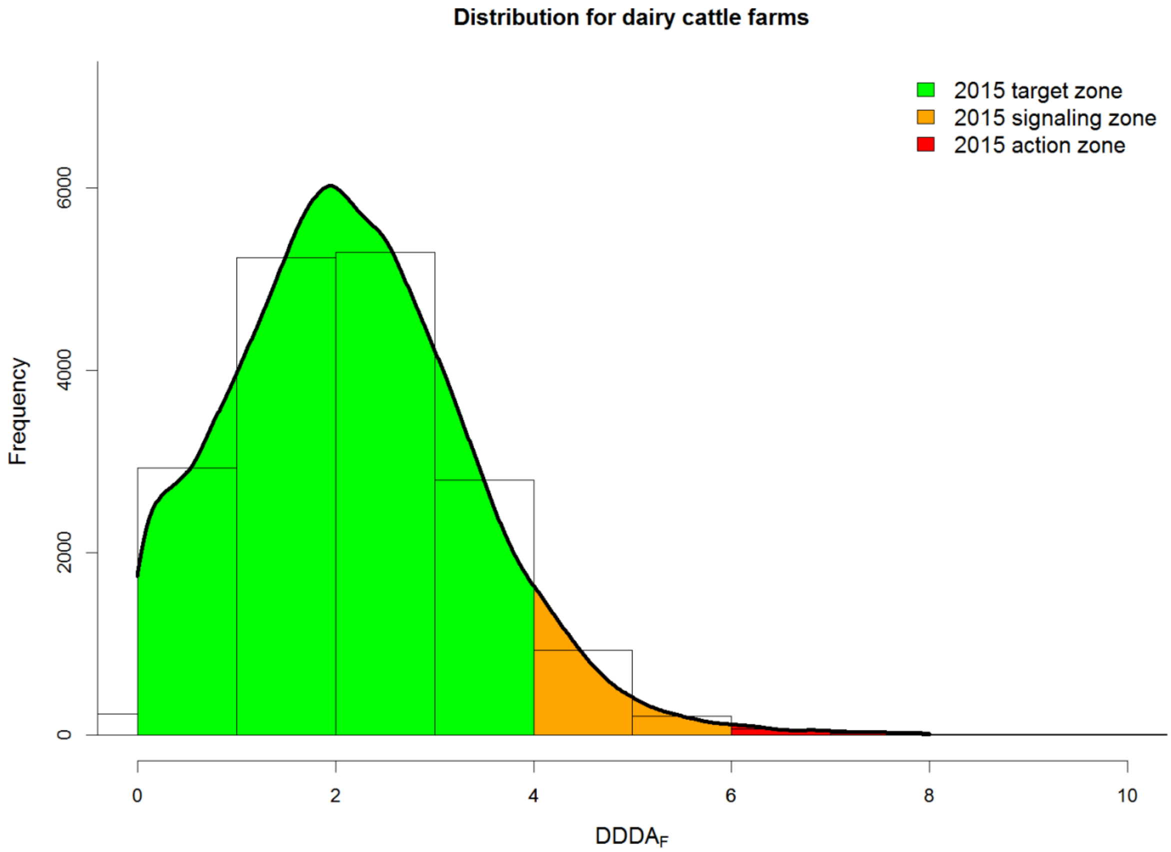
Benchmark thresholds for livestock farms with usage levels indicating prudent veterinary usage of antibiotics

In several livestock sectors or subsectors the expert panel has observed the development of usage patterns that are characterized by regular zero-level usage, limited variation between individual livestock farms in the amounts of antibiotics used, and limited usage-level changes over time. These characteristics indicate near-optimum usage patterns.

The dairy cattle farming sector is a livestock sector currently undergoing such a development. The dairy cattle farming sector's usage level distribution is narrow, with minimal usage having been recorded for a large proportion of farms, and some asymmetry towards higher usage levels (see Figure 3; detailed information on this graph is included in the appendices). Dairy cattle farms with usage levels exceeding 4-5 $DDDA_F$ a year were an exception. Due to the narrow distribution and the fact that through the years, most dairy cattle farms have moved relatively randomly throughout the distribution, the current benchmark thresholds for the dairy cattle farming sector are based on the values representing the 80th and 90th percentiles. For the other livestock sectors, values representing the 50th and 75th percentiles are used. The benchmarking results for the dairy cattle farming sector may still show a certain level of heterogeneity, however, since dairy cattle are not categorized by age group. As a result, dairy cattle farms with a larger proportion of adult cows may score slightly better, since antibiotics are administered less frequently to adult cows. Prior analyses by the expert panel have shown this effect is limited, but it will nevertheless be taken into account when new, and potentially final, benchmark thresholds are being defined.

The expert panel expects it will be able to redefine the benchmark thresholds for dairy cattle farms and possibly most other cattle farms as well later this year. The revised benchmark thresholds should represent prudent usage of minimal amounts of antibiotics. It expects that the revised benchmark thresholds will only require very sporadic further adjustments in the years to come.

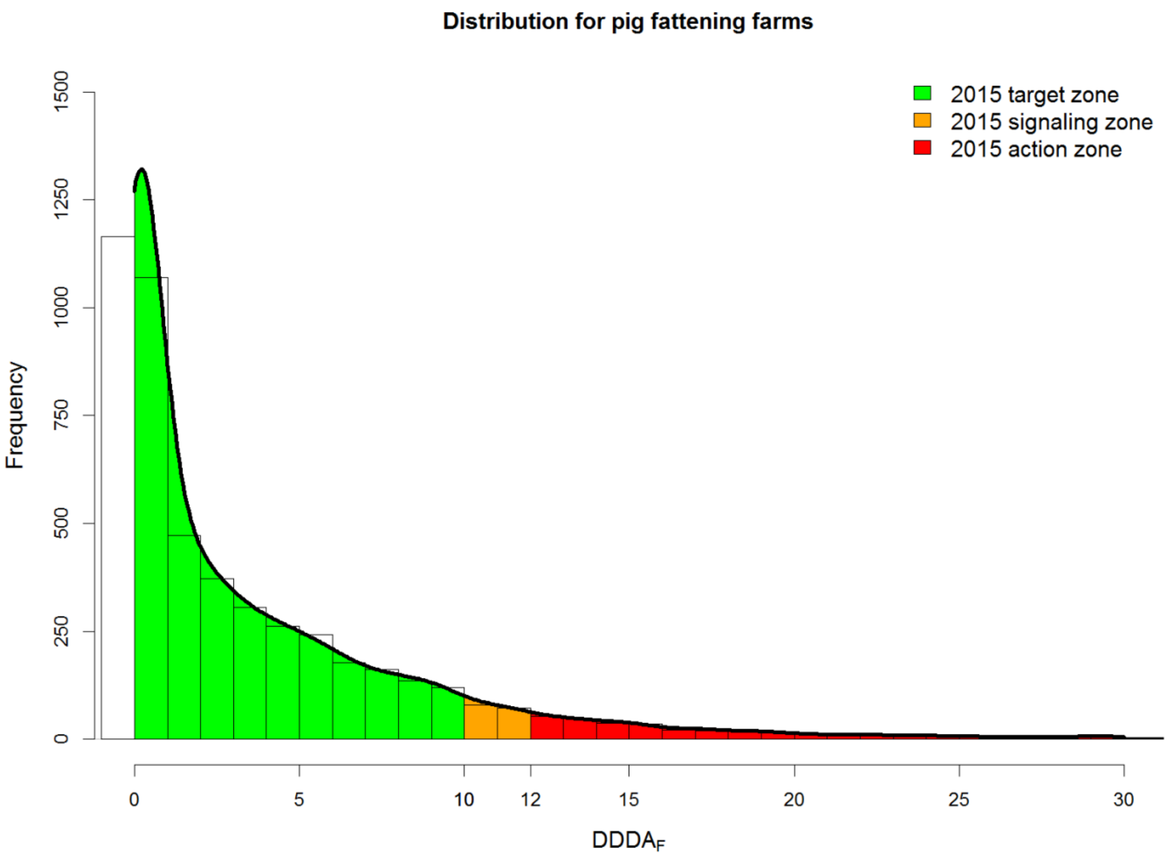
Figure 3. Distribution of usage levels recorded for individual dairy cattle farms, in $DDDA_F$



In some of the livestock sectors, only particular types of farms show a similar development in usage patterns. This is the case for certain pig farms (farms with fattening pigs and possibly farms with sows/suckling piglets as well) and rosé veal fattening farms. The paragraph below describes the development observed for farms with fattening pigs.

In absolute terms, usage levels of pig fattening farms are low. Most pig fattening farms have recorded zero- or low-level usage (only several $DDDA_F$ per year). For many farms only very limited year-to-year movement throughout the distribution has been recorded, indicating limited year-to-year variation for the pig farms concerned. The distribution does, however, have a long tail showing extreme usage levels amounting to tens of $DDDA_F$ per year. It should also be noted that the base of the tail is located in the area still representing the green, target level zone. Given the shape of the distribution, application of the current target zone is no longer justified. A move towards a final signaling threshold of about 3-5 $DDDA_F$ seems to be reasonable. Currently, 30-40% of the pig fattening farms still have usage levels exceeding the proposed threshold. 7% of the pig fattening farms have usage levels positioning them in the current action zone, with 20% of them having recorded structurally high usage levels. Examining which factors cause usage levels exceeding 5-10 $DDDA_F$ could lead to improvements. It should also help identify whether the expert panel was correct in its assessment, and whether usage of a substantial proportion of the antibiotics administered at pig fattening farms with structurally high usage levels could indeed have been avoided. Once more information on these matters is available (in 2017 at the latest), the temporary benchmark thresholds can be adjusted based on the new findings. The new findings will presumably enable the expert panel to derive long-term benchmark thresholds.

Figure 4. Distribution of usage levels recorded for individual pig fattening farms, in $DDDA_F$



For the types of livestock farms for which the expert panel feels it could define benchmark thresholds representing prudent veterinary use of antibiotics, the expert panel plans to only define signaling thresholds (and therefore only distinguish between green and orange zones). If one of these livestock farms were to exceed the signaling threshold two years in a row, it should be required to take action, such as drawing up an additional farm-specific improvement plan aimed at bringing its antibiotic use in line with the desired usage level. This should be included in the IKB system concerned.

Pragmatic benchmark thresholds
For all other livestock sectors it will take longer for their long-term benchmark thresholds to be implemented, probably at least another five to ten years. This is due to the relatively wide and irregular distributions observed for the remaining livestock sectors and types of livestock farms or categories of animals concerned. Wide distributions with several irregularities (e.g. multiple peaks) indicate heterogeneity in terms of usage levels and a large degree of variation over time. The expert panel cannot predict when the desired prescription patterns will be recorded and whether the livestock sectors concerned will be sufficiently homogenous to enable implementation of long-term benchmark thresholds that represent prudent veterinary use of antibiotics.

Substantial efforts are expected in these livestock sectors, and the level of aspiration for these sectors is high. Currently, only pragmatic benchmark thresholds can be defined for the livestock farms concerned, similar to the ones applied in the previous years. In due time, once more homogenous usage patterns have emerged, these thresholds could be replaced by benchmark thresholds representing prudent veterinary use of antibiotics. As long as pragmatic benchmark thresholds are being applied, the expert panel will continue to distinguish between the existing three benchmark zones (green, orange and red). This means it will continue to define both signaling and action thresholds for the sectors concerned. Ideally, in such cases the signaling threshold will correspond to the long-term target level identified for prudent veterinary use of antibiotics, i.e. the level to be met by the great majority of livestock farms in the livestock sector concerned. The expert panel will then gradually move the action threshold towards the signaling threshold. The number of intermediate steps and time required to eventually arrive at the signaling threshold will be determined by the expert panel. Once a livestock sector's action and signaling values coincide, only two benchmark zones can be distinguished. By then, the final situation has been realized. If for a particular livestock sector the level of knowledge or insight does not allow for the identification of a well-substantiated signaling threshold representing prudent usage of antibiotics, application of pragmatic signaling and action thresholds will have to be continued. By definition, pragmatic benchmark thresholds have to be revised after a number of years. The SDa expert panel will determine and communicate how long a particular pragmatic benchmark threshold will remain valid. Livestock sectors monitored by means of pragmatic benchmark thresholds will need to intensify their efforts in order to realize target zone usage levels at each individual livestock farm.

Revision of the benchmark thresholds
By revising the benchmarking method, the SDa expert panel wants to introduce a sector-specific approach. This means the benchmarking method has to be customized for each individual livestock sector. The expert panel will therefore consult with each of the livestock sectors in order to agree on the specific course of action. In light of the revision, the expert panel has closely analyzed the existing benchmark thresholds. It first assessed which livestock sectors qualify for identification of more or less final benchmark thresholds, and which livestock sectors are likely to require another period with monitoring based on pragmatic benchmark thresholds. It then explained the new benchmarking method to livestock sector representatives. In the months to come, the expert panel and the various livestock sectors will consult closely on the benchmark threshold revision process. The expert panel expects that for several livestock sectors, this will soon result in new benchmark

thresholds. In late 2017/early 2018 at the latest, updated benchmark thresholds should have been defined for each of the livestock sectors. Factors contributing to the amounts of antibiotics used will have to be taken into account in some cases, which means the expert panel will have to identify the critical success factors for the livestock sector concerned before it can redefine the benchmark thresholds. Critical success factor-informed assessment of signaling and action zone farms will help determine which proportion of the antibiotics used represents avoidable antibiotic use. A similar course of action will be taken with regard to veterinarians.

The number of livestock farms included in the signaling and action zones varies per livestock sector. For each livestock sector, the SDa expert panel has calculated the decline in antibiotic use that can be expected if all individual livestock farms were to achieve a target zone usage level. According to these calculations, the amounts of antibiotics used in a particular livestock sector can be expected to drop by 1-20%, depending on the sector concerned, if none of the livestock farms were to record an action zone usage level. If signaling zone usage levels are included in these calculations, the resulting drop in percentages increase substantially. This information can be obtained for each of the livestock sectors, and helps the expert panel decide whether or not monitoring in the next period should be based on pragmatic benchmark thresholds. The expert panel wants to quantify the aspiration levels for individual livestock sectors by defining explicit objectives. As a result of this approach, the targeted reductions in the amounts of antibiotics used are expected to differ for the various livestock sectors.

Benchmark thresholds for veterinarians

Since 2015, veterinarians active within one or more of the monitored livestock sectors have access to their recorded prescription patterns, represented by the Veterinary Benchmark Indicator. The expert panel has noted that in human medicine, processes are being implemented that enable physicians to discuss usage of antibiotics with their colleagues. It is aware of similar processes occasionally being implemented for veterinarians as well, and it hopes they will soon be applied on a larger scale.

In its 2014 report, the expert panel already noted that with the current benchmark thresholds for veterinarians it takes quite a lot for a veterinarian's prescription pattern to be classified as too high. It is one of the reasons for reevaluating between-farm usage level variations, and prescription pattern variations between individual veterinarians. Also relevant in this respect is the fact that in 2015, new calculation methods have been introduced for several livestock sectors. This means that benchmark thresholds have to be adjusted accordingly. In 2016, the expert panel will therefore revise the benchmarking method used for veterinarians. In doing so, it aims to bring this benchmarking method more in line with the method used for benchmarking livestock farms.

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Appendices

Trends in defined daily doses animal (in $DDDA_{NAT}$) observed in the dairy cattle farming sector

Table A1. $DDDA_{NAT}$ figures recorded for the dairy cattle farming sector. These additional analyses were conducted to facilitate comparison with LEI Wageningen UR's MARAN data

	Dairy cattle farms			
Number of dairy cattle farms with delivery records	18,053	18,005	17,747	17,737
Pharmacotherapeutic group	2012	2013	2014	2015
Amphenicols	0.04	0.05	0.06	0.06
Aminoglycosides	0.00	0.00	0.00	0.01
1st- and 2nd-gen. cephalosporins	0.04	0.03	0.02	0.02
3rd- and 4th-gen. cephalosporins	0.04	0.00	0.00	0.00
Quinolones	0.00	0.00	0.00	0.00
Fluoroquinolones	0.01	0.00	0.00	0.00
Macrolides/lincosamides	0.07	0.06	0.10	0.11
Penicillins	1.86	2.19	2.00	1.87
Pleuromutilins	-	-	-	-
Polymyxins	0.06	0.02	0.01	0.01
Tetracyclines	0.43	0.42	0.39	0.37
Trimethoprim/sulfonamides	0.20	0.22	0.24	0.25
Fixed dose combinations	1.30	1.01	0.48	0.42
Other	-	-	-	-
Overall	**4.06**	**4.03**	**3.30**	**3.11**

*Number of kilograms of animal estimated based on data provided by EUROSTAT: 924,600, 958,200, 966,000 and 1,030,200 x 1,000 kg for the years 2012, 2013, 2014 and 2015, respectively.

Computational basis for Figure 1 – Long-term developments in usage of antibiotics

- Until 2010, defined daily doses animal were based on data reported by LEI Wageningen UR (DD/AY). From 2011 onwards, SDa-reported defined daily doses animal ($DDDA_F$) have been used;
- The 2011 $DDDA_{NAT}$ figures were estimated as follows:
    - For the veal and pig farming sectors: by means of the 2011:2012 $DDDA_F$ ratio (with weighting based on the average number of kilograms present at individual farms);
    - For the dairy cattle farming sector: by means of the 2011:2012 DD/AY ratio;
    - For the broiler farming sector: by means of the 2011:2012 treatment days ratio (with weighting based on the number of animal days at individual farms);
- Data on the overall number of kilograms of animal in a particular livestock sector, on which the $DDDA_{NAT}$ figures are based, were provided by EUROSTAT (for the pig and dairy cattle farming sectors) and CBS (for the broiler and veal farming sectors);
- 95% confidence intervals were based on the corresponding confidence intervals for the weighted $DDDA_F$ figures.

Numbers of animals in the Dutch livestock sector

Table A2a. Numbers of agricultural livestock (x1,000) from 2004 to 2015 in the Netherlands, based on data provided by CBS (for the poultry and veal farming sectors) and EUROSTAT (for the remaining livestock sectors)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Piglets (<20 kg)	4,300	4,170	4,470	4,680	4,555	4,809	4,649	4,797	4,993	4,920	5,116	5,408
Sows	1,125	1,100	1,050	1,060	1,025	1,100	1,098	1,106	1,081	1,095	1,106	1,053
Fattening pigs	3,850	3,830	4,040	4,010	4,105	4,099	4,419	4,179	4,189	4,209	4,087	4,223
Other types of pigs	1,865	1,900	1,660	1,960	2,050	2,100	2,040	2,021	1,841	1,789	1,765	1,769
Turkeys	1,238	1,245	1,140	1,232	1,044	1,060	1,036	990	827	841	794	863
Other types of poultry	86,776	94,220	93,195	94,479	98,184	98,706	102,585	98,253	96,268	98,587	103,944	107,743
With broilers accounting for	50,127	54,660	42,289	44,262	44,496	41,914	43,352	44,358	43,285	44,748	47,020	49,107
Veal calves	765	829	844	860	899	894	928	906	908	925	921	909
Other types of cattle	2,984	2,933	2,849	2,960	3,083	3,112	3,039	2,993	3,045	3,064	3,230	3,360
Sheep	1,700	1,725	1,755	1,715	1,545	1,091	1,211	1,113	1,093	1,074	1,070	1,032

Table A2b. Standardized mean animal body weights used for determining the $DDDA_{NAT}$ figures, by livestock sector and type of animal

Livestock sector	Type of animal	Standardized body weight in kg[1]
Veal farming sector		172
Pig farming sector	Piglets (<20 kg)	10
	Sows	220
	Fattening pigs	70.2
	Other types of pigs	70
Broiler farming sector		1
Turkey farming sector		6
Cattle farming sector	Dairy cattle	600
	Other types of cattle	500

[1] Body weights as defined by LEI Wageningen UR, determined at the start of the agricultural census in the Netherlands. The standardized body weights are to be multiplied by the numbers of animals reported by CBS/EUROSTAT.

Table A2c. Standardized mean animal body weights used for determining the $DDDA_F$ figures, by livestock sector and type of animal

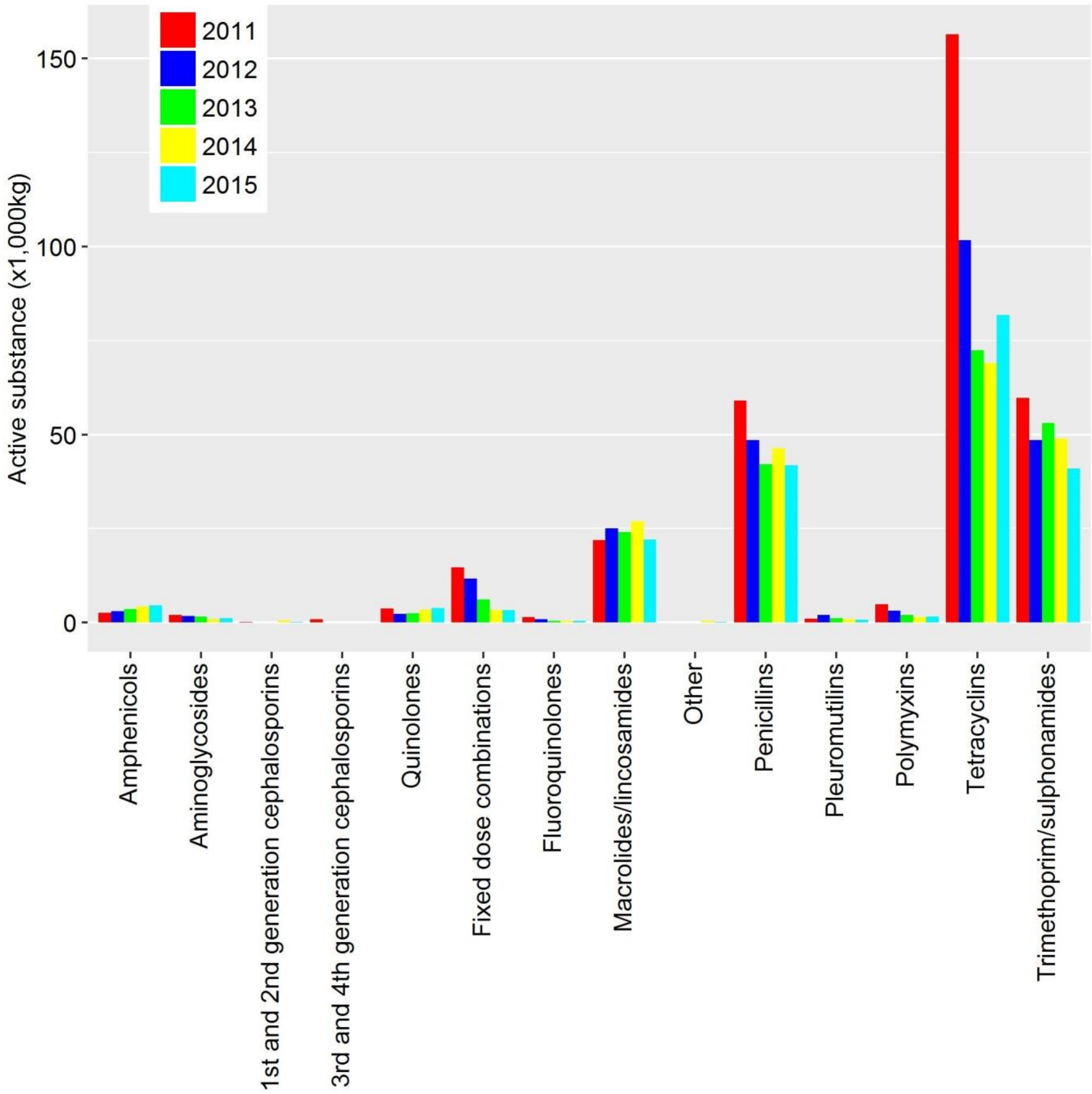
Livestock sector	Type of animal	Specification	Age	Standardized body weight in kg[1]
Veal farming sector	Calves at white veal farms		0-222 days	160
	Calves at rosé veal starter farms		0-98 days	77.5
	Calves at rosé veal fattening farms		98-256 days	232.5
	Calves at rosé veal combination farms		0-256 days	192
Pig farming sector	Sows/suckling piglets	Sows (all females that have been inseminated), breeding boars and heat-check boars		220
		Suckling piglets	0-25 days	4.5
		Replacement gilts	7 months - 1st insemination	135
	Weaner pigs	Weaned piglets	25-74 days	17.5
	Fattening pigs/gilts	Fattening pigs	74 days - 5 months	70
		Gilts	74 days - 7 months	70
Broiler farming sector			0-42 days	1
Turkey farming sector		Toms		10.5
		Hens		5.6
Cattle farming sector	[2]	Dairy cattle	>2 years	600
		Heifers	1-2 years	440
		Yearlings	56 days - 1 year	235
		Calves (female)	<56 days	56.5
		Beef bulls	>2 years	800
		Beef bulls	1-2 years	628
		Beef bulls	56 days - 1 year	283
		Calves (male)	<56 days	79

[1] Body weights (in kilograms) as determined in consultation with the livestock sectors concerned. They may be adjusted if deemed necessary (e.g. in response to refinement of the benchmarking method).

[2] Livestock farms in the cattle farming sector are categorized based on whether or not they produce milk. They are classified as either dairy cattle farms or non-dairy cattle farms. Non-dairy cattle farms include rearing farms (with <40% of cattle present being male and none of the cows being over 2 years of age), suckler cow farms (with <40% of cattle present being male and some of the cows being over 2 years of age) and beef farms (with >40% of cattle present being male).

Sales figures for antibiotics, by class of antibiotics

Figure A1. Sales of antibiotics from 2011 to 2015, by class of antibiotics



Usage of antibiotics in $DDDA_F$ in veal calves

White veal calves

Number of white veal farms: 855
Number of white veal farms with $DDDA_F$ = 0: 7
Number of white veal farms that used third- and fourth-generation cephalosporins: 0
Number of white veal farms that used fluoroquinolones: 96

Table A3. Usage of antibiotics in $DDDA_F$ at white veal farms from 2011 to 2015

Year	N	Mean	Median	P75	P90
2011	934	41.1	33.2	44.9	57.8
2012	904	33.6	30.7	40.1	50.9
2013	862	31.4	26.2	35.1	45.2
2014	864	24.5	23.4	31.0	37.8
2015	855	25.1	24.3	31.7	38.3

Figure A2. $DDDA_F$ frequency distribution for 855 white veal farms in 2015

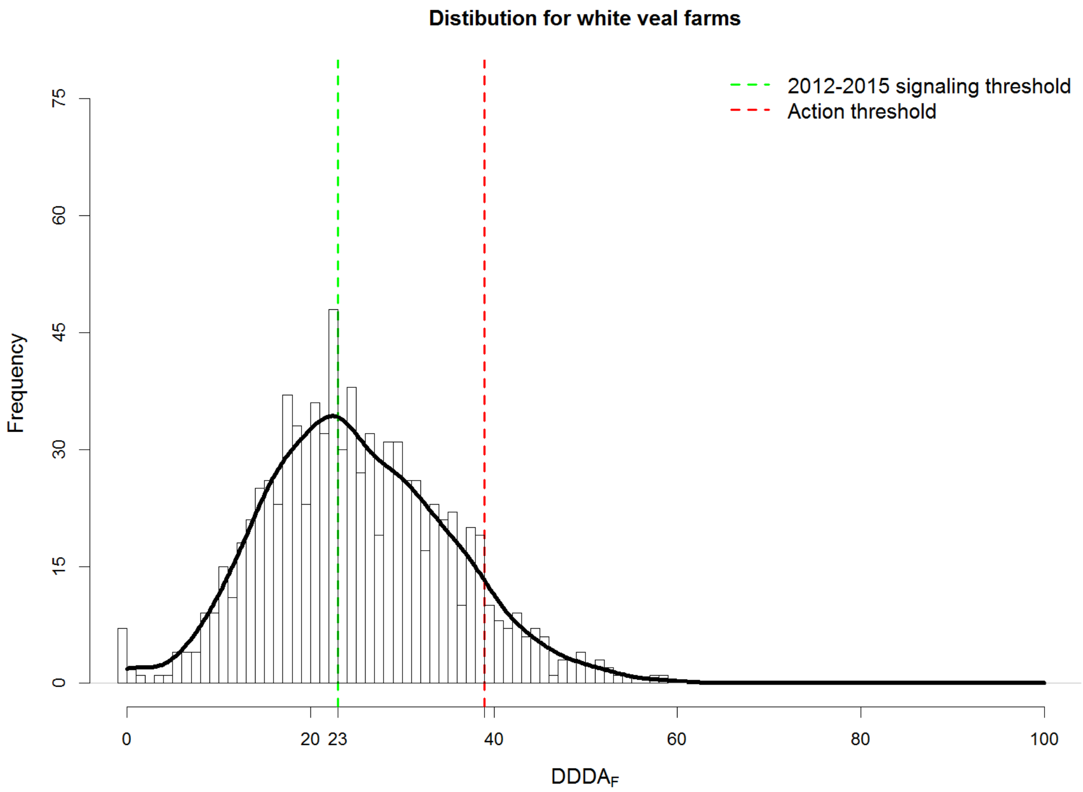


Table A4. Usage in $DDDA_F$ at white veal farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F$ = 0	$DDDA_F$ Median	P75	Mean
Amphenicols	Intramammary	855	0.00	0.00	0.00
Amphenicols	Oral	855	0.00	0.00	0.00
Amphenicols	Parenteral	14	1.17	1.78	1.37
Aminoglycosides	Intramammary	855	0.00	0.00	0.00
Aminoglycosides	Oral	535	0.00	0.03	0.13
Aminoglycosides	Parenteral	502	0.00	0.08	0.08
Quinolones	Intramammary	855	0.00	0.00	0.00
Quinolones	Oral	676	0.00	0.00	0.83
Quinolones	Parenteral	855	0.00	0.00	0.00
Fixed dose combinations	Intramammary	855	0.00	0.00	0.00
Fixed dose combinations	Oral	855	0.00	0.00	0.00
Fixed dose combinations	Parenteral	831	0.00	0.00	0.00
Fluoroquinolones	Intramammary	855	0.00	0.00	0.00
Fluoroquinolones	Oral	845	0.00	0.00	0.02
Fluoroquinolones	Parenteral	763	0.00	0.00	0.01
Macrolides/lincosamides	Intramammary	855	0.00	0.00	0.00
Macrolides/lincosamides	Oral	46	4.15	5.12	4.00
Macrolides/lincosamides	Parenteral	114	0.20	0.51	0.36
Penicillins	Intramammary	852	0.00	0.00	0.00
Penicillins	Oral	307	0.54	4.07	2.42
Penicillins	Parenteral	26	0.42	0.74	0.57
Polymyxins	Intramammary	855	0.00	0.00	0.00
Polymyxins	Oral	731	0.00	0.00	0.23
Polymyxins	Parenteral	673	0.00	0.00	0.01
Tetracyclines	Intramammary	855	0.00	0.00	0.00
Tetracyclines	Oral	14	12.01	16.14	12.86
Tetracyclines	Parenteral	669	0.00	0.00	0.02
Trimethoprim/sulfonamides	Intramammary	855	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	359	0.42	3.35	2.03
Trimethoprim/sulfonamides	Parenteral	159	0.06	0.13	0.12

Calves at rosé veal starter farms

Number of rosé veal starter farms: 247
Number of rosé veal starter farms with $DDDA_F$ = 0: 7
Number of rosé veal starter farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal starter farms that used fluoroquinolones: 9

Table A5. Usage of antibiotics in $DDDA_F$ at rosé veal starter farms from 2011 to 2015

Year	N	Mean	Median	P75	P90
2011	207	120.0	94.4	127.8	171.5
2012	189	97.5	84.2	107.1	143.1
2013	264	115.6	80.9	102.2	131.0
2014	260	79.6	77.7	97.2	113.9
2015	247	82.7	83.0	101.5	115.1

Figure A3. $DDDA_F$ frequency distribution for 247 rosé veal starter farms in 2015

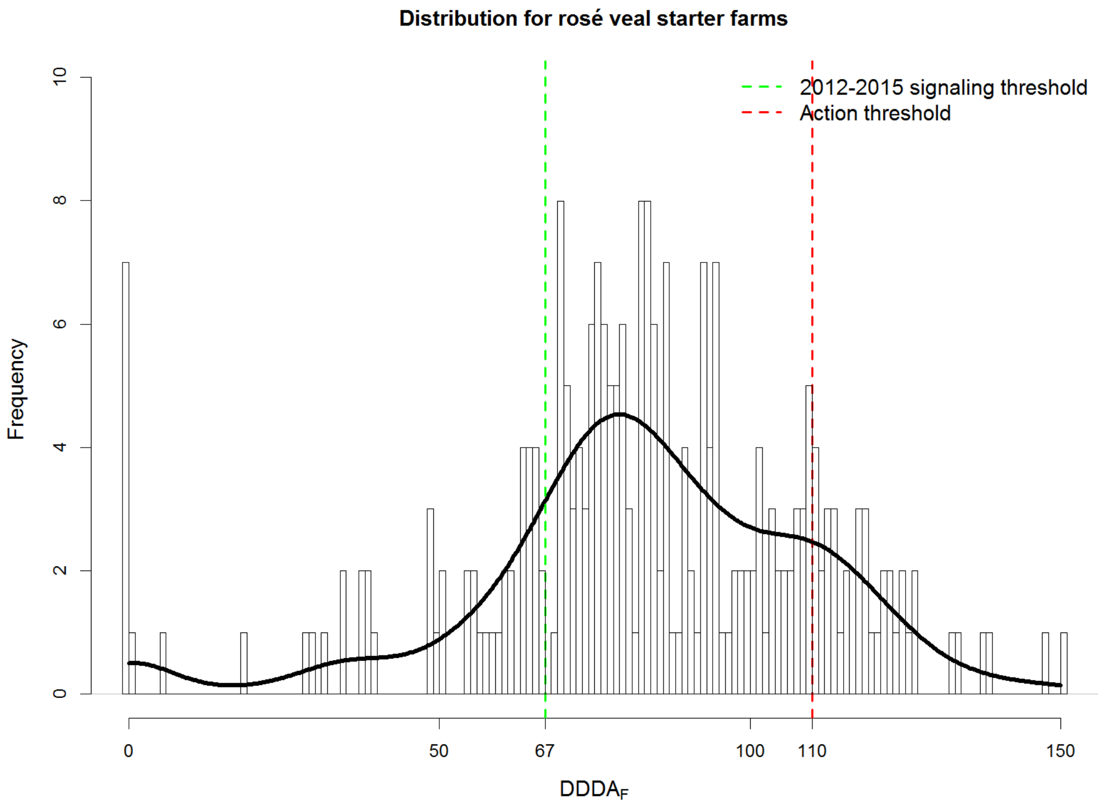


Table A6. Usage in $DDDA_F$ at rosé veal starter farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F$ = 0	$DDDA_F$ Median	P75	Mean
Amphenicols	Intramammary	247	0.00	0.00	0.00
Amphenicols	Oral	247	0.00	0.00	0.00
Amphenicols	Parenteral	8	6.00	9.68	7.61
Aminoglycosides	Intramammary	247	0.00	0.00	0.00
Aminoglycosides	Oral	179	0.00	0.05	0.50
Aminoglycosides	Parenteral	134	0.00	0.45	0.34
Quinolones	Intramammary	247	0.00	0.00	0.00
Quinolones	Oral	218	0.00	0.00	0.54
Quinolones	Parenteral	247	0.00	0.00	0.00
Fixed dose combinations	Intramammary	246	0.00	0.00	0.00
Fixed dose combinations	Oral	247	0.00	0.00	0.00
Fixed dose combinations	Parenteral	242	0.00	0.00	0.00
Fluoroquinolones	Intramammary	247	0.00	0.00	0.00
Fluoroquinolones	Oral	247	0.00	0.00	0.00
Fluoroquinolones	Parenteral	238	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary	247	0.00	0.00	0.00
Macrolides/lincosamides	Oral	20	17.16	21.59	15.65
Macrolides/lincosamides	Parenteral	29	0.77	1.73	1.36
Penicillins	Intramammary	247	0.00	0.00	0.00
Penicillins	Oral	145	0.00	1.80	2.41
Penicillins	Parenteral	16	1.70	2.78	2.12
Polymyxins	Intramammary	247	0.00	0.00	0.00
Polymyxins	Oral	216	0.00	0.00	0.46
Polymyxins	Parenteral	184	0.00	0.02	0.05
Tetracyclines	Intramammary	247	0.00	0.00	0.00
Tetracyclines	Oral	12	43.99	52.63	42.10
Tetracyclines	Parenteral	193	0.00	0.00	0.27
Trimethoprim/sulfonamides	Intramammary	247	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	68	6.65	11.95	8.68
Trimethoprim/sulfonamides	Parenteral	47	0.27	0.58	0.60

Calves at rosé veal fattening farms

Number of rosé veal fattening farms: 638
Number of rosé veal fattening farms with $DDDA_F$ = 0: 93
Number of rosé veal fattening farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal fattening farms that used fluoroquinolones: 5

Table A7. Usage of antibiotics in $DDDA_F$ at rosé veal fattening farms from 2011 to 2015

Year	N	Mean	Median	P75	P90
2011	671	7.8	1.5	6.6	14.5
2012	717	5.8	2.3	7.3	15.5
2013	723	5.2	1.4	5.4	10.8
2014	663	3.4	1.2	4.5	9.5
2015	638	2.7	1.0	4.0	7.3

Figure A4. $DDDA_F$ frequency distribution for 638 rosé veal fattening farms in 2015

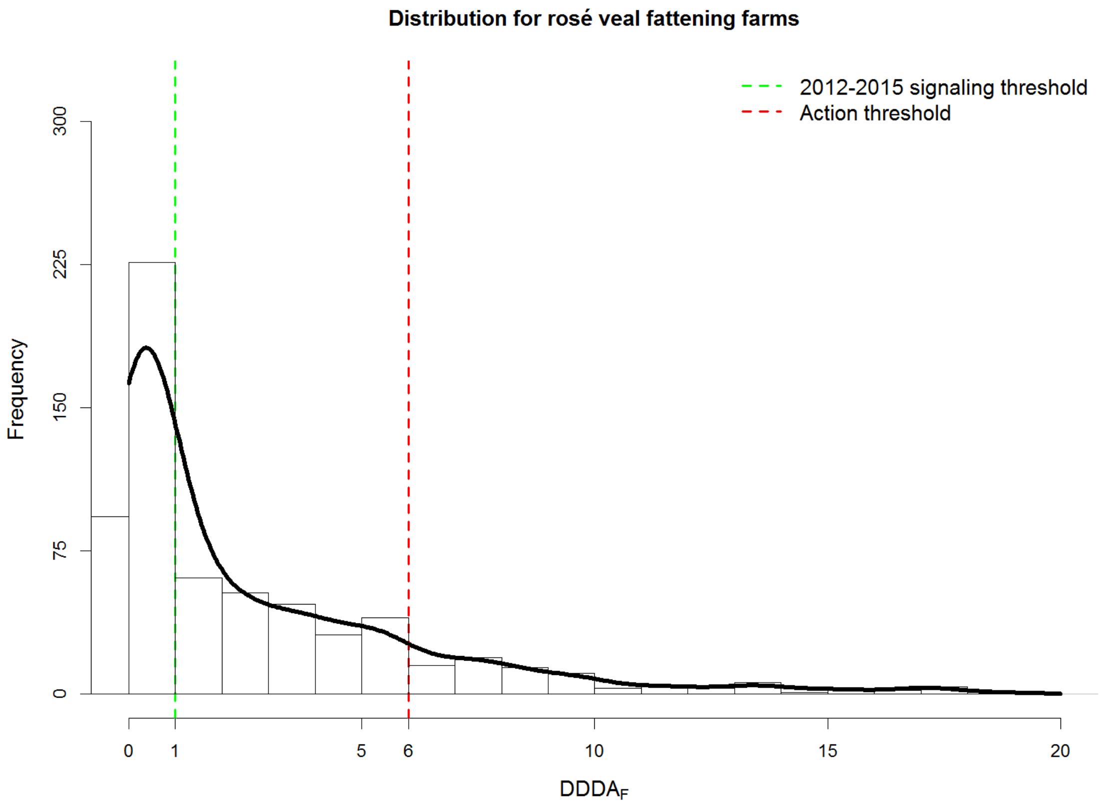


Table A8. Usage in $DDDA_F$ at rosé veal fattening farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Intramammary	638	0.00	0.00	0.00
Amphenicols	Oral	638	0.00	0.00	0.00
Amphenicols	Parenteral	148	0.30	0.58	0.43
Aminoglycosides	Intramammary	638	0.00	0.00	0.00
Aminoglycosides	Oral	638	0.00	0.00	0.00
Aminoglycosides	Parenteral	628	0.00	0.00	0.00
Fixed dose combinations	Intramammary	637	0.00	0.00	0.00
Fixed dose combinations	Oral	638	0.00	0.00	0.00
Fixed dose combinations	Parenteral	621	0.00	0.00	0.00
Fluoroquinolones	Intramammary	638	0.00	0.00	0.00
Fluoroquinolones	Oral	638	0.00	0.00	0.00
Fluoroquinolones	Parenteral	633	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary	638	0.00	0.00	0.00
Macrolides/lincosamides	Oral	593	0.00	0.00	0.07
Macrolides/lincosamides	Parenteral	422	0.00	0.05	0.12
Penicillins	Intramammary	638	0.00	0.00	0.00
Penicillins	Oral	625	0.00	0.00	0.01
Penicillins	Parenteral	286	0.04	0.21	0.16
Polymyxins	Intramammary	638	0.00	0.00	0.00
Polymyxins	Oral	635	0.00	0.00	0.00
Polymyxins	Parenteral	634	0.00	0.00	0.00
Tetracyclines	Intramammary	638	0.00	0.00	0.00
Tetracyclines	Oral	411	0.00	1.77	1.30
Tetracyclines	Parenteral	570	0.00	0.00	0.03
Trimethoprim/sulfonamides	Intramammary	638	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	511	0.00	0.00	0.51
Trimethoprim/sulfonamides	Parenteral	539	0.00	0.00	0.01

Calves at rosé veal combination farms

Number of rosé veal combination farms: 238
Number of rosé veal combination farms with $DDDA_F$ = 0: 24
Number of rosé veal combination farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal combination farms that used fluoroquinolones: 13

Table A9. Usage of antibiotics in $DDDA_F$ at rosé veal combination farms from 2011 to 2015

Year	N	Mean	Median	P75	P90
2011	313	34.6	17.3	29.7	45.7
2012	365	21.5	13.2	23.7	37.4
2013	276	11.7	10.1	16.2	23.8
2014	215	13.0	12.0	17.1	21.9
2015	238	11.8	11.2	16.2	21.4

Figure A5. $DDDA_F$ frequency distribution for 238 rosé veal combination farms in 2015

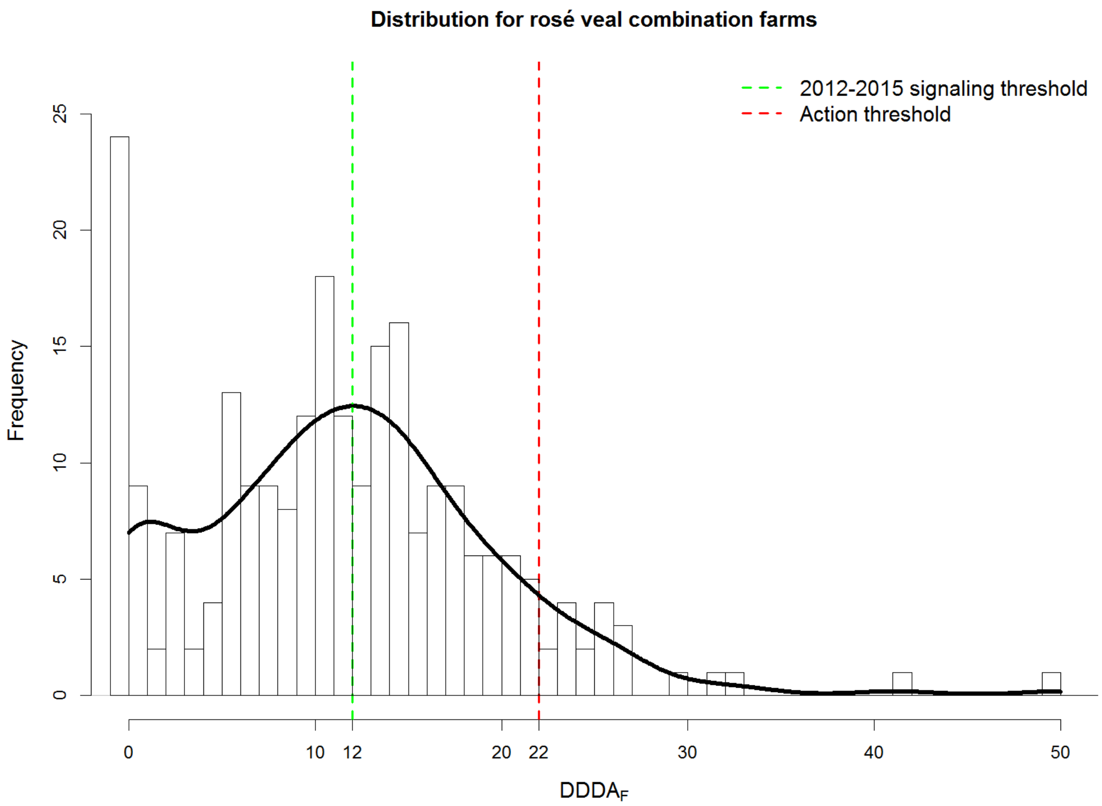


Table A10. Usage in $DDDA_F$ at rosé veal combination farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	$DDDA_F$ P75	$DDDA_F$ Mean
Amphenicols	Intramammary	238	0.00	0.00	0.00
Amphenicols	Oral	238	0.00	0.00	0.00
Amphenicols	Parenteral	34	1.06	1.81	1.30
Aminoglycosides	Intramammary	238	0.00	0.00	0.00
Aminoglycosides	Oral	196	0.00	0.00	0.07
Aminoglycosides	Parenteral	166	0.00	0.02	0.06
Quinolones	Intramammary	238	0.00	0.00	0.00
Quinolones	Oral	220	0.00	0.00	0.08
Quinolones	Parenteral	238	0.00	0.00	0.00
Fixed dose combinations	Intramammary	238	0.00	0.00	0.00
Fixed dose combinations	Oral	238	0.00	0.00	0.00
Fixed dose combinations	Parenteral	225	0.00	0.00	0.00
Fluoroquinolones	Intramammary	238	0.00	0.00	0.00
Fluoroquinolones	Oral	238	0.00	0.00	0.00
Fluoroquinolones	Parenteral	225	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary	238	0.00	0.00	0.00
Macrolides/lincosamides	Oral	79	1.59	2.62	1.68
Macrolides/lincosamides	Parenteral	64	0.13	0.39	0.37
Penicillins	Intramammary	236	0.00	0.00	0.00
Penicillins	Oral	168	0.00	0.11	0.30
Penicillins	Parenteral	44	0.23	0.57	0.51
Polymyxins	Intramammary	238	0.00	0.00	0.00
Polymyxins	Oral	222	0.00	0.00	0.08
Polymyxins	Parenteral	192	0.00	0.00	0.01
Tetracyclines	Intramammary	238	0.00	0.00	0.00
Tetracyclines	Oral	44	5.37	8.70	6.06
Tetracyclines	Parenteral	185	0.00	0.00	0.03
Trimethoprim/sulfonamides	Intramammary	238	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	106	0.31	1.66	1.15
Trimethoprim/sulfonamides	Parenteral	110	0.01	0.07	0.09

Usage of antibiotics in $DDDA_F$ at pig farms

Farms with sows and suckling piglets

Number of farms with sows and suckling piglets: 2,109
Number of farms with sows and suckling piglets with $DDDA_F = 0$: 164
Number of farms with sows and suckling piglets that used third- and fourth-generation cephalosporins: 0
Number of farms with sows and suckling piglets that used fluoroquinolones: 8

Table A11. Usage of antibiotics in $DDDA_F$ at farms with sows and suckling piglets

Year	N	Mean	Median	P75	P90
2015	2,109	5.3	3.1	6.8	12.7

Figure A6. $DDDA_F$ frequency distribution for 2,109 farms with sows and suckling piglets in 2015

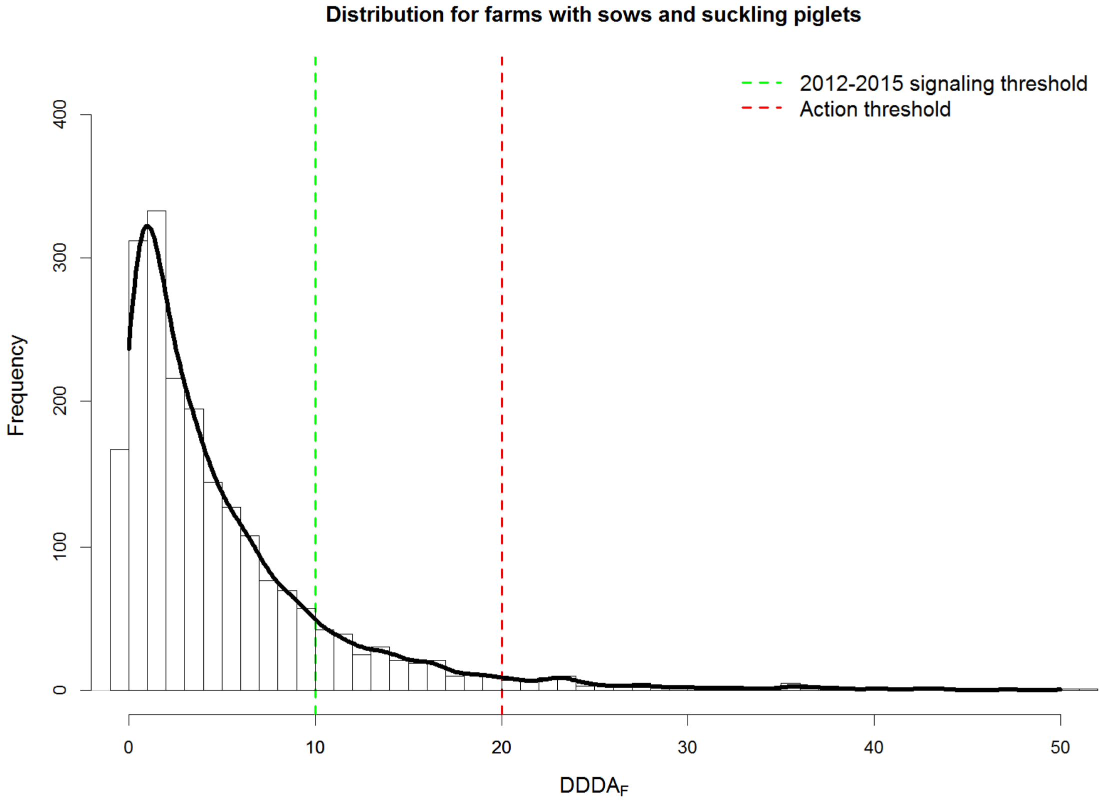


Figure A7. Mean antibiotic use at farms with sows and suckling piglets in 2015, by ATCvet group (left) and by first-, second- and third-choice products (right)

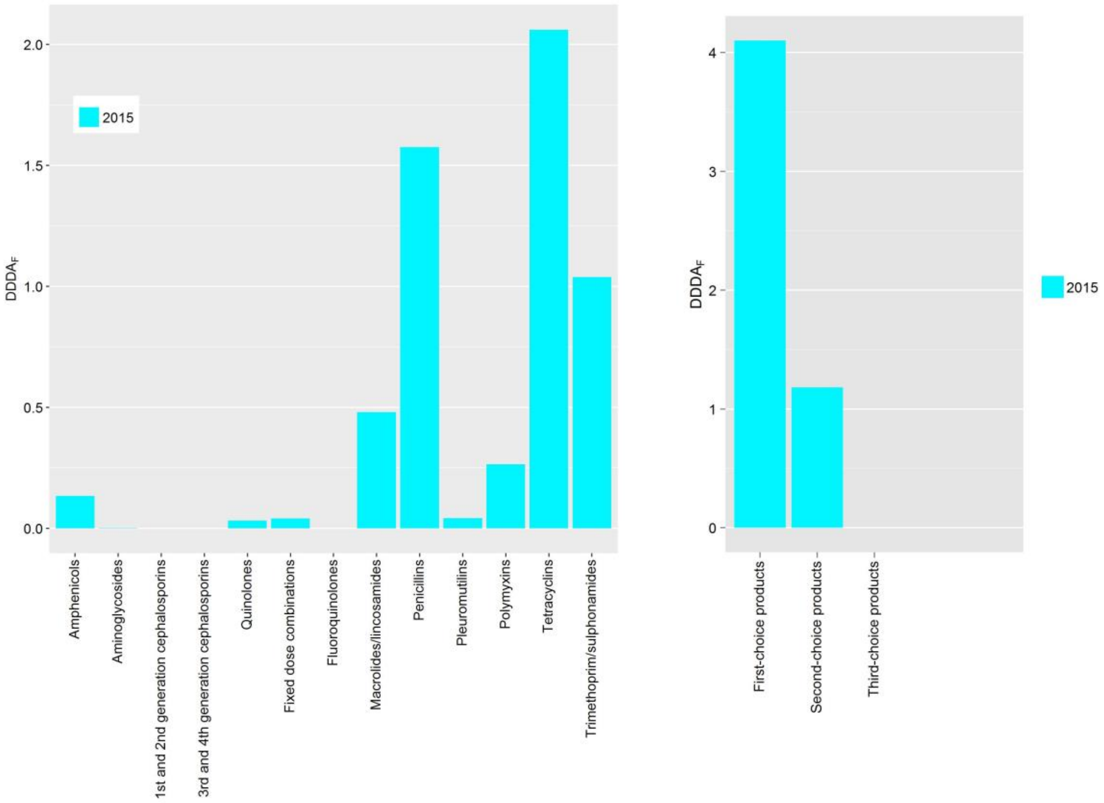


Table A12. Usage in $DDDA_F$ at farms with sows and suckling piglets in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Oral	2,103	0.00	0.00	0.00
Amphenicols	Parenteral	1,610	0.00	0.00	0.13
Aminoglycosides	Oral	2,101	0.00	0.00	0.00
Aminoglycosides	Parenteral	2,108	0.00	0.00	0.00
Quinolones	Oral	2,087	0.00	0.00	0.03
Quinolones	Parenteral	2,109	0.00	0.00	0.00
Fixed dose combinations	Oral	2,082	0.00	0.00	0.02
Fixed dose combinations	Parenteral	1,895	0.00	0.00	0.02
Fluoroquinolones	Oral	2,109	0.00	0.00	0.00
Fluoroquinolones	Parenteral	2,101	0.00	0.00	0.00
Macrolides/lincosamides	Oral	1,830	0.00	0.00	0.27
Macrolides/lincosamides	Parenteral	1,621	0.00	0.00	0.20
Penicillins	Oral	1,704	0.00	0.00	0.53
Penicillins	Parenteral	249	0.69	1.37	1.03
Pleuromutilins	Oral	2,078	0.00	0.00	0.04
Pleuromutilins	Parenteral	2,035	0.00	0.00	0.00
Polymyxins	Oral	1,735	0.00	0.00	0.17
Polymyxins	Parenteral	1,609	0.00	0.00	0.04
Tetracyclines	Oral	1,283	0.00	1.49	1.45
Tetracyclines	Parenteral	908	0.04	0.34	0.38
Trimethoprim/sulfonamides	Oral	1,353	0.00	0.33	0.67
Trimethoprim/sulfonamides	Parenteral	848	0.06	0.30	0.30

Weaner pigs

Number of weaner pig farms: 2,276
Number of weaner pig farms with $DDDA_F$ = 0: 443
Number of weaner pig farms that used third- and fourth-generation cephalosporins: 0
Number of weaner pig farms that used fluoroquinolones: 7

Table A13. Usage of antibiotics in $DDDA_F$ at weaner pig farms in 2015

Year	N	Mean	Median	P75	P90
2015	2,276	19.6	7.6	24.4	52.2

Figure A8. $DDDA_F$ frequency distribution for 2,276 weaner pig farms in 2015

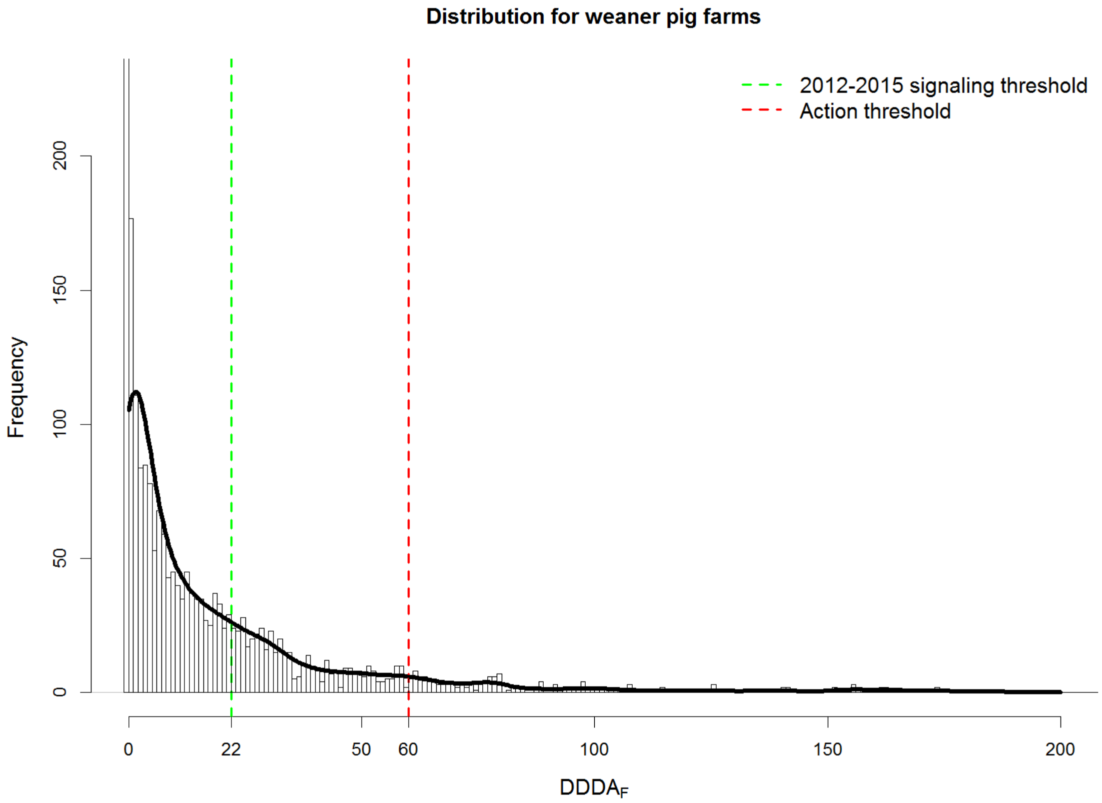
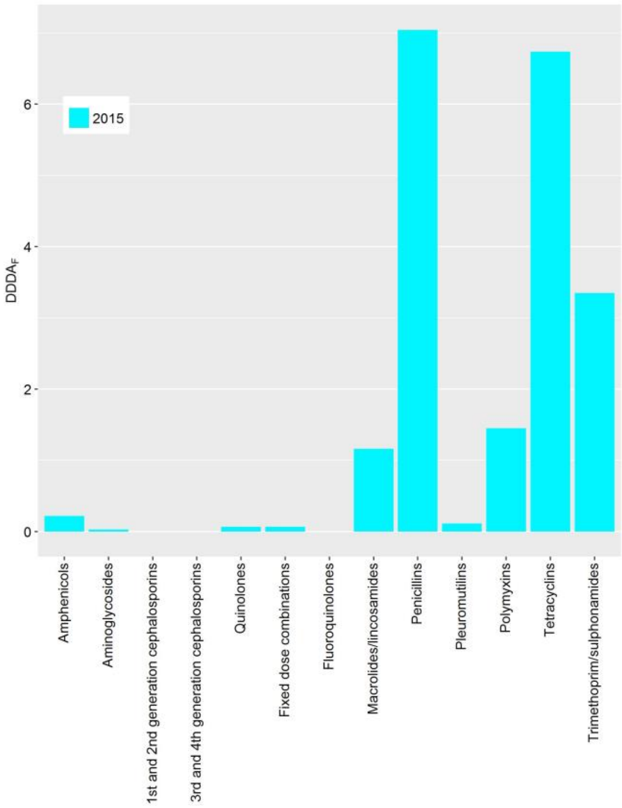


Figure A9. Mean antibiotic use at weaner pig farms in 2015, by ATCvet group (left) and by first-, second- and third-choice products (right)



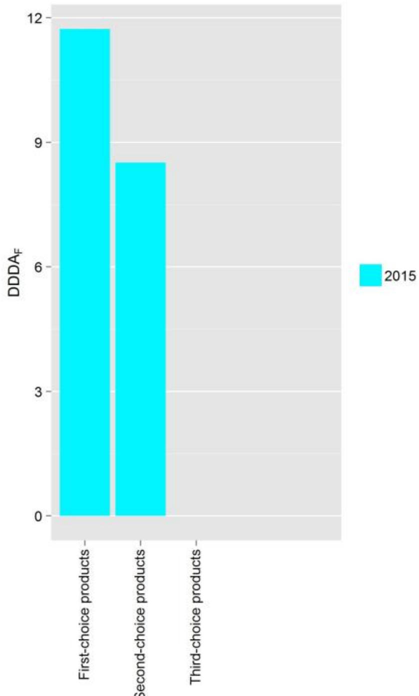


Table A14. Usage in $DDDA_F$ at weaner pig farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	$DDDA_F$ P75	$DDDA_F$ Mean
Amphenicols	Oral	2,271	0.00	0.00	0.01
Amphenicols	Parenteral	1,968	0.00	0.00	0.17
Aminoglycosides	Oral	2,261	0.00	0.00	0.03
Aminoglycosides	Parenteral	2,276	0.00	0.00	0.00
Quinolones	Oral	2,269	0.00	0.00	0.07
Quinolones	Parenteral	2,276	0.00	0.00	0.00
Fixed dose combinations	Oral	2,257	0.00	0.00	0.05
Fixed dose combinations	Parenteral	2,169	0.00	0.00	0.02
Fluoroquinolones	Oral	2,276	0.00	0.00	0.00
Fluoroquinolones	Parenteral	2,269	0.00	0.00	0.00
Macrolides/lincosamides	Oral	2,052	0.00	0.00	0.54
Macrolides/lincosamides	Parenteral	1,931	0.00	0.00	0.62
Penicillins	Oral	1,618	0.00	2.38	5.59
Penicillins	Parenteral	834	0.32	1.31	1.14
Pleuromutilins	Oral	2,239	0.00	0.00	0.11
Pleuromutilins	Parenteral	2,245	0.00	0.00	0.00
Polymyxins	Oral	1,760	0.00	0.00	1.29
Polymyxins	Parenteral	1,878	0.00	0.00	0.12
Tetracyclines	Oral	1,373	0.00	6.11	6.00
Tetracyclines	Parenteral	1,689	0.00	0.05	0.47
Trimethoprim/sulfonamides	Oral	1,451	0.00	2.09	3.26
Trimethoprim/sulfonamides	Parenteral	1,929	0.00	0.00	0.09

Pig fattening farms

Number of pig fattening farms: 5,072
Number of pig fattening farms with $DDDA_F$ = 0: 1,180
Number of pig fattening farms that used third- and fourth-generation cephalosporins: 0
Number of pig fattening farms that used fluoroquinolones: 5

Table A15. Usage of antibiotics in $DDDA_F$ at pig fattening farms in 2015

Year	N	Mean	Median	P75	P90
2015	5,072	4.1	1.6	5.4	10.2

Figure A10. $DDDA_F$ frequency distribution for 5,072 pig fattening farms in 2015

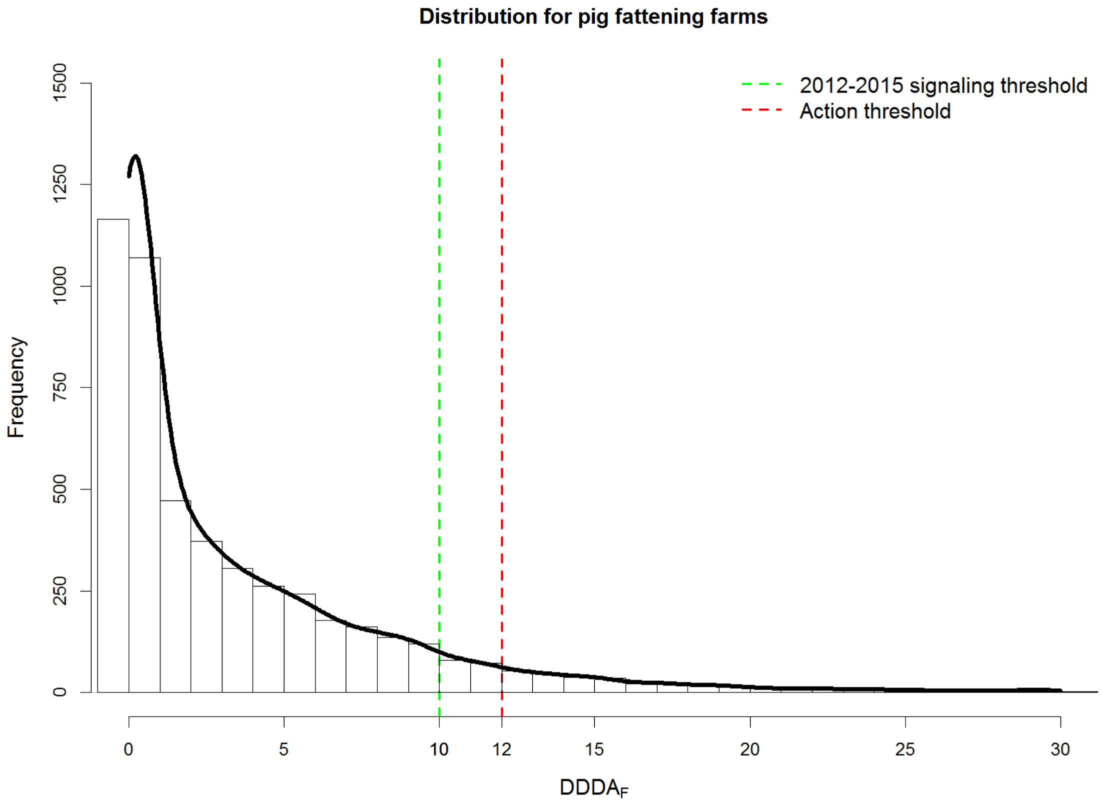


Figure A11. Mean antibiotic use at pig fattening farms in 2015, by ATCvet group (left) and by first-, second- and third-choice products (right)

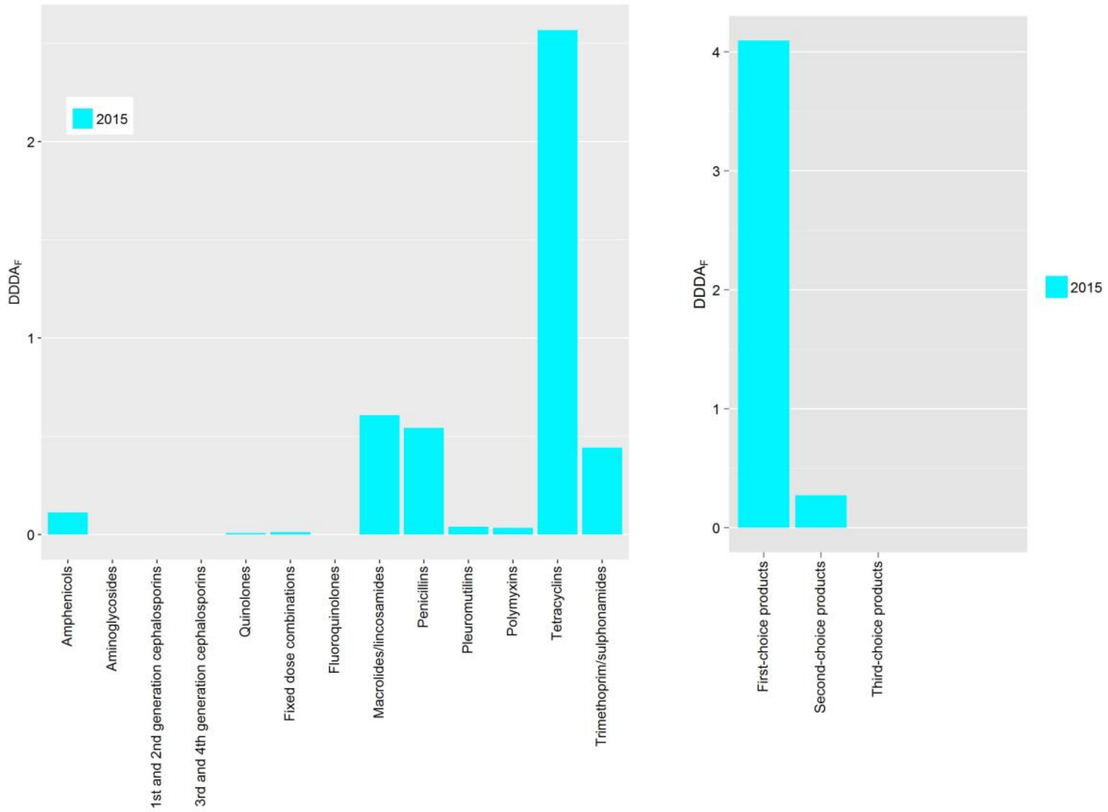


Table A16. Usage in $DDDA_F$ at pig fattening farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Oral	5,070	0.00	0.00	0.00
Amphenicols	Parenteral	4,015	0.00	0.00	0.11
Aminoglycosides	Oral	5,070	0.00	0.00	0.00
Aminoglycosides	Parenteral	5,072	0.00	0.00	0.00
Quinolones	Oral	5,055	0.00	0.00	0.01
Quinolones	Parenteral	5,072	0.00	0.00	0.00
Fixed dose combinations	Oral	5,053	0.00	0.00	0.01
Fixed dose combinations	Parenteral	4,954	0.00	0.00	0.01
Fluoroquinolones	Oral	5,072	0.00	0.00	0.00
Fluoroquinolones	Parenteral	5,067	0.00	0.00	0.00
Macrolides/lincosamides	Oral	4,029	0.00	0.00	0.58
Macrolides/lincosamides	Parenteral	4,421	0.00	0.00	0.02
Penicillins	Oral	4,894	0.00	0.00	0.08
Penicillins	Parenteral	1,802	0.10	0.35	0.34
Pleuromutilins	Oral	4,960	0.00	0.00	0.04
Pleuromutilins	Parenteral	4,876	0.00	0.00	0.00
Polymyxins	Oral	4,888	0.00	0.00	0.03
Polymyxins	Parenteral	4,908	0.00	0.00	0.00
Tetracyclines	Oral	2,903	0.00	2.59	2.16
Tetracyclines	Parenteral	2,675	0.00	0.17	0.23
Trimethoprim/sulfonamides	Oral	3,998	0.00	0.00	0.44
Trimethoprim/sulfonamides	Parenteral	4,995	0.00	0.00	0.00

Usage of antibiotics in $DDDA_F$ at poultry farms

Broiler farms

Number of broiler farms: 816
Number of broiler farms with $DDDA_F$ = 0: 210
Number of broiler farms that used third- and fourth-generation cephalosporins: 0
Number of broiler farms that used fluoroquinolones: 45

Table A17. Usage of antibiotics in $DDDA_F$ at broiler farms from 2013 to 2015

Year	N	Mean	Median	P75	P90
2013	770	11.5	8.8	17.7	26.6
2014	790	13.2	9.3	19.7	34.6
2015	816	12.2	7.2	17.9	30.5

Figure A12. $DDDA_F$ frequency distribution for 816 broiler farms in 2015

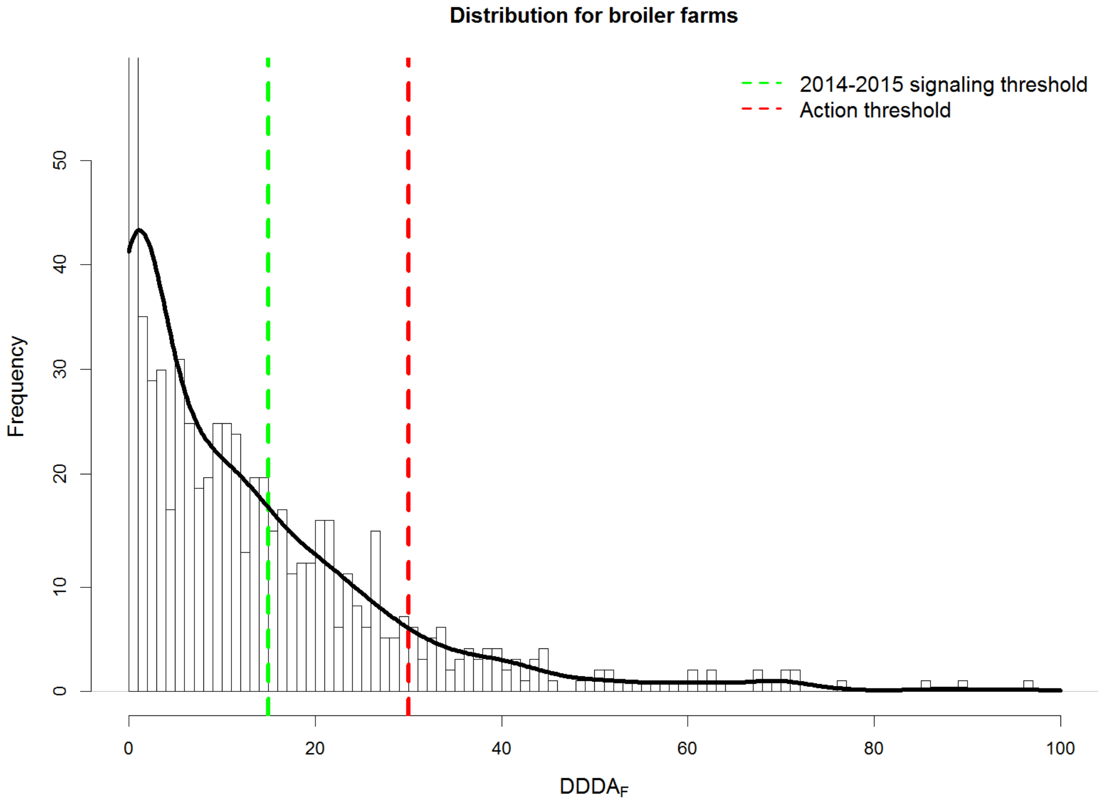


Table A18. Usage in $DDDA_F$ at broiler farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F$ = 0	$DDDA_F$		
			Median	P75	Mean
Aminoglycosides	Oral	804	0.00	0.00	0.02
Quinolones	Oral	588	0.00	1.72	2.43
Fixed dose combinations	Oral	759	0.00	0.00	0.08
Fluoroquinolones	Oral	771	0.00	0.00	0.07
Macrolides/lincosamides	Oral	692	0.00	0.00	0.36
Penicillins	Oral	359	2.79	10.06	6.86
Polymyxins	Oral	803	0.00	0.00	0.06
Tetracyclines	Oral	585	0.00	1.02	1.32
Trimethoprim/sulfonamides	Oral	382	0.28	1.30	1.00

Turkey farms

Number of turkey farms: 40
Number of turkey farms with $DDDA_F$ = 0: 0
Number of turkey farms that used third- and fourth-generation cephalosporins: 0
Number of turkey farms that used fluoroquinolones: 29

Table A19. Usage of antibiotics in $DDDA_F$ at turkey farms from 2013 to 2015

Year	N	Mean	Median	P75	P90
2013	48	21.9	18.5	30.8	41.6
2014	41	22.4	16.6	34.0	45.3
2015	40	25.9	18.9	33.3	59.5

Figure A13. $DDDA_F$ frequency distribution for 40 turkey farms in 2015

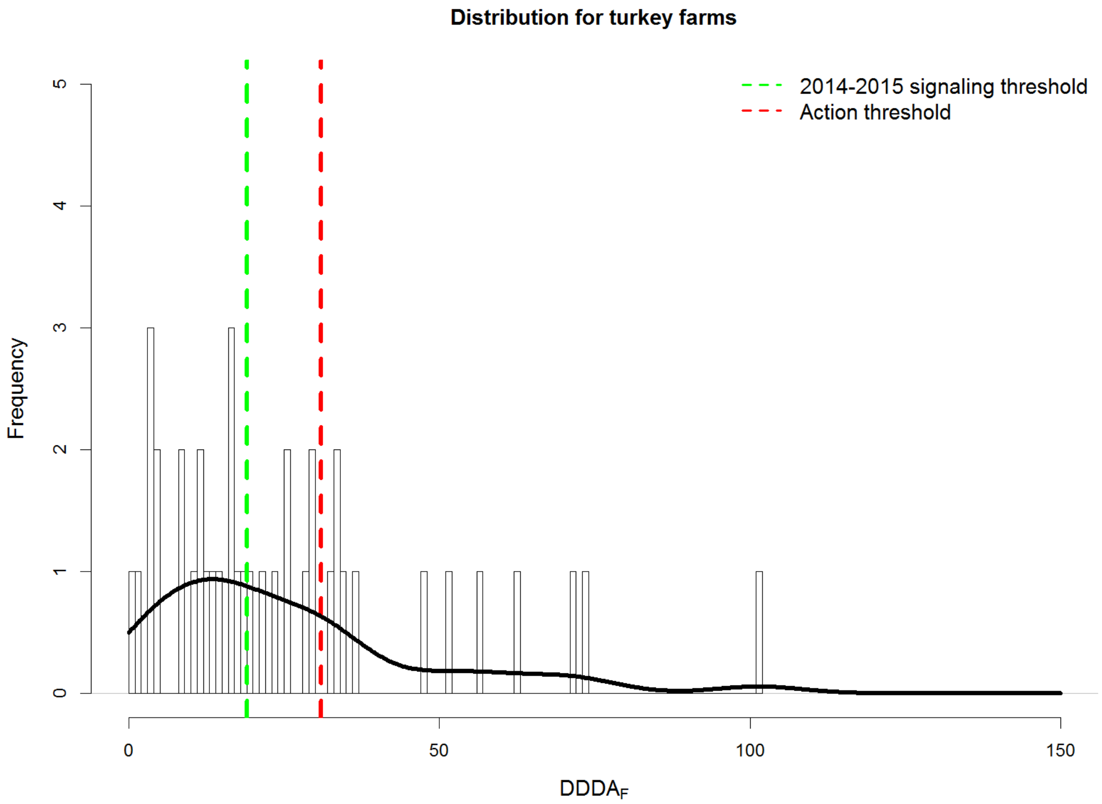


Figure A14. Mean antibiotic use at turkey farms in 2013, 2014 and 2015, by ATCvet group (left) and by first-, second- and third-choice products (right)

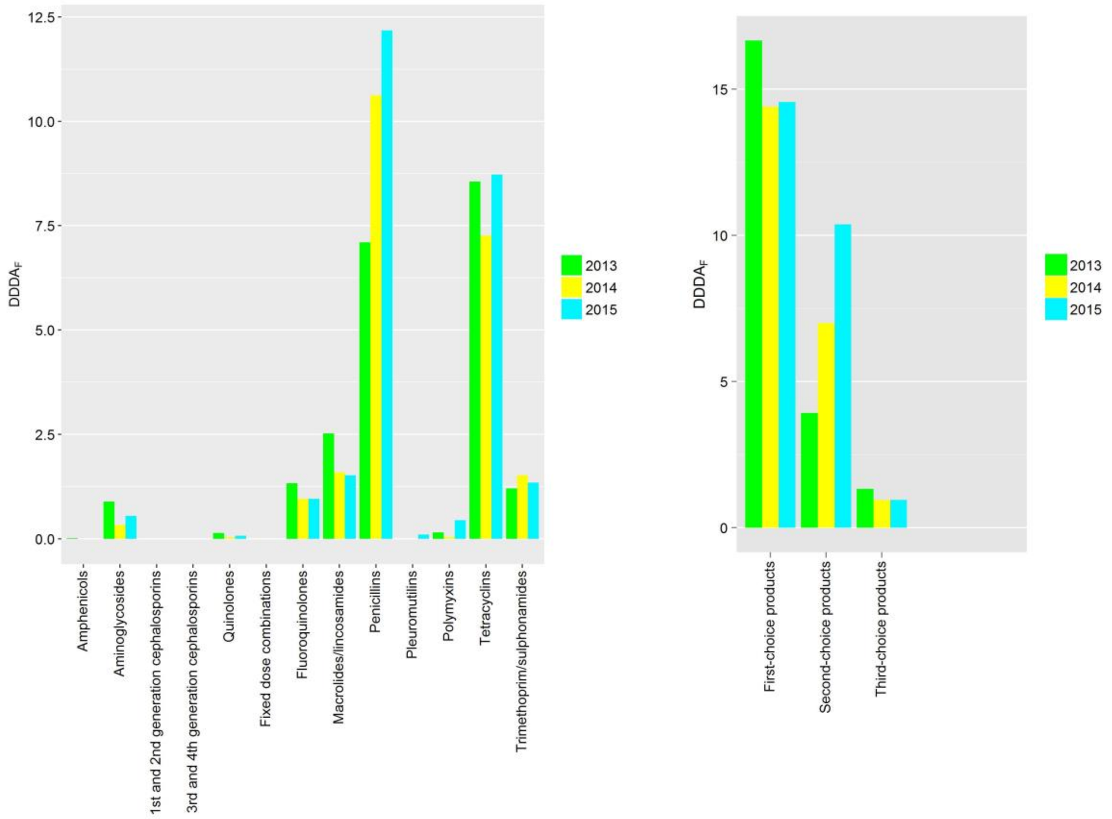


Table A20. Usage in $DDDA_F$ at turkey farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F$ = 0	$DDDA_F$ Median	P75	Mean
Amphenicols	Oral	35	0.00	0.00	0.55
Aminoglycosides	Oral	39	0.00	0.00	0.07
Quinolones	Oral	11	0.40	1.18	0.96
Fluoroquinolones	Oral	12	0.76	2.31	1.52
Macrolides/lincosamides	Oral	7	6.29	17.04	12.18
Penicillins	Oral	38	0.00	0.00	0.10
Polymyxins	Oral	30	0.00	0.05	0.45
Tetracyclines	Oral	10	6.61	14.74	8.72
Trimethoprim/sulfonamides	Oral	20	0.13	2.03	1.34

Usage of antibiotics in $DDDA_F$ at cattle farms

Dairy cattle farms

Number of dairy cattle farms: 17,737
Number of dairy cattle farms with $DDDA_F$ = 0: 227
Number of dairy cattle farms that used third- and fourth-generation cephalosporins: 333
Number of dairy cattle farms that used fluoroquinolones: 1,321

Table A21. Usage of antibiotics at dairy cattle farms from 2012 to 2015, presented as overall usage (A), usage of dry-cow (intramammary) antibiotics (B), usage of mastitis injectors (C), and usage of oral antibiotics in calves (D).

A **Overall usage, in $DDDA_F$**

Year	N	Mean	Median	P75	P90
2012	18,053	2.9	2.7	3.8	4.9
2013	18,005	2.8	2.8	3.7	4.7
2014	17,747	2.3	2.2	3.0	3.9
2015	17,737	2.2	2.1	2.9	3.7

B

Usage of dry-cow (intramammary) antibiotics, in $DDDA_F$ (animals >2 years of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,737	1.2	1.2	1.8	2.3

C

Usage of mastitis injectors, in $DDDA_F$ (animals >2 years of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,737	0.7	0.5	0.9	1.4

D

Usage of oral antibiotics in calves, in $DDDA_F$ (animals <56 days of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,737	3.7	0.0	0.0	6.2

Figure A15. $DDDA_F$ frequency distribution for 17,737 dairy cattle farms in 2015

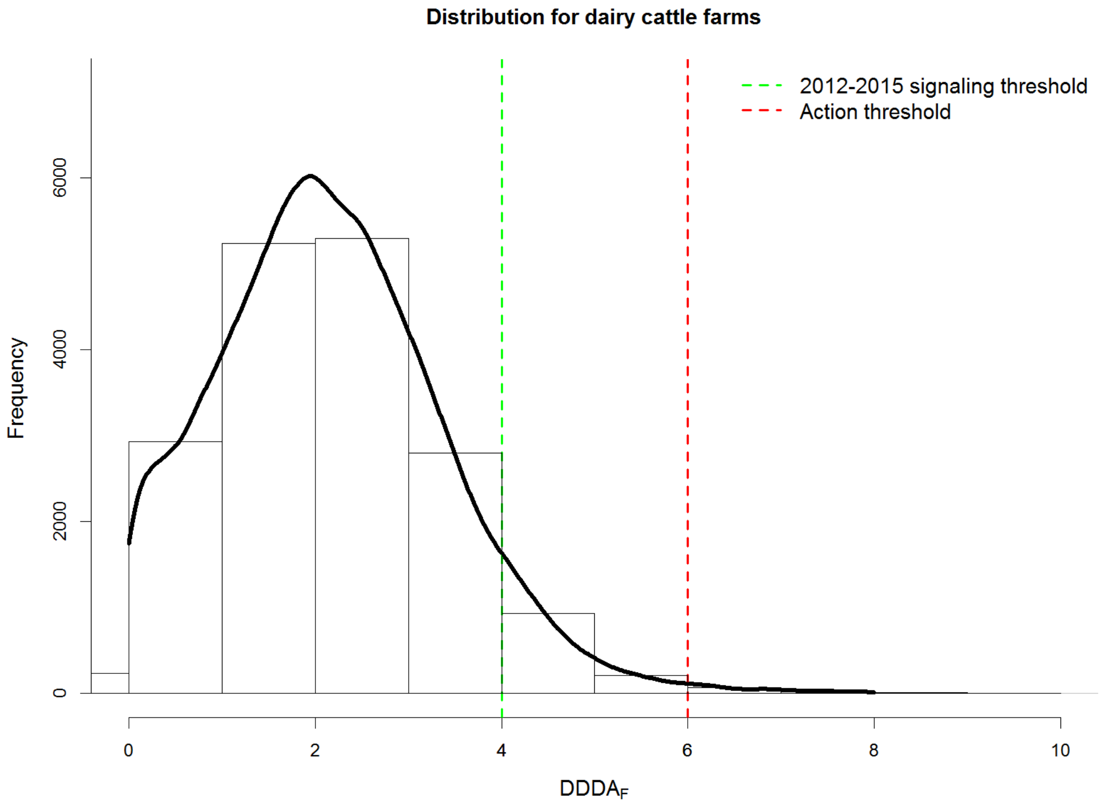


Table A22. Usage in $DDDA_F$ at dairy cattle farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Intramammary	17,737	0.00	0.00	0.00
Amphenicols	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Amphenicols	Oral	17,737	0.00	0.00	0.00
Amphenicols	Parenteral	9,567	0.00	0.05	0.03
Amphenicols	Intrauterine	17,737	0.00	0.00	0.00
Aminoglycosides	Intramammary	17,737	0.00	0.00	0.00
Aminoglycosides	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Aminoglycosides	Oral	16,902	0.00	0.00	0.00
Aminoglycosides	Parenteral	17,393	0.00	0.00	0.00
Aminoglycosides	Intrauterine	17,737	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary	17,291	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Oral	17,737	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Parenteral	17,737	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intrauterine	12,440	0.00	0.01	0.01
3rd- and 4th-gen. cephalosporins	Intramammary	17,437	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Oral	17,737	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Parenteral	17,686	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intrauterine	17,737	0.00	0.00	0.00
Quinolones	Intramammary	17,737	0.00	0.00	0.00
Quinolones	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Quinolones	Oral	17,732	0.00	0.00	0.00
Quinolones	Parenteral	17,737	0.00	0.00	0.00
Quinolones	Intrauterine	17,737	0.00	0.00	0.00
Fixed dose combinations	Intramammary	7,430	0.09	0.38	0.25
Fixed dose combinations	Intramammary for dry-cow therapy	17,318	0.00	0.00	0.01
Fixed dose combinations	Oral	17,725	0.00	0.00	0.00
Fixed dose combinations	Parenteral	12,773	0.00	0.02	0.02
Fixed dose combinations	Intrauterine	17,737	0.00	0.00	0.00

Fluoroquinolones	Intramammary	17,737	0.00	0.00	0.00
Fluoroquinolones	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Fluoroquinolones	Oral	17,732	0.00	0.00	0.00
Fluoroquinolones	Parenteral	16,418	0.00	0.00	0.00
Fluoroquinolones	Intrauterine	17,737	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary	17,438	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Macrolides/lincosamides	Oral	17,712	0.00	0.00	0.00
Macrolides/lincosamides	Parenteral	10,543	0.00	0.06	0.07
Macrolides/lincosamides	Intrauterine	17,737	0.00	0.00	0.00
Penicillins	Intramammary	5,396	0.15	0.37	0.25
Penicillins	Intramammary for dry-cow therapy	3,465	0.85	1.33	0.87
Penicillins	Oral	17,635	0.00	0.00	0.00
Penicillins	Parenteral	2,827	0.13	0.28	0.20
Penicillins	Intrauterine	17,737	0.00	0.00	0.00
Polymyxins	Intramammary	17,737	0.00	0.00	0.00
Polymyxins	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Polymyxins	Oral	17,303	0.00	0.00	0.00
Polymyxins	Parenteral	17,269	0.00	0.00	0.00
Polymyxins	Intrauterine	17,737	0.00	0.00	0.00
Tetracyclines	Intramammary	17,737	0.00	0.00	0.00
Tetracyclines	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Tetracyclines	Oral	17,052	0.00	0.00	0.01
Tetracyclines	Parenteral	3,518	0.11	0.23	0.17
Tetracyclines	Intrauterine	7,216	0.02	0.10	0.07
Trimethoprim/sulfonamides	Intramammary	17,737	0.00	0.00	0.00
Trimethoprim/sulfonamides	Intramammary for dry-cow therapy	17,737	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	15,812	0.00	0.00	0.01
Trimethoprim/sulfonamides	Parenteral	2,944	0.10	0.22	0.16
Trimethoprim/sulfonamides	Intrauterine	17,737	0.00	0.00	0.00

Suckler cow farms

Number of suckler cow farms: 9,305
Number of suckler cow farms with $DDDA_F$ = 0: 4,408
Number of suckler cow farms that used third- and fourth-generation cephalosporins: 9
Number of suckler cow farms that used fluoroquinolones: 100

Table A23. Usage of antibiotics in $DDDA_F$ at suckler cow farms from 2012 to 2015

Year	N	Mean	Median	P75	P90
2012	11,927	0.9	0.0	0.6	2.0
2013	9,857	0.7	0.1	0.8	2.2
2014	9,588	0.7	0.1	0.7	2.0
2015	9,305	0.6	0.1	0.7	2.0

Figure A16. $DDDA_F$ frequency distribution for 9,305 suckler cow farms in 2015

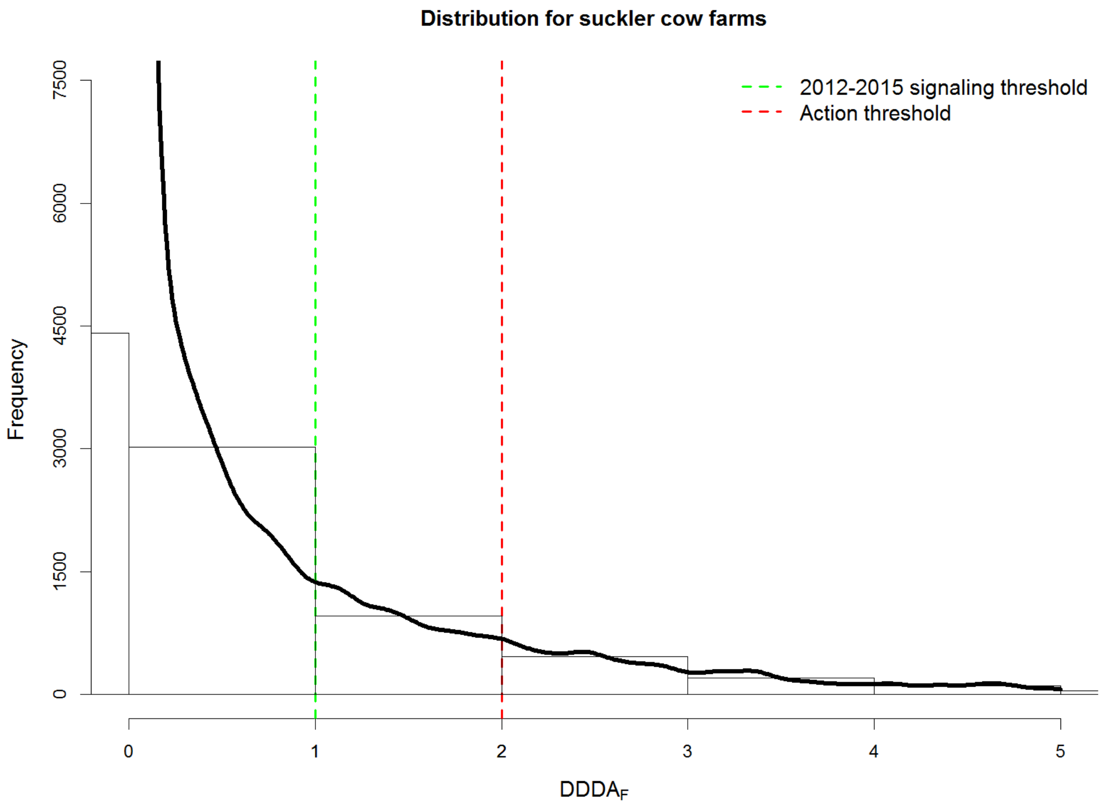


Table A24. Usage in $DDDA_F$ at suckler cow farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Intramammary	9,305	0.00	0.00	0.00
Amphenicols	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Amphenicols	Oral	9,305	0.00	0.00	0.00
Amphenicols	Parenteral	7,754	0.00	0.00	0.05
Amphenicols	Intrauterine	9,305	0.00	0.00	0.00
Aminoglycosides	Intramammary	9,305	0.00	0.00	0.00
Aminoglycosides	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Aminoglycosides	Oral	9,269	0.00	0.00	0.00
Aminoglycosides	Parenteral	9,242	0.00	0.00	0.00
Aminoglycosides	Intrauterine	9,305	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary	9,298	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Oral	9,305	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Parenteral	9,305	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intrauterine	9,177	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intramammary	9,300	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Oral	9,305	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Parenteral	9,301	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intrauterine	9,305	0.00	0.00	0.00
Fixed dose combinations	Intramammary	9,073	0.00	0.00	0.01
Fixed dose combinations	Intramammary for dry-cow therapy	9,297	0.00	0.00	0.00
Fixed dose combinations	Oral	9,304	0.00	0.00	0.00
Fixed dose combinations	Parenteral	8,084	0.00	0.00	0.10
Fixed dose combinations	Intrauterine	9,305	0.00	0.00	0.00
Fluoroquinolones	Intramammary	9,305	0.00	0.00	0.00
Fluoroquinolones	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Fluoroquinolones	Oral	9,305	0.00	0.00	0.00
Fluoroquinolones	Parenteral	9,205	0.00	0.00	0.00
Fluoroquinolones	Intrauterine	9,305	0.00	0.00	0.00

Macrolides/lincosamides	Intramammary	9,303	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Macrolides/lincosamides	Oral	9,301	0.00	0.00	0.00
Macrolides/lincosamides	Parenteral	8,620	0.00	0.00	0.02
Macrolides/lincosamides	Intrauterine	9,305	0.00	0.00	0.00
Penicillins	Intramammary	8,967	0.00	0.00	0.01
Penicillins	Intramammary for dry-cow therapy	9,002	0.00	0.00	0.04
Penicillins	Oral	9,287	0.00	0.00	0.00
Penicillins	Parenteral	6,165	0.00	0.18	0.24
Penicillins	Intrauterine	9,305	0.00	0.00	0.00
Polymyxins	Intramammary	9,305	0.00	0.00	0.00
Polymyxins	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Polymyxins	Oral	9,276	0.00	0.00	0.00
Polymyxins	Parenteral	9,194	0.00	0.00	0.00
Polymyxins	Intrauterine	9,305	0.00	0.00	0.00
Tetracyclines	Intramammary	9,305	0.00	0.00	0.00
Tetracyclines	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Tetracyclines	Oral	9,209	0.00	0.00	0.01
Tetracyclines	Parenteral	7,674	0.00	0.00	0.06
Tetracyclines	Intrauterine	7,675	0.00	0.00	0.04
Trimethoprim/sulfonamides	Intramammary	9,305	0.00	0.00	0.00
Trimethoprim/sulfonamides	Intramammary for dry-cow therapy	9,305	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	9,127	0.00	0.00	0.01
Trimethoprim/sulfonamides	Parenteral	8,057	0.00	0.00	0.02
Trimethoprim/sulfonamides	Intrauterine	9,305	0.00	0.00	0.00

Rearing farms

Number of rearing farms: 470
Number of rearing farms with $DDDA_F$ = 0: 333
Number of rearing farms that used third- and fourth-generation cephalosporins: 0
Number of rearing farms that used fluoroquinolones: 5

Table A25. Usage of antibiotics in $DDDA_F$ at rearing farms from 2013 to 2015

Year	N	Mean	Median	P75	P90
2012*	-	-	-	-	-
2013	472	1.1	0.0	0.2	2.3
2014	474	1.4	0.0	0.2	1.8
2015	470	0.8	0.0	0.2	1.7

* Rearing and beef farms were grouped together for 2012, as the available data did not allow for categorization based on sex.

Figure A17. $DDDA_F$ frequency distribution for 470 rearing farms in 2015

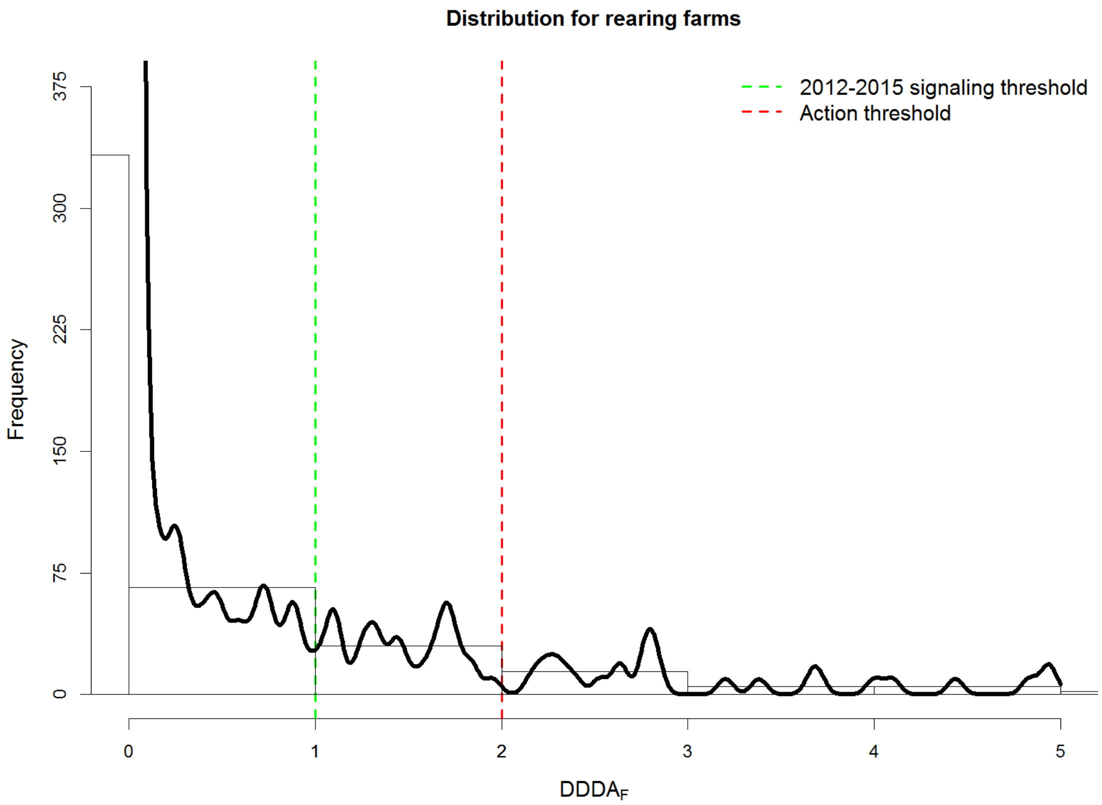


Table A26. Usage in $DDDA_F$ at rearing farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	P75	Mean
Amphenicols	Oral	470	0.00	0.00	0.00
Amphenicols	Parenteral	390	0.00	0.00	0.20
Amphenicols	Intrauterine	470	0.00	0.00	0.00
Aminoglycosides	Oral	468	0.00	0.00	0.00
Aminoglycosides	Parenteral	467	0.00	0.00	0.00
Aminoglycosides	Intrauterine	470	0.00	0.00	0.00
Quinolones	Oral	469	0.00	0.00	0.00
Quinolones	Parenteral	470	0.00	0.00	0.00
Quinolones	Intrauterine	470	0.00	0.00	0.00
Fixed dose combinations	Oral	470	0.00	0.00	0.00
Fixed dose combinations	Parenteral	458	0.00	0.00	0.01
Fixed dose combinations	Intrauterine	470	0.00	0.00	0.00
Fluoroquinolones	Oral	470	0.00	0.00	0.00
Fluoroquinolones	Parenteral	465	0.00	0.00	0.00
Fluoroquinolones	Intrauterine	470	0.00	0.00	0.00
Macrolides/lincosamides	Oral	465	0.00	0.00	0.03
Macrolides/lincosamides	Parenteral	436	0.00	0.00	0.04
Macrolides/lincosamides	Intrauterine	470	0.00	0.00	0.00
Penicillins	Oral	469	0.00	0.00	0.01
Penicillins	Parenteral	399	0.00	0.00	0.13
Penicillins	Intrauterine	470	0.00	0.00	0.00
Polymyxins	Oral	467	0.00	0.00	0.01
Polymyxins	Parenteral	467	0.00	0.00	0.00
Polymyxins	Intrauterine	470	0.00	0.00	0.00
Tetracyclines	Oral	452	0.00	0.00	0.19
Tetracyclines	Parenteral	438	0.00	0.00	0.04
Tetracyclines	Intrauterine	469	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	465	0.00	0.00	0.05
Trimethoprim/sulfonamides	Parenteral	434	0.00	0.00	0.04
Trimethoprim/sulfonamides	Intrauterine	470	0.00	0.00	0.00

Beef farms

Number of beef farms: 3,196
Number of beef farms with $DDDA_F = 0$: 2,051
Number of beef farms that used third- and fourth-generation cephalosporins: 1
Number of beef farms that used fluoroquinolones: 30

Table A27. Usage of antibiotics in $DDDA_F$ at beef farms from 2013 to 2015

Year	N	Mean	Median	P75	P90
2012*	-	-	-	-	-
2013	3,316	1.8	0.0	0.6	4.2
2014	3,297	1.7	0.0	0.5	4.4
2015	3,196	1.5	0.0	0.4	2.9

* Beef and rearing farms were grouped together for 2012, as the available data did not allow for categorization based on sex.

Figure A18. $DDDA_F$ frequency distribution for 3,196 beef farms in 2015

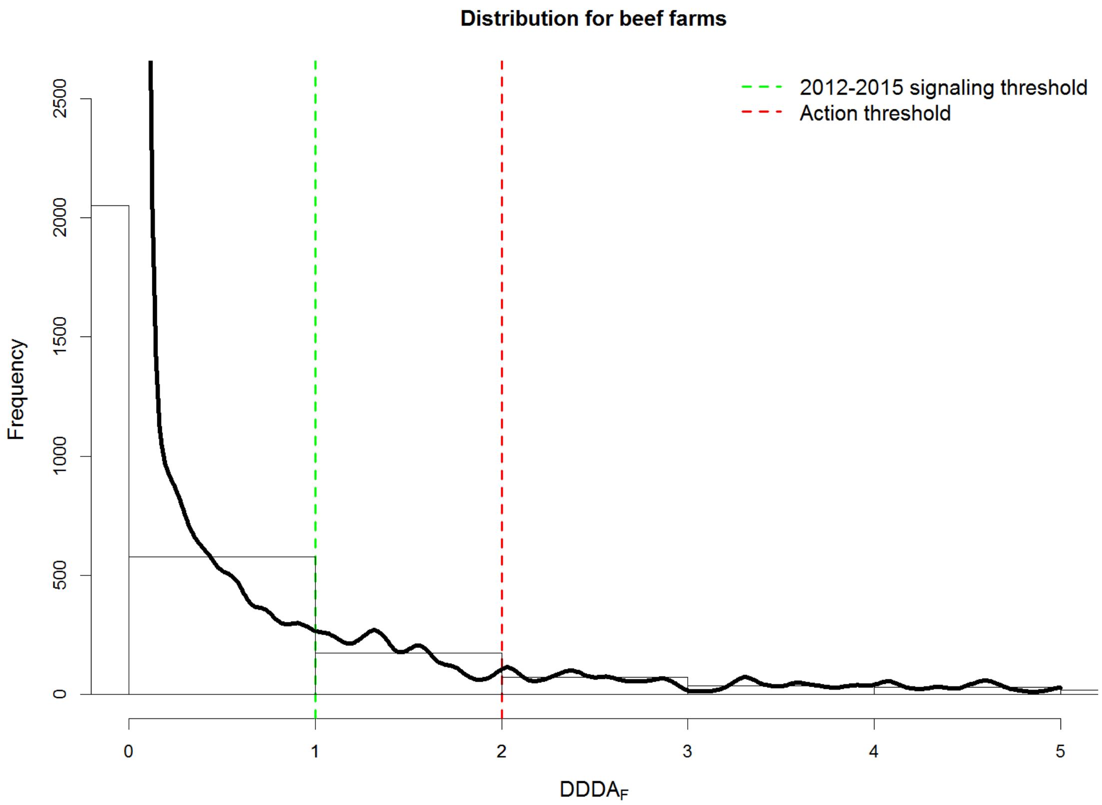


Table A28. Usage in $DDDA_F$ at beef farms in 2015, by ATCvet group and route of administration

ATCvet group	Route of administration	# of farms with $DDDA_F = 0$	$DDDA_F$ Median	$DDDA_F$ P75	$DDDA_F$ Mean
Amphenicols	Intramammary	3,196	0.00	0.00	0.00
Amphenicols	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Amphenicols	Oral	3,196	0.00	0.00	0.00
Amphenicols	Parenteral	2,416	0.00	0.00	0.18
Amphenicols	Intrauterine	3,196	0.00	0.00	0.00
Aminoglycosides	Intramammary	3,196	0.00	0.00	0.00
Aminoglycosides	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Aminoglycosides	Oral	3,128	0.00	0.00	0.01
Aminoglycosides	Parenteral	3,152	0.00	0.00	0.00
Aminoglycosides	Intrauterine	3,196	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary	3,195	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Oral	3,196	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Parenteral	3,196	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	Intrauterine	3,187	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intramammary	3,196	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Oral	3,196	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Parenteral	3,195	0.00	0.00	0.00
3rd- and 4th-gen. cephalosporins	Intrauterine	3,196	0.00	0.00	0.00
Quinolones	Intramammary	3,196	0.00	0.00	0.00
Quinolones	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Quinolones	Oral	3,168	0.00	0.00	0.02
Quinolones	Parenteral	3,196	0.00	0.00	0.00
Quinolones	Intrauterine	3,196	0.00	0.00	0.00
Fixed dose combinations	Intramammary	3,178	0.00	0.00	0.00
Fixed dose combinations	Intramammary for dry-cow therapy	3,194	0.00	0.00	0.00
Fixed dose combinations	Oral	3,194	0.00	0.00	0.00
Fixed dose combinations	Parenteral	3,049	0.00	0.00	0.01
Fixed dose combinations	Intrauterine	3,196	0.00	0.00	0.00

Fluoroquinolones	Intramammary	3,196	0.00	0.00	0.00
Fluoroquinolones	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Fluoroquinolones	Oral	3,195	0.00	0.00	0.00
Fluoroquinolones	Parenteral	3,167	0.00	0.00	0.00
Fluoroquinolones	Intrauterine	3,196	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary	3,196	0.00	0.00	0.00
Macrolides/lincosamides	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Macrolides/lincosamides	Oral	2,966	0.00	0.00	0.24
Macrolides/lincosamides	Parenteral	2,755	0.00	0.00	0.04
Macrolides/lincosamides	Intrauterine	3,196	0.00	0.00	0.00
Penicillins	Intramammary	3,173	0.00	0.00	0.00
Penicillins	Intramammary for dry-cow therapy	3,172	0.00	0.00	0.00
Penicillins	Oral	3,106	0.00	0.00	0.06
Penicillins	Parenteral	2,399	0.00	0.00	0.12
Penicillins	Intrauterine	3,196	0.00	0.00	0.00
Polymyxins	Intramammary	3,196	0.00	0.00	0.00
Polymyxins	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Polymyxins	Oral	3,174	0.00	0.00	0.01
Polymyxins	Parenteral	3,114	0.00	0.00	0.00
Polymyxins	Intrauterine	3,196	0.00	0.00	0.00
Tetracyclines	Intramammary	3,196	0.00	0.00	0.00
Tetracyclines	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Tetracyclines	Oral	2,858	0.00	0.00	0.61
Tetracyclines	Parenteral	2,804	0.00	0.00	0.04
Tetracyclines	Intrauterine	3,042	0.00	0.00	0.01
Trimethoprim/sulfonamides	Intramammary	3,196	0.00	0.00	0.00
Trimethoprim/sulfonamides	Intramammary for dry-cow therapy	3,196	0.00	0.00	0.00
Trimethoprim/sulfonamides	Oral	2,990	0.00	0.00	0.14
Trimethoprim/sulfonamides	Parenteral	2,803	0.00	0.00	0.02
Trimethoprim/sulfonamides	Intrauterine	3,196	0.00	0.00	0.00

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